AN ABSTRACT OF THE DISSERTATION

Waleed F. Manzour for the degree of Doctor of Philosophy in Human Performance presented on May 4, 2000. Title: Isolated Anterior Cruciate Ligament Deficiency: Comparison of Results Following Acute and Chronic Arthroscopic Reconstruction with Patellar Tendon Autograft.

Abstract approved: _____

Rod A. Harter

Isolated injury of the anterior cruciate ligament (ACL) is less frequent and typically perceived as less severe than ACL injuries with concurrent damage to other knee stabilizing structures. The timing of the ACL reconstructive surgery is thought to be a critical factor that affects the patient's postoperative outcome. No previous study has compared the results of acute reconstruction (interval between injury and surgery less than or equal to 3 months) and chronic reconstruction (interval between injury and surgery greater than 3 months) of isolated ruptures of the ACL. The primary aim of this study was to assess the differences in functional outcomes between two distinct patient populations treated using the same surgical intervention. The secondary aim of this study was to determine which functional outcome variables differed between the acute isolated and chronic isolated patient populations in order to identify the etiology of any long-term functional impairment. Two separate investigations were conducted to address these questions. The first study evaluated the efficacy of an arthroscopic-assisted surgical technique using an autogenous substitute for the ACL in a group of patients who had surgery more than 3 months after isolated injury to their ACL. Fifty-five patients from Cairo, Egypt (mean age, 27.1 $\pm$ 4.5 years) underwent ACL reconstruction an average of

7.0 $\pm$ 2.6 months (range, 3.3 to 16.6 months) after injury. Patients were evaluated at an average of 2.2 $\pm$ .3 years postoperatively (range, 2.0 to 3.4 years) using a battery of objective and subjective tests. No significant differences were observed between the patients' surgical and contralateral normal knees ($p > .05$). International Knee Documentation Committee (IKDC) scores questionnaire rated 48 of 55 patients (87.3%) as "normal", 5 patients (9.1%) as "nearly normal" and 2 patients (3.6%) as "abnormal"; no patients were categorized as "severely abnormal". The second investigation evaluated the effect of timing of surgery on functional outcomes. From a group of 773 arthroscopic-assisted ACL reconstruction patients in Cairo, Egypt, 200 of 234 patients (mean age, 32.2 $\pm$ 6.9 yrs.) with isolated ACL injuries participated in this study. Subjects were assigned to groups based on the interval between ACL injury and surgery. Patients in the acute reconstruction group ($n = 100$) had surgery an average of 62 days postinjury, while the chronic reconstruction group ($n = 100$) had surgery an average of 211 days postinjury. The mean follow-up period was 2.2 $\pm$ 0.3 years (range, 2.0 to 3.8 years) for all subjects. There were statistically significant differences between the acute and chronic group in the final score (χ^2 2= 6.43 with $p = 0.04$). IKDC scores rated 62% of the acute and 58% of chronic group patients as "normal", 37% of acute and 38% of chronic group patients as "near normal", and 1% of acute and 4% of chronic group knees as "abnormal". Delaying the ACL reconstruction to allow for reduction of the acute inflammatory process and participation in pre-operative rehabilitation resulted in fewer cases of postoperative arthrofibrosis in the chronic group compared to the acute group. However, delays of surgery more than 3 months between isolated injury of the ACL and surgical reconstruction resulted in greater frequency of arthritic changes.

ISOLATED ANTERIOR CRUCIATE LIGAMENT DEFICIENCY: COMPARISON OF RESULTS FOLLOWING ACUTE AND CHRONIC ARTHROSCOPIC RECONSTRUCTION WITH PATELLAR TENDON AUTOGRAFT.

By

Waleed F. Manzour

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DEDICATIONS

To *the Manzour family, who built themselves with months and years of endless hard work, facing life's challenges, persevering, succeeding and becoming one of the greatest families in Cairo, I am very proud to be a member of this family.*

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Without struggle there is no progress

ISOLATED ANTERIOR CRUCIATE LIGAMENT DEFICIENCY: COMPARISON OF RESULTS FOLLOWING ACUTE AND CHRONIC ARTHROSCOPIC RECONSTRUCTION WITH PATELLAR TENDON AUTOGRAFT.

CHAPTER I
INTRODUCTION

The importance of the anterior cruciate ligament in the maintenance of stability of the knee is well known. Rupture of the anterior cruciate ligament diminishes the stability of the knee, impairs athletic performance and increases the risk of subsequent meniscal injury[4, 38,64] and increased risk of early degenerative joint disease. [4, 33, 37,38, 48,50,54.]

Efforts to reconstruct the anterior cruciate ligament over the past 100 years have resulted in improved surgical techniques, specifically arthroscopic-assisted autogenous reconstruction of the anterior cruciate ligament using the central one-third of the patient's patellar tendon[84].

Anterior cruciate ligament injuries are common, with the greatest number of these injuries occurring in sports activities, principally those that involve deceleration, twisting, cutting, and jumping movements. Because of the variability of patient impairment after an anterior cruciate ligament injury and the lack of documentation that anterior cruciate ligament reconstructive surgery prevents osteoarthritis, there is controversy over the indications for ligament surgery[38]. There are two general categories of treatment of anterior cruciate ligament lesions: non-operative treatment and operative treatment, e.g., reconstruction with autograft, allograft or prosthetic materials. Arthroscopic reconstruction of the anterior cruciate ligament using the central one third

of the patellar tendon, which has had highly satisfactory results, is the treatment of choice.[6,32,7,17,23,41,46,81,83]

Controversies exist over whether the most suitable period for reconstructing the anterior cruciate ligament is at the early stage immediately post-injury or after the joint inflammation has disappeared. Late (three weeks from the injury) anterior cruciate ligament reconstruction, using a patellar tendon free bone-tendon-bone graft, has been reported by Shelbourne and his colleagues to provide highly satisfactory results[84]. O'Brien et al.[72] and Clancy et al.[23] have shown satisfactory clinical and laxity testing results in more than 93% of their cases.

Recent advances in orthopaedic surgery instrumentation and anterior cruciate ligament fixation have facilitated more anatomically accurate graft placement and stronger fixation[3], which has permitted earlier, more aggressive rehabilitation. The advent of arthroscopically-assisted anterior cruciate ligament reconstruction techniques lessened tissue morbidity and enhanced immediate rehabilitation[6]. In addition, early aggressive postoperative care, consisting of immediate passive motion, immediate protected weight bearing, and more rapid return to functional activities[15], has shortened the previously long rehabilitation process.

The natural history of surgically untreated anterior cruciate ligament tears may provide a guideline in both preventive and curative treatment. The treatment of individuals who have suffered an anterior cruciate ligament disruption has changed dramatically over the past 50 years. The treatment of anterior cruciate ligament has made a full circle from the original description of the reconstruction by Campbell[19] using the patellar tendon as a graft.

Most published reports with anterior cruciate ligament ruptures involve patients with concomitant tibiofemoral joint injuries.[74, 80,81,84,86,88] The combination of anterior cruciate ligament with meniscal damage or other ligamentous damage is most common.[38,60,81,84,86,88] Re-injury data are not comparable for the same reason, because existing studies do not specify whether certain physical activities were avoided or permitted.

Analysis of the knee injury and physical findings after the injury, followed by early arthroscopic examination combined with examination of the knee under anesthesia, provides precise information regarding anterior cruciate ligament injury. This early examination regimen demonstrated that isolated anterior cruciate ligament damage does occur.

The timing of surgical intervention in anterior cruciate ligament deficient knee has received considerable attention. Shelbourne and Nitz [82] and Hamer et al. [46] independently concluded that the incidence of knee flexion contractures and postoperative stiffness of the knee were significantly decreased when surgery was deferred until three or four weeks after anterior cruciate ligament injury.

Recent work reported by Shelbourne et al. [84] suggested that delaying anterior cruciate ligament reconstruction for more than three weeks after acute injury might decrease the incidence of arthrofibrosis. This study's sample consisted entirely of patients who underwent anterior cruciate ligament reconstruction with the central third of the patellar tendon autograft[84].

The two research studies that are combined to form this dissertation compared the clinical outcomes of anterior cruciate ligament reconstruction using the patellar tendon

autograft technique at two or more years after surgery. These studies are unique for two reasons: (a) all subjects sustained an isolated anterior cruciate ligament injury (patients with associated injuries were excluded to control for confounding features that may have affected the outcomes), and (b) the arthroscopic reconstruction surgical technique used for all patients employed the same autogenous patellar tendon graft technique, including the methods for determining graft placement location, graft fixation technique, and postoperative rehabilitation program.

Most of the literature pertaining to anterior cruciate ligament compares the injured or post-surgical knee with their normal (contralateral) knee in a retrospective manner. [29,36,38,39]. These studies analyzed the functional abilities of patients with chronic anterior cruciate ligament disruptions with knee symptoms, mixed patient populations with acute or chronic injuries, patients with failed anterior cruciate ligament repairs, and patient populations gleaned from surgical logs or hospital records[2,6,7].

There are many key points that can be extrapolated from the outcomes of accelerated anterior cruciate ligament rehabilitation reported by Shelbourne and Nitz [76]. First, it appears that the patients who were treated sooner with surgery exhibited better results. These patients exhibited improved muscular strength at 3, 6, and 12 months postoperatively; greater range of motion; and better stability during objective knee laxity testing than those patients did not have an accelerated anterior cruciate ligament rehabilitation. The patients who were treated with the accelerated rehabilitation program had a lower incidence of tibiofemoral arthrofibrosis (4 per cent) compared to the conventional rehabilitation program (12 per cent) [84].

In addition to improved postsurgical results, the anterior cruciate ligament subjects in the Shelbourne study experienced lesser incidence of joint stiffness, less patellofemoral pain and other symptoms, and, overall, were more satisfied with their outcomes. Secondly, Shelbourne and Nitz[76] pointed out a critical issue of patient compliance and motivation, observing that compliance with the rehabilitation program is critical to the ultimate success of the surgery[76]. They documented that the program must be dynamic and measurable to continually challenge the patient and that this may improve patient compliance.

Significance of the Study

Active individuals who have a torn anterior cruciate ligament are frequently troubled by chronic instability and recurrent episodes of giving-way, which often are associated with intra-articular injuries. The timing of the anterior cruciate ligament reconstruction surgery is a critical factor that influences the functional outcome. If anterior cruciate ligament reconstruction is delayed and patients attempt to increase their activity levels in the presence of symptomatic anterior cruciate ligament deficiency, the resultant chronic condition may represent a different clinical entity than existed with the acute anterior cruciate ligament deficiency. Progressive instability and further loss of secondary static restraints may result during the interval between injury to surgery from the patient's attempts to increase activity or unwillingness to modify such activity.

Statement of the Problem

Recently, Barber-Westin et al. [8] concluded that the overall functional rating of chronic anterior cruciate ligament injury patients should not be done in the same categorical manner as acute anterior cruciate ligament injury patients since those with chronic injuries may already have concomitant problems that cannot be corrected with anterior cruciate ligament reconstruction. The first investigation (Chapter Two) was conducted to evaluate the surgical reconstruction of the anterior cruciate ligament using autogenous bone-tendon-bone free graft using the central one third of the patellar tendon for anterior cruciate ligament reconstruction in a group of patients who underwent surgical reconstruction at least 3 months from the date of their isolated anterior cruciate ligament injury.

The second study (Chapter three) was designed to identify the optimal time interval between anterior cruciate ligament injury and anterior cruciate ligament surgical reconstruction. Additionally, to determine the differences in International Knee Documentation Committee knee ligament questionnaire scores functional outcomes between two distinct patient populations treated using the same surgical intervention and to recognize which functional outcome variables differ between the acute isolated and chronic isolated patient populations in order to know the etiology of any long-term functional impairment after anterior cruciate ligament reconstruction. To answer these questions we compared isolated-anterior cruciate ligament lesion patients who had surgical reconstruction within 3 months post-injury (acute surgery group) to isolated-anterior cruciate ligament lesion patients who had surgical reconstruction longer than 3 months from the date of their anterior cruciate ligament injury (chronic surgery group).

To the best of our knowledge, no previous study has compared the objective and subjective findings in this large of a group of isolated anterior cruciate ligament patients.

Chapter Two consists of the manuscript entitled "Arthroscopic-Assisted Reconstruction For Chronic Isolated Anterior Cruciate Ligament Rupture" to be submitted for publication in the American volume of the *Journal of Bone and Joint Surgery.* The study is primarily a descriptive, retrospective study of a group of fifty-five patients who underwent arthroscopic-assisted anterior cruciate ligament reconstruction. The results of this study were presented at the 46th Annual Meeting of the American College of Sports Medicine in Seattle, Washington on June 3, 1999. An abstract of this paper was published in the May 1999 supplement issue of *Medicine and Science in Sports and Exercise*, Volume 31, page S147.

Chapter Three, a manuscript entitled "Isolated Anterior Cruciate Ligament Deficiency: Comparison of Results Following Acute and Chronic Arthroscopic Reconstruction with Patellar Tendon Autograft" will also be submitted for publication in the American volume of the *Journal of Bone and Joint Surgery.* It was hypothesized that patients undergoing arthroscopically assisted techniques of acute isolated anterior cruciate ligament reconstruction (interval between injury and surgery less than or equal to 3 months) have better functional outcomes, represented by higher IKDC knee ligament questionnaire scores, than the chronic isolated group (interval between injury and surgery greater than 3 months). It is also believed that any observed differences in functional outcomes between the acute and chronic isolated groups will be identified by decreased IKDC scores which are usually associated with arthritic changes category for the chronic isolated group. An abstract of this study was published in the May 2000 supplement issue of *Medicine and Science in Sports and Exercise* Volume 32, page S207. The

abstract of this study has been accepted for oral presentation at the 47th Annual Meeting of the American College of Sports Medicine in Indianapolis, Indiana on June 2, 2000.

CHAPTER 2

ARTHROSCOPIC-ASSISTED RECONSTRUCTION FOR CHRONIC ISOLATEDANTERIOR CRUCIATE LIGAMENT RUPTURE

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ABSTRACT

Background: Isolated injury to the anterior cruciate ligament is perceived as a less frequent and less severe problem than the more typical anterior cruciate ligament injury that involves other static stabilizers. Patients with isolated anterior cruciate ligament lesions are uncomplicated by concomitant injuries to surrounding knee joint structures, and thus provide a unique forum for evaluating the efficacy of our arthroscopic-assisted technique. The purpose of this study was to evaluate the outcome of surgical reconstruction for anterior cruciate ligament rupture to determine the differences in International Knee Documentation Committee knee ligament questionnaire scores functional outcomes in patients who had surgery at least three months from the date of their injury using an autogenous bone-tendon-bone free graft of the central one-third of the patellar tendon.

Methods: We evaluated fifty-five (fifty-two male and three female) patients who had undergone arthroscopic-assisted autogenous patellar tendon anterior cruciate ligament reconstruction for isolated injury, at an average of 7.0$\pm$ 2.6 months between injury and surgery (range, 3.3 to 16.6 months). The patients were evaluated at an average of 2.2 years postoperatively (range, 2.0 to 3.4 years) using a battery of objective and subjective tests. These measures included the patient's subjective assessment of activity, symptoms, KT-2000 arthrometer values, radiographs, clinical laxity tests, and range of motion, and the International Knee Documentation Committee knee ligament questionnaire and Lysholm knee rating scale scores.

Results: There were no significant differences between the surgical and contralateral normal limbs on any of the eight subjective parameters ($p > .05$). Knee arthrometer

testing at 134N revealed surgical to contralateral normal knee differences less than or equal to three millimeters in forty-seven of fifty-five patients (85.4 percent), between three and five millimeters in seven patients (12.7 percent), and greater than five millimeters in one patient (1.8 percent). Radiographically, fifty-two patients (94 percent) had no joint space narrowing. At the follow-up examination, a negative pivot shift was noted in fifty-one patients (92 percent), and grade 1+ in four patients (7.3 percent). The International Knee Documentation Committee scores rated forty-eight of fifty-five patients (88.3 percent) as "normal", five patients (9.1 percent) as "nearly normal" and two patients 3.6 percent as "abnormal", no patients scored "severely abnormal" in the final evaluation. The mean Lysholm score was 91.3 of a possible 100, with fifty-two of fifty-five patients (94.5 percent) scoring in the "excellent" category (95 points or more), three patients (5.5 percent) scoring in the "good" category (84-94 points); none of the patients scored less than "good".

Conclusion: Based on the final International Knee Documentation Committee and Lysholm scores we found, chronic reconstruction of isolated rupture of the anterior cruciate ligament using the arthroscopic reconstruction with the central one-third of the patellar tendon successfully restored joint stability and range of motion, to that of the contralateral normal knee, and patients generally returned to full activity and function. These post-operative results are better than those reported previously in chronic injury patients population with non-isolated anterior cruciate ligaments lesions.

INTRODUCTION

Chronic instability of the knee with recurrent episodes of giving way frequently troubles individuals with torn anterior cruciate ligaments and often results in other intra-articular injuries [3,8, 10,13,14,20]. Many published reports have focused only on results of patients treated with reconstructive surgery for chronic anterior cruciate ligament deficiency associated with other injuries.[1,7,17,18,19]

Several investigators have observed that the natural history of the anterior cruciate ligament deficient knee ultimately includes osteoarthritis and functional disability[5, 6]. Additionally, chronic knee instability is associated with frequent meniscal lesions [9] and early osseous degenerative changes[16]. Therefore, based on clinical studies documenting the limited success of various nonoperative treatment approaches, it is the opinion of many that an anterior cruciate ligament deficient knee in an active individual requires surgical reconstruction. This is particularly important if the patient's functional goals include continued participation in sport or work-related activities that involve high magnitude forces and rapid changes in direction during gait [1,5,7,15,16].

The choice of the treatment depends on the patient's age, the length of the time since injury, future demands on the knee, rehabilitation prospects of the patients, and the surgeon's philosophy.

We are presenting the results of the International Knee Documentation Committee and Lysholm scores follow-up evaluation of a series of fifty-five patients with chronic isolated anterior cruciate ligament instabilities. The purpose of this study was to assess the postoperative results, the residual symptoms produced by activity, the loss of motion, and the frequency of patellofemoral problems using an autogenous graft of the central

one-third of the patellar tendon for anterior cruciate ligament reconstruction in fifty-five patients who had surgery at least three months from the date of their injury.

MATERIALS AND METHODS

Fifty-five of the sixty-one patients (90 percent) with isolated anterior cruciate ligament insufficiency (55 knees) were reviewed by a single surgeon (WFM) at the Cairo Medical Center and Ain Shams University Hospitals in Cairo, Egypt. Surgical reconstruction of the anterior cruciate ligament injury using arthroscopic reconstruction with a free graft from the central one-third of the patellar tendon was performed on all the patients during the period from January 1995 through December 1997. All fifty-five patients met the following criteria for inclusion in this study: (a) possess a chronic isolated anterior cruciate ligament insufficient knee defined as having an injury-to-surgery interval of at least 3 months; (b) have no associated ligament injury, chondral damage, previous meniscectomy, or abnormal radiographic findings at the time of the anterior cruciate ligament injury; (c) reconstruction performed with arthroscopic-assisted technique using a bone-tendon-bone free graft from the central one-third of the patellar tendon; (d) a contralateral normal knee for purpose of comparison; and (e) all the patients had preoperative and follow-up radiographic data. Conversely, if a patient had a history of any of the following, they were excluded from the study: (a) major previous surgery of the injured knee involving a ligament repair or reconstruction; (b) presence of a posterior, medial, or lateral tibiofemoral laxity; (c) additional surgical procedures performed on the knee at the index operation; and (d) significant injury to the contralateral knee, including an anterior cruciate ligament insufficiency or lower limb abnormalities that might decrease the activity level and for comparison purposes.

Fifty-five of the sixty-one patients met these criteria and participated in the follow-up study. This selected group of patients was identified for study by a retrospective review of our hospital records of surgical cases performed during the period from January 1995 through December 1997.

Table 1-1. **Subject Demographics**

Characteristic	**Patients with chronic anterior cruciate ligament injury**
Number: Male Female	55 52 3
Height (mean ± SD)	175.3 ± 7.2 cm
Weight (mean ± SD)	90.9 ± 10.9 kg
Age	27.2 ± 4.5 years
Interval between injury and surgery (mean ± SD)	3.3 ± .8 months
Length of postoperative follow-up period.	26.8 ± 3.7 months
Initial trauma: Contact Sports Others	 31 24
Side affected: Right Left	 43 12

All subjects in this study participated in a formal rehabilitation program that included pre-operative and postoperative treatment programs. Before anterior cruciate ligament reconstructive surgery was performed, all patients had to meet specific physical goals. Those goals were: (a) restoration of full range of motion in the injured knee,

including full hyperextension compared with the contralateral knee; (b) decreased swelling; and (c) restoration of a normal gait and limb voluntary control. After the preoperative physical goals had been achieved, the surgery was scheduled and performed when the patient was mentally prepared and when his/her schedule allowed time for the surgery and the postoperative rehabilitation. Within a few hours after surgery, the postoperative rehabilitation program was initiated. The patient's leg was placed in a continuous passive motion machine that moved the knee from 0 degrees of extension to 30 degrees of flexion. Once an hour for 10 minutes, the patient lifted their leg out of the continuous passive motion machine and propped the heel on the end of the bed frame to passively extend the knee to 0 degrees. Three times daily, the patient sat on the side of the bed to flex the knee to 90 degrees and to perform short-arc quadriceps muscle exercises. On average, patients were discharged from the hospital within two to four days postsurgery.

CLINICAL EVALUATION

The symptoms of pain, swelling, and giving way were evaluated according to the activity level the patient could perform with minimal or no symptoms. The activity level was recorded with attention to the ability to jump and cut[20].

The Lachman test was performed at 25 degrees of knee flexion. A 0 to 5 millimeters side-to-side difference was graded as "1+", 6 to 10 millimeters as "2+", and a difference greater than 10 millimeters as "3+". While performing the Lachman test, the presence or the absence of a firm end point was noted. The pivot shift was graded as 1+ (glide), 2+(jerk), and 3+ (subluxation).

Instrumented knee laxity with a KT-2000 arthrometer (Medmetric, San Diego, CA) was employed at the follow-up evaluation and graded as less than three millimeters difference between the injured and contralateral knee as normal ("excellent"), three to five millimeters as nearly normal ("good"), while more than five millimeters considered as abnormal ("fair, poor") [11].

The active range of motion in the surgical knee was measured with a standard goniometer and compared to the contralateral normal knee. Extension loss was measured with the patient supine and with the heels resting on a 10-cm support, while the flexion loss was measured with the patient actively flexing the knees.

Patellofemoral problems were specifically studied pre-operatively and postoperatively. Any sign of a mild or a severe patellofemoral crepitus with the patient actively extending the knee was noted. Patellofemoral crepitus associated with pain and swelling caused by stair climbing, squatting, or sports activities was also recorded.

The pre-operative and postoperative follow-up radiographic images included the anteroposterior 30 centimeters x 40 centimeters weight bearing film, a lateral view and the sky line view. At follow-up, a lateral view of the contralateral knee was also obtained; both views were taken with the knee in 45 degree of flexion for comparison.

The presence of degenerative changes of the joint was assessed using the Hospital for Special Surgery numerical rating scale that allots 28 points to the normal knee, 10 points are given for the absence of peripheral changes (osteophytes) and 18 points to absence of degenerative changes (subchondral sclerosis and cysts, narrowing of the joint line, axial deviation, and loose bodies) [26]. A score of 27 to 28 points was considered "normal", a score of 24 to 26 points was indicative of "mild changes", and a score of 21

to 23 points was defined as moderate changes. Postoperative radiological evaluation criteria are summarized in Table 1-2.

The Lysholm knee score of one hundred points combines the patient's subjective assessment with examiner's clinical exam and functional test results (see Table 1-3) and assigns point values to various categories of evaluation.

The International Knee Documentation Committee knee ligament standard evaluation form has established widely accepted guidelines for assessing patient's outcomes after knee ligament injury and/or surgery[4]. The International Knee Documentation Committee questionnaire includes eight different categories of evaluation: Patient Subjective Assessment, Symptoms, Range of Motion, Ligament Evaluation, Compartmental Findings, Harvest Site Pathology, X-Ray Findings, and Functional Test. Each category is given an overall grade of A (normal), B (nearly normal), C (abnormal), or D (severely abnormal). The overall letter grade final rating is based on the worst rating for the categories of the patient-reported function, symptoms, range of motion, and ligament laxity evaluation[4].

Table 1-2.

Hospital for Special Surgery radiographic rating system (Sherman et al., 1988)

Criteria	Points*
Spurring	
Patella	
None	2
Mild or moderate	1
Severe	0
Medial compartment on: tibia- femur-	
None	3
Mild	2
Moderate	1
Severe	0
Lateral compartment on: tibia- femur	
None	3
Mild	2
Moderate	1
Severe	0
Tibial spine	
None	2
Mild or moderate	1
Severe	0
Subchondral sclerosis	
Medial: tibia- femur	
None	2
Mild Or moderate	1
Severe	0
Lateral: tibia- femur	
None	2
Mild or moderate	1
Severe	0
Joint-space narrowing	
Medial compartment	
None	3
1 mm	2
2mm	1
≥3 mm	0
Lateral compartment	
None	3
1 mm	2
2 mm	1
≥3 mm	0
Angular deformity	
>5 varus- >12 valgus-	
None	2
Present Angle	0
Subchondral cysts	
Medial: tibia- femur-	
None	2
Mild or moderate	1
Severe	0
Lateral: tibia- femur	
None	2
Mild or moderate	1
Severe	0
Loose bodies	
None	2
1 or 2	1
≥3	0
Total	**28**

Table 1-3. **Grading of results with Lysholm score (Feagin et al., 1994)**

Result	Findings
Excellent	
Subjective	Very satisfied, no pain, no swelling, normal knee
Objective	Absent Lachman and pivot shift test; KT-2000 side-to-side difference -3 millimeters
Functional	Return to sport without limitations
Scores	Lysholm score, > 94 points.
Good	
Subjective	Satisfied, occasional mild pain, rare swelling with stressful activity, rarely limiting, no giving way
Objective	1+ Lachman test with firm endpoint and negative pivot shift test; KT-2000 side-to-side difference -3 millimeters
Functional	Return to sports with limitation or active in a different sport
Scores	Lysholm score, > 84-94 points.
Fair	
Subjective	Unsure of success of surgery, mild to moderate pain, some limitation with sports, no giving way
Objective	>1+ Lachman test and negative pivot shift test; KT-1000 side-to-side difference of 3.1 to 5 millimeters
Functional	Return to different sport with limitations
Scores	Lysholm score, < 75-84 points.
Poor	
Subjective	Dissatisfied, moderate to severe pain that can affect activities of marked limitations with sports or no sports; complaint of giving way
Objective	>1+ Lachman test and + pivot shift test; KT-1000 side-to-side difference of >5 millimeters
Functional	Unable to return to sports
Scores	Lysholm score, <75 points

STATISTICAL ANALYSIS

Statistical analyses were performed using the SPSSX software package (SSPS, Inc., Chicago, IL). One-way analysis of variance (ANOVA) was used to evaluate the differences between the reconstructed knee and the contralateral normal knee. Statistical significance was established at (α= .05). One sample t-tests were also run to determine if there is a significant difference between the subject's surgical and contralateral knee.

RESULTS

There were no statistically significant differences between the surgical and contralateral normal limbs on any of the nine evaluative parameters ($p > .05$).

Subjective evaluation

Based on the final score with the International Knee Documentation Committee and Lysholm scores, all patients felt that knee stability had been improved by the surgical procedure, and thirty of the fifty-five patients had no complaints or symptoms of instability. However, in postoperative follow-up there was one patient who still experienced episodes of giving way. An additional two patients noted residual symptomatic instability when cutting or jumping. While similar to their pre-operative episodes of giving way, these residual symptoms were less severe in both magnitude and frequency, and were not associated with pain and swelling.

Subjectively, all fifty-five patients reported that their knees were improved compared with their pre-operative status.

At follow-up, 14 patients had given up the sports that they were playing when first injured. Although several patients had returned to competitive sports participation after surgery, at an average follow-up of 27 months, these twenty-three patients had changed their lifestyle and were no longer playing at the competitive level.

Clinical results

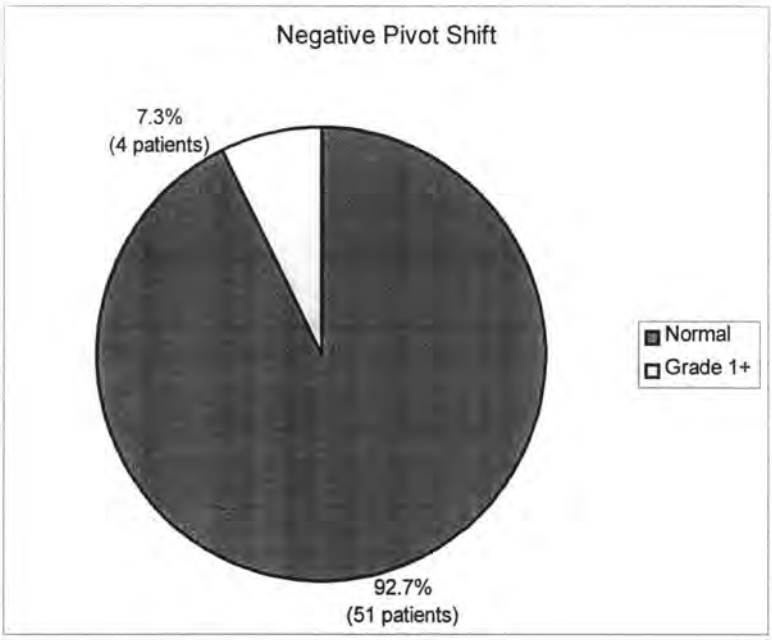
No intra-operative or postoperative complications were recorded for any patient. Significant rehabilitation difficulties, defined as problems to regain a complete range of motion within 3 months, were noted in one patient (1.8 percent). At follow-up, this patient had recovered a full range of motion.

At follow-up examination, pain and swelling were present during activities of daily living for 27 percent (15 of 55) of the patients and in 13 percent (7 of 55) patients during recreational activities.

No statistically significant differences were detected between the reconstructed and the contralateral knee with regard to tests of knee joint laxity evaluation, including the Lachman test ($p = .62$), pivot shift ($p = .47$) (Fig. 2.1) and the reverse pivot shift ($p = .29$)

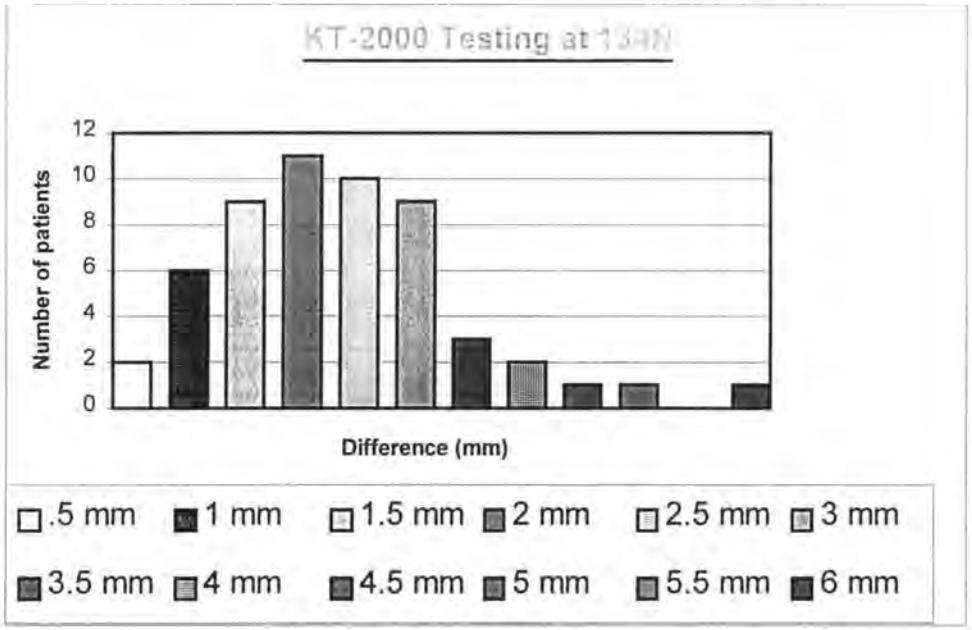
Pre-operatively the Lachman test was graded 2+ to 3+ in fifty-two of fifty-five patients (95 percent). At follow-up it was absent in forty-nine (89 percent), 1+ in five (9 percent, all with firm end point), and 2+ in one patient (2 percent, with soft end point). Prior to the surgery, 98 percent of the patients (fifty-four of fifty-five) had a grade 2+ or 3+ pivot shift test; Postoperatively, the pivot shift was negative in forty-two (76 percent) of the cases at follow-up and grade 1+ in four patients (7 percent).

Fig. 2. 1. Pivot shift test



There was no statistically significant difference in anterior tibial translation between the reconstructed and the contralateral knee during the KT-2000 testing ($p = .32$). Instrumented Lachman tests at 134N revealed side-to-side differences less than or equal to three millimeters in forty-seven patients (85 percent), between three and five millimeters in seven patients (13 percent), and greater than five millimeters in one patient (2 percent) (Fig.2.2).

Fig. 2.2. Histogram for the K-T 2000 Results



No statistically significant difference was detected between the reconstructed and the contralateral knee in the active range of motion ($p = .07$). An extension loss of 3 to 4 degrees (compared to the normal knee) was found in four patients (7 percent), of 5 to 6 degrees in two knees (4 percent), and seven degrees in two patients (4 percent).

Thigh circumference was measured for atrophy at 10 centimeters proximal to the patella. Pre-operatively atrophy was < 1 centimeter in twenty-five patients (46 percent), < 2 centimeters in twenty-four (43 percent), and < 3 centimeters in six patients (11 percent). At follow-up it was < 1 centimeter in twenty-four (44 percent), < 2 centimeter in twenty-two (40 percent), and < 3 centimeters in nine patients (16 percent). No

statistically significant difference was detected between the reconstructed and the contralateral knee.

A mild patellofemoral crepitus was present pre-operatively in the injured knee in fourteen patients (26 percent). At follow-up, there were twenty-seven patients (49 percent) who had mild crepitus, fifteen patients (27 percent) who had moderate crepitus, while thirteen (25 percent) had no signs of patellofemoral crepitation.

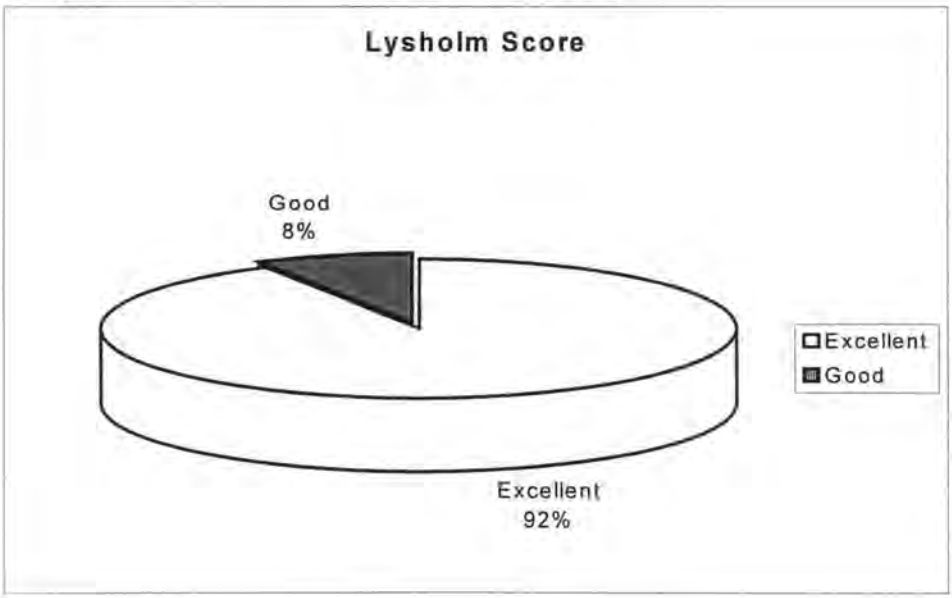
Radiographic results

Appropriate pre-operative radiographs were available for all fifty-five patients. The mean pre-operative score, according to the Hospital for Special Surgery radiographic scoring system[26], was 26 $\pm$ 1.3 points. The total radiographic score decreased from twenty-eight points pre-operatively to 25.5 at follow-up. Pre-operatively, fifty-two knees (94 percent) had a normal radiographic examination (27 to 28 points), two patients (4 percent) had mild changes (24 to 26 points), and one patient had moderate changes (21-23 points). At follow-up, twenty-seven patients (49 percent) had normal radiographs, sixteen (29 percent) had mild changes, and twelve (22 percent) had moderate changes (21 to 23 points).

The postoperative height of the patella was found to be unchanged in fifty-four patients (98 percent) and decreased in one case (2 percent). The variations in the height of the patella were minor and ranged from 3 percent to 7 percent of the contralateral patellar tendon length. No correlation existed between the variation of patellar height and patellofemoral symptoms, rehabilitation difficulties, or flexion loss (r =.26).

The International Knee Documentation Committee score ratings categorized forty-eight patients (88 percent) as "normal", five patients (9 percent) as "nearly normal" and two patients 4 percent as "abnormal"; no patients scored "severely abnormal" in the final evaluation. The mean Lysholm score was 91.3 of a possible 100, with fifty-two patients (95percent) scored "excellent" (95 points or more), three patients (6percent) scored "good" (84-94 points); none of the patients were scored less than "good" (Fig.2.3). The International Knee Documentation Committee scores and Lysholm score were similar (r = .629) in the final score. However the International Knee Documentation Committee scale is negatively biased[4] and automatically places the patient into a lower category than the Lysholm score Fig. 2.3.

Fig. 2.3. Lysholm score



DISCUSSION

Most of the literature pertaining to patients with an unoperated knee with an ACL injury and the natural history of the ACL-injured knee is retrospective and has analyzed patients with chronic ACL disruptions with other knee injuries, mixed patient populations with acute or chronic injuries, and patients with failed ACL repairs or hospital records.

Retrospectively we reviewed fifty-five patients (mean age, 27.1 $\pm$ 4.5 years) who underwent ACL reconstruction with an average of 7.0 $\pm$ 2.6 months (range, 3.3 to 16.6 months) after injury. Patients were evaluated at an average of 2.2 $\pm$ .3 years postoperatively (range, 2.0 to 3.4 years). To the best of our knowledge, no previous study has reviewed chronic isolated injury of the anterior cruciate ligament using arthroscopically- assisted techniques, particularly in this large a group of patients.

The current study of 55 patients had a follow-up period of sufficient duration (2.2 years) to be considered prognostic. Postoperatively, both knees of all 55 subjects were examined clinically and graded by one evaluator (WFM). Our patient population was young with an overall mean age for both groups of 27.1 years. Furthermore, the outcome assessment techniques were identical for each experimental group, and the groups were comparable in age, sex, activity level, height, weight, side affected, condition of the contralateral knee, and indications for surgery.

There were several limitations inherent to retrospective studies that were encountered in the research process. The best case scenario is to formulate a prospective experiment that randomly assigns patients to the treatment groups. In the present study we would have beneficial from all patients having full pre-operative radiographic

evaluations including C-T scan and MRI for comparative purposes. [There was imbalance in the gender of the patients in this study (52 males and 3 females) due to either the cultural differences or the observation that not too many women in the Middle East practice vigorous sports]

Knee joint stability was restored to that of the contralateral knee in the 54 of the 55 cases. The KT-2000 manual maximum test was the main method of evaluation of the knee instability, and a side-to-side difference of greater than 5 millimeters was recorded only in one of fifty-five patients (2 percent). We found no increase in anterior tibial displacement at follow-up evaluation 2 years postoperatively. Although a return to higher levels of activity is not a prime indicator of the success of a procedure, it is interesting to note that 27 of the 55 patients (62 percent) could return to high-risk sports, e.g., soccer without instability.

Separate analysis of subjective patient interpretation of outcome revealed no significant differences between reconstructed and the contralateral normal knees. In addition, the Lysholm knee score and International Knee Documentation Committee rating system score did not significantly differ at follow-up (r= .629). International Knee Documentation Committee is more rigid and defined overall score that incorporates all outcome parameters, including the aforementioned knee scores and arthrometer data is introduced. The lowest score in each category determines the highest overall grade (i.e., normal, nearly normal, abnormal and severely abnormal). We believe that this system more accurately reflects overall outcome. Published knee ligament rating scores and systems have been studied and may vary according to the emphasis placed on subjective, objective, and functional data. The Lysholm scale is a subjective patient assessment of

function. The International Knee Documentation Committee rating system is an overall score that combines subjective, objective, and functional data. Neither score incorporates arthrometric data nor both systems may disproportionally weigh individual data to arrive at an overall score. Functional outcome, as measured by restoration of knee stability and return to preinjury activity participation was better in our study than any of previously published reports.

The arthroscopic or radiographic extent of associated chondral lesions, specifically addressed and documented in this study, remains as a possible etiology for the variations of subjective and objective outcome.

Marder et al.[18] evaluated alternating patients with patellar tendon or four-strand hamstring tendon reconstruction. Their patients had chronic anterior cruciate ligament tears and included patients with meniscectomy and chondral damage. Suspensory fixation was used for both types of grafts. Similar results between groups were demonstrated at a mean follow-up of 29 months.

Aglietti et al.[1] used a study group similar to that of Marder et al., with suspensory fixation in the hamstring tendon group but with a combination of suspensory and interference screw in the patellar tendon group. They showed little difference in outcome between the two groups at a mean follow-up of 28 months except that a greater number of patients in the patellar tendon group had returned to sports at the). International Knee Documentation Committee functional level of grade I or II. Our 2-year results do not confirm this difference. However, there was a significant trend if level I alone was compared with levels II, III, and IV collectively. A 1 to 3 degree extension loss was noted in 47% of their patellar tendon group compared with 3% in their hamstring tendon group-

a significant difference also unconfirmed in our series. A nonsignificant trend toward anterior knee symptoms was noted.

Similar overall study results were reported by Barber et al[4], who also compared acute versus chronic reconstruction with the pes anserine tendons. The patients in that study who were operated on earlier had superior objective and subjective results. The same study recommended avoiding the use of the semitendinosus in chronic anterior cruciate ligament deficient knees because of a 50% failure rate. . Barber et al[4]. report that hamstring tendon grafts are inferior in cases of chronic injury reconstruction compared with acute injury reconstruction. Barber et al[4] found that the hamstring tendon graft was inferior to the patellar tendon graft in terms of laxity by Lachman and KT-2000 arthrometer testing.

Cumulative meniscal injury has been implicated in poorer results reported after reconstruction of chronic ligament ruptures as compared with those after reconstruction of acute ruptures[22]. In our study, only isolated ACL injuries were included, thereby eliminating those cases of chronic injury in which recurrent instability had already led to further injury.

In our study only four patients (7 percent) had difficulty in recovering full range of motion. Postoperative active range of motion was near normal in our series, because we did early motion, immediate full extension, and faster rehabilitation, without compromising stability. Sachs et al.[21] reported that 1 centimeter limited flexion corresponded to a 1-degree knee flexion contracture. Despite reporting an incidence of 20 percent knee flexion contractures measured by bilateral differences in prone heel heights, no patient had more than a 3-centimeter heel height discrepancy in the Sachs et

al.[21] study. Harner et al. defined loss of knee extension as >10 degrees, and they noted an incidence of 11 percent, whereas Shelbourne and Nitz defined knee flexion contractures by asymmetric prone heel heights that take into account contralateral knee hyperextension, and they re-operated on 21 of 140 patients (15 percent) who met their diagnostic criteria. The principle of immediate postsurgical extension has also been strongly recommended by Shelbourne and Nitz. [23] and Shelbourne et al. [25] Most studies evaluate the knee extension in a supine position so it is difficult to compare our results with other studies.

Sachs et al.[21] previously reported a relationship between knee flexion contractures, quadriceps muscle weakness, and patellar pain symptoms in 54 percent of their cases using the same surgical procedure, and they popularized early complete passive extension as a tenet of postoperative rehabilitation. Their observations were based on a group of patients casted for 3 weeks followed by use of a knee rehabilitation brace set with a range of motion of 30 degrees of a knee. Their patients were instructed to avoid terminal extension exercises for the first postoperative year. Sachs et al.[21]observed that 25 percent of their subjects had a knee flexion contracture >5 degrees, noted a mean quadriceps muscle deficit of 34 percent, an average hop index of 78 percent, and knee flexion contracture in 54 percent of their cases.

One unresolved problem after reconstruction of the anterior cruciate ligament is the increased incidence in patellofemoral crepitus, indicative of earlier patellofemoral osteoarthrosis. In our study mild patellofemoral crepitus was present pre-operatively in the injured knee in fourteen patients (26 percent). At follow-up there were twenty-seven patients (49 percent) who had mild crepitus, fifteen patients had moderate crepitus, while

thirteen had no signs of patellofemoral crepitation. Roberts et al.[63] reported an increase in patellofemoral crepitus from none to mild in eighteen (58 percent) of thirty-one knees and from none to marked in four (13 percent), at a mean of two years after arthroscopic reconstruction with a bone-patellar tendon-bone allograft for a chronic rupture of the anterior cruciate ligament. They found no association between crepitus and symptoms related to the patellofemoral joint. Shelbourne et al.[22] reported that twenty-seven (54 percent) of fifty knees had patellofemoral crepitus one year after reconstruction with a patellar ligament autogenous graft, but they did not state how many of the knees had had crepitus pre-operatively or if the crepitus was associated with the patellofemoral symptoms.

Recently, the International Knee Documentation Committee rating system has received widespread attention in the orthopaedic sports medicine literature, and is becoming the rating system of choice for most anterior cruciate ligament studies. In the design phase of the International Knee Documentation Committee knee questionnaire, members adopted significant portions of the Cincinnati System, which formed the primary basis of the current International Knee Documentation Committee rating knee questionnaire[4]. This included both the factors used to form the final analysis (subjective assessment, symptoms, knee examination, knee stability, radiographs, functional testing) and the scheme used to formulate final patient grades for acute and subacute populations. That scheme incorporated the theory that the final patient grade was based on the single lowest score in any category. The overall rating categories of International Knee Documentation Committee rating system of normal, nearly normal, abnormal, and

severely abnormal are similar to the Lysholm score categories of excellent, good, fair, and poor.

Unfortunately, there has been considerable confusion in the use of these systems for patients with chronic anterior cruciate ligament deficiency in whom preexisting problems cannot be corrected by anterior cruciate ligament reconstruction. Because in the International Knee Documentation Committee rating system, the worst score rating for any category determines the overall final rating, it is unlikely that this assessment battery is responsive to clinically significant differences over time. For example, if a patient's level of symptoms improves but the laxity remain unchanged, the overall final rating according to International Knee Documentation Committee rating system guidelines remains the same. This lack of responsiveness may fail to detect important changes in a patient with the passage of time.

For patients with chronic knee ligament injuries, the International Knee Documentation Committee scale is negatively biased and automatically places the patient into a lower category if we compare with Lysholm score[20]. Examples include the presence of moderate patellofemoral or tibiofemoral crepitus or moderate or severe joint space narrowing detected on radiographs, which places patients into the abnormal or-severely abnormal (or fair or poor) categories both pre-operatively and postoperatively. The disadvantage of the Lysholm Knee Scoring Scale is the questionable weighting scheme that gives to the categories, with 50 percent of the total score dependent on pain and swelling. No explanation of the weighting system was provided in the description of this instrument. Also, the Lysholm Knee Scoring Scale does not factor in an individual's

ability to perform running, cutting, and jumping maneuvers, making it likely to exhibit a ceiling effect when used with patients who place high demand on the knee.

The International Knee Documentation Committee scores and Lysholm score showed satisfactory recovery and patient's subjective assessment. Including the patients who had a good or excellent score on the Lysholm score and the patients who had normal or nearly normal score on the International Knee Documentation Committee assessment.

CONCLUSIONS:

The International Knee Documentation Committee and Lysholm scores were similar in the final score. However, International Knee Documentation Committee scale is negatively biased and automatically places the patient into a lower category when compared to Lysholm scale[4]. Further research is needed to establish the usefulness of reporting outcomes following knee ligament injury and surgery according to International Knee Documentation Committee rating system guidelines.

Based on our subjective and objective findings, we concluded that arthroscopic-assisted reconstruction of isolated anterior cruciate ligament ruptures at least three months post-injury using the central one-third of the patellar tendon was a highly successful method of treatment if compared to the patients' contralateral normal knees.

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CHAPTER 3

ISOLATED ANTERIOR CRUCIATE LIGAMENT DEFICIENCY: COMPARISON OF RESULTS FOLLOWING ACUTE AND CHRONIC ARTHROSCOPIC RECONSTRUCTION WITH PATELLAR TENDON AUTOGRAFT

by

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ABSTRACT

Background: To the best of our knowledge, no previous study has compared the postoperative results of acute anterior cruciate ligament those patients who had surgical reconstruction within 3 months of their injury and chronic reconstruction of the anterior cruciate ligament those patients who had surgical reconstruction longer than 3 months from the date of their anterior cruciate ligament injury using arthroscopically-assisted techniques, particularly in this large a group of patients. These two groups are thought not to be equivalent because those with chronic lesions may already have sustained further orthopaedic injures that cannot be corrected with anterior cruciate ligament reconstruction. The purpose of this study was to determine if postoperative functional outcomes were significantly affected by the timing of surgery in a population of patients who sustained isolated anterior cruciate ligament injuries.

Methods: From a group of 773 arthroscopic patellar tendon anterior cruciate ligament reconstructions, 200 of the 234 patients with isolated anterior cruciate ligament injury (85 percent) were available for follow-up evaluation. Patients (mean age, 32.2 $\pm$ 6.9 years) were assigned to groups based on the interval between their anterior cruciate ligament injury and reconstruction. Subjects in the acute group (n =100) had surgery an average of 62 days post-injury (range, 9 to 90 days), while the chronic group (n = 100) had surgery an average of 211 days post-injury (range, 98 to 497 days). The mean follow-up period was 2.2 $\pm$ 0.3 years (range, 2.0 to 3.8 years) for all subjects, and was not significantly different between groups (p =.56).

Results: Using the International Knee Documentation Committee knee ligament standard evaluation form, 62 percent of acute knees and 58 percent of chronic knees were classified as "normal" at follow-up; 37 percent of acute and 38 percent of chronic knees as "near normal", and 1 percent of acute and 4 percent of chronic knees as "abnormal". Subjects in the acute group had significantly better International Knee Documentation Committee knee ligament standard evaluation outcomes than those in the chronic group ($p = 0.04$). There were no significant differences present in KT-2000 anterior knee laxity measures between the groups ($p = .19$), as 88 percent of acute reconstruction patients and 86 percent of chronic patients had difference of three millimeters or less between their surgical and contralateral normal knees. The chronic group had a greater incidence of joint space narrowing and radiographic changes ($p =0.0001$) than did the acute reconstruction group. Within the acute group, those patients ($N= 9$) who underwent surgery less than three weeks after their injury had significantly more postoperative complications than those in the acute group ($N= 91$) who had surgery at least three weeks after isolated anterior cruciate ligament injury.

Conclusion: Delaying anterior cruciate ligament reconstruction by at least 3 weeks resulted in significantly improved results in most International Knee Documentation Committee evaluation categories when compared with those patients reconstructed sooner than 3 weeks after injury. Similar to published reports of patients with injuries to the anterior cruciate ligament in combination with other static knee stabilizers, our findings in patients with isolated anterior cruciate ligament injuries support the recommendation that anterior cruciate ligament reconstructive surgery be performed as soon as possible following injury, but not within the initial 3 weeks.

INTRODUCTION

The treatment of individuals who have suffered an anterior cruciate ligament disruption has changed dramatically over the past 50 years. Recent controversy concerning the functional disability and the prognosis of such patients is a result of multiple factors: patient populations differ widely among studies as far as the degree of their athletic participation, the magnitude of their ligamentous laxity, and their compliance with rehabilitation programs [30,34,37,42,48,51,56,60,64,83].

The vast majority of published reports on anterior cruciate ligament reconstruction involve patient populations with combined injuries to the knee.[5,6,8,15,18,20,42,47,64,83] In fact, for a period of time, surgeons thought that there could be no such clinical entity as an isolated anterior cruciate ligament injury[37,42,83].

Analysis of the knee injury and physical findings after the injury, followed by early arthroscopic examination combined with examination of the knee under anesthesia, provides precise information regarding anterior cruciate ligament injury[73]. This early post-injury examination regimen has demonstrated that isolated anterior cruciate ligament lesions do occur.[73]

The timing of the anterior cruciate ligament reconstructive surgery is now considered to be a critical factor that influences the functional outcome. Finsterbush et al. [33] and Marcacci et al. [54] suggested that if anterior cruciate ligament reconstruction is delayed and patients attempt to increase their activity levels in the face of symptomatic anterior cruciate ligament deficiency, the resultant chronic condition might represent a different clinical entity than acute anterior cruciate ligament deficiency. Progression of laxity and further loss of secondary restraints may result during the interval from injury to

surgery from the patient's attempts to increase activity or their unwillingness to modify such activity. We propose four possible explanations for this progression: a) greater injury in the chronic reconstructed knees before surgery than in the acutely-reconstructed patients, b) abnormal joint mechanics before surgery, c) the joint's response to stress deprivation before surgery, and d) prolonged joint inflammation and instability before surgery.

Recent work reported by Shelbourne et al. [79] suggests that delaying anterior cruciate ligament reconstruction for more than 3 weeks after acute injury will decrease the incidence of arthrofibrosis and postoperative extensor mechanism lag [79]. To the best of our knowledge, no previous study has compared patients with acute isolated anterior cruciate ligament injury (i.e., those patients who had surgical reconstruction within 3 months of their injury,) with chronic isolated anterior cruciate ligament injury patients (i.e., those who had reconstruction more than 3 months after the date of their injury).

The purpose of this study was to compare the postsurgical results using the International Knee Documentation Committee knee ligament standard form to evaluate patients who had acute and chronic isolated anterior cruciate ligament deficiency at a minimum of two years after reconstruction of the anterior cruciate ligament using arthroscopically-assisted techniques with the central one-third of the patellar tendon.

MATERIALS AND METHODS

Subjects

Arthroscopic anterior cruciate ligament reconstruction with patellar tendon autograft fixation was performed on 773 patients at the Cairo Medical Center and Ain Shams University Hospitals, in Cairo, Egypt between January 1995 and December 1997. From this group of anterior cruciate ligament reconstruction patients, 234 of the 773 patients (26 percent) sustained an isolated anterior cruciate ligament injury and were eligible for inclusion in this study. Patients with any associated ligament knee injury, chondral damage, previous meniscectomy, and/or abnormal radiographs, did not qualify for inclusion in the study group. Of a total group of 234 patients, 200 (86 percent) were seen for follow-up examination during the period from July 1998 to September 1999 as part of this study.

The designation of acute or chronic anterior cruciate ligament reconstruction was based on the time between the injury and surgical reconstruction. Furthermore, the outcome assessment techniques used for each group were identical, and the groups were comparable in terms of age, sex, activity level, height, weight, side affected, condition of the contralateral knee, and indications for surgery. Therefore, the time after injury was the only initial difference between groups.

We reviewed a group of 200 patients who represented a cross-section of the population, some involved in sports and others active only for leisure. Each patient sustained a knee injury that resulted in a unilateral isolated injury to his or her anterior cruciate ligament. Arthroscopic examination was used to establish the final diagnosis.

Our follow-up study was limited to patients who originally sustained an isolated anterior cruciate ligament injury. All patients whose medical record indicated the presence of additional intra-articular injury at the time of the primary arthroscopy were excluded from the study group. The 200 patients with isolated anterior cruciate ligament injury who participated in this study do not represent the exact number of isolated anterior cruciate ligament tears at the time of the primary injury. Not all patients with injury were available or willing to participate in the follow-up study.

The right knee was involved in 66 of 100 patients in the acute reconstructed group, while the chronic group had 77 patients (77 percent) injury to the right side. The contralateral knee was normal in all patients for the purposes of comparison. After the postoperative clinical and radiological examinations, patients were referred to physiotherapy for hamstring and quadriceps exercises. Bracing was recommended when episodes of giving way were frequent and interfered with daily activities, and for sports activity. Patients were instructed to minimize temporarily strenuous activities requiring jumping, sharp turning, and quick starts and stops. Patients who regained full muscle power and who did not have functional instability after surgery gradually returned to their previous activities.

Prior to participation in this study, all patients gave their informed consent in accordance with the policies of Cairo Medical Center, Ain Shams University Hospital, and the Institutional Review Board for the Protection of Human Subjects at Oregon State University. This entire patient population received free medical care at these hospitals. All the patients received, at no cost, complete orthopedic evaluations of their anterior

cruciate ligament reconstructed knee and were provided with a current assessment of the functional status of their knee.

Table 2-1. **Subject Demographics**

Characteristic	**Acute anterior cruciate ligament reconstruction**	**Chronic anterior cruciate ligament reconstruction**
Number: Male Female	100 98 2	100 96 4
Height (mean ± SD)	176.1 ± 7.2 cm	176.1 ± 7.6 cm
Weight (mean ± SD)	90.7 kg	96.2 kg
Age	32.5 ± 6.3 years	31.8 ± 7.4 years
Interval between injury and surgery (mean ± SD)	57.4 ± 23.1 days	211.8 ± 71.2 days
Length of postoperative follow-up period.	2.2± 0.3 years	2.2± 0.3 years

The follow-up testing was performed at 26.7 ± 3.4 months after surgery. The acute reconstruction group was comprised of ninety-eight males and two female patients with a mean age were 32.5 ± 6.3 years (range, 20 to 45). The chronic reconstruction group had similar demographics, ninety-six male and four female patients, with a mean age of 31.8 ± 7.4 years (range, 20 to 46). The indication for surgery was anterior cruciate ligament rupture confirmed by clinical and arthroscopic diagnosis in an otherwise healthy patient who experienced instability in daily activities or wished to maintain his or her pre-injury level of activity.

Pre-operatively, all 100 patients in the acute had a grade 1 or 2 Lachman test and ninety-one had positive pivot shift tests. The remaining nine patients in the acute reconstruction group did not have complete knee extension, and thus the pivot shift test could not be performed. To reduce the potential for postoperative arthrofibrosis, surgery was not performed on acute anterior cruciate ligament injuries until the knee had minimal effusion and pain and within five degrees of active range of motion present in the contralateral knee[79]. In the chronic group pre-operatively, all 100 patients had a grade 1 or 2 Lachman test and ninety-eight had positive pivot shift tests. Two patients in this group had incomplete extension, and no pivot shift test could be performed on their injured knee.

Patients in the acute reconstruction group (n =100) underwent surgery an average of 62 days post-injury (range, 9 to 90 days), while the chronic reconstruction group (n = 100) had surgery an average of 211 days post-injury (range, 98 to 497 days). The mean follow-up period was 2.2 $\pm$ 0.3 years (range, 2.0 to 3.8 years) in the acute group, while the chronic group had mean follow up period of 2.2 $\pm$ 0.3 years with a range of 2.0 to 3.4 years.

Etiology

Contact sports participation accounted for most of the injuries in acute group (eighty-two patients) as well as for fifty-nine patients in the chronic group. Activities of daily living were the cause of injury in sixteen patients in the acute group and eleven patients in the chronic group. Two patients in the acute group and thirty patients in the chronic group were injured due to other causes e.g., non-contact sports injuries and motor

vehicle crashes. Playing football (soccer) was the most frequent cause of sports-related knee injuries. The average period from injury to diagnostic arthroscopy was five weeks in the acute group and thirteen months in the chronic group.

Surgical Procedures

At the Cairo Medical Center and Ain Shams University Hospitals in Cairo, Egypt, the preferred method of anterior cruciate ligament reconstruction from January 1995 through December 1997 was the arthroscopic placement of the central-one third patellar of the tendon autograft, using interference screws for aperture fixation at the femur and near-aperture fixation at the tibia. This selected group of patients was obtained for study by a retrospective review of our hospital records of surgical cases performed during the period from January 1995 through December 1997.

A group of nine orthopaedic surgeons operated on all the patients in both groups. All of the arthroscopically-assisted procedures were performed using the same technique in both groups. Initially, a diagnostic arthroscopy was performed with use of superomedial, inferomedial, and inferolateral portals.

The principles of adequate notch preparation and notchplasty, "isometric" (anatomic) placement of drill holes, confirmation of "isometry" using the Graf-Clancy isometer (Acufex Microsurgical, Inc., Norwood, MA), and rigid graft fixation using 9 millimeter diameter Kurosaka interference screws (DePuy, Inc., Warsaw, IN) were employed. All patients had less than 2.5 millimeter of displacement on strain gauge measurements between 90 degrees of knee flexion and complete extension. In general, 10 to 12 millimeter middle third grafts was obtained, leaving at least 20 millimeter of

remaining patellar tendon width. A commercially available aiming device was employed for femoral and tibial tunnel placement (Acufex Microsurgical, Inc.). Determination of Kurosaka screw length was made intra-operatively and usually matched the bone plug lengths (20 to 30 millimeters). Screws were secured against the cortical edge of the grafts to allow maximum cancellous bone contact. Grafts were routinely secured on the femoral side with the cortical edge aligned in the sagittal plane, the knee was cycled in flexion and extension multiple times to pretension the graft, and the tibial bone plug was secured with the knee in complete extension with tension applied to the graft. The cortical edge of the tibial plug was oriented in the coronal plane so that fiber rotation mimicked the normal anterior cruciate ligament. An intra-operative decision was sometimes made to augment the fixation with an AO screw-and-post technique or with a Hewson ligament button in 10 percent of the patients (Smith Nephew Richards, Memphis, TN), depending on the quality of bone.

The entire subject population in this study participated in a formal rehabilitation program that included pre-operative and postoperative treatment plans. Before anterior cruciate ligament reconstructive surgery was performed, all the patients needed to meet specific physical goals. Those goals were (a) restoration of full range of motion in the injured knee, including full extension compared with the contralateral knee; (b) decrease swelling, and; (c) restoration of a normal gait and limb control. After the pre-operative physical goals had been achieved, the surgery was scheduled and performed when the patient was mentally prepared and when his/her schedule allowed time for the surgery and the postoperative rehabilitation program.

Table 2-2. **Summary of Postoperative Anterior Cruciate Ligament Rehabilitation**

Time after Reconstruction	*Rehabilitation Program*
Day 1	Continuous passive motion, rigid knee immobilizer in full extension for walking, weight bearing as tolerated without crutches.
Days 2-3	Continuous passive motion, passive range of motion 0 to 90 degrees (emphasis on full extension), weight bearing as tolerated without crutches.
Days 2-4	Discharge from hospital; continuous passive motion at home. Note: Prerequisite to discharge is: a) satisfactory pain management, b) full extension symmetrical to non-operated knee, c) able to do straight Leg raising for leg control, 4) full weight bearing with or without crutches.
Days 7-10	Active range of motion terminal extension, prone hangs (2 pounds) if patient has not achieved full extension, towel extensions, wall slides, heel slides, active-assisted flexion, strengthening-knee bends, step-ups, calf raises, weight beating partial to full weight bearing.
Weeks 2-3	Active range of motion (0 to 110), unilateral knee bends, step-ups, calf raises, Stair Master 4000, weight room activities; leg press; quarter squats and calf raises in the squat rack, stationary bicycling, swimming, custom-made functional knee brace with no preset limits to be used at all times out of the home for the next 4 weeks.
Weeks 5-6	Active range of motion (0 to 130), isokinetic evaluation with 20-degree block at 180 and 240 deg/sec. When strength is 70 percent or greater than the opposite unoperated knee, the patient can begin lateral shuffles, Carioca, light jogging, agility drills, weight room activities, cycling, and swimming. Note: Functional brace discontinued except for sports activities when muscle tone and strength are sufficient.
Week 10	Full range of motion; isokinetic evaluation a 60, 180, and 240 deg/sec, KT-2000, increase agility workouts, sport-specific activities.
Week 16	Isokinetic evaluation, KT-2000, increased agility workouts.
Weeks 16-24	Return to full sports participation if patient has: met criteria of full range of motion, no effusion, good knee stability, and has completed the running program.

Within a few hours after surgery the postoperative rehabilitation program was initiated. The patient's leg was placed in a continuous passive motion machine that moved the knee from 0 degrees of extension to 30 degrees of flexion. Once an hour for 10 minutes, the patient lifted the leg out of the continuous passive motion machine and propped the heel of the foot on the end of the bed frame to allow the knee to extend fully to 0 degrees. Three times daily, the patient sat on the side of the bed to flex the knee to 90 degrees and to perform short-arc quadriceps muscle exercises. On average, patients were discharged from the hospital within 2 to 4 days postsurgery. The postoperative rehabilitation program that all patients followed is summarized in Table 2-2.

CLINICAL EVALUATION:

Although several instruments have been developed to assess patient outcomes following knee injury, there is currently little agreement on how to report these outcomes[7]. This creates difficulty when comparing studies that report results for treatment of knee injuries. One of the most widely used outcome instruments in both the United States and Europe is the International Knee Documentation Committee knee ligament standard evaluation form, which has established guidelines for evaluating the current subjective and objective status of the knee ligament following injury and/or surgery[7].

The first part of the International Knee Documentation Committee form establishes demographic information, history of prior surgery, and findings of the index procedure, morphotype, and knee alignment. For activity, the patient selects the highest

activity level that he/she is able to perform at pre-injury, pretre-atment, and post-treatment; these data are recorded but not graded.

The International Knee Documentation Committee evaluation includes eight groups or categories, each of which is assigned one of four grades. The eight specific groups and the instructions for completion of each of the components within the category are as follows:

Patient Subjective Assessment: How does your knee function? The patient is asked to rate the involved knee compared to the normal knee or what is perceived as normal[29].

Symptoms: Grade at the highest activity level at which the patient thinks he/she would be able to function without significant symptoms, even if they were not actually performing activities at this level. Performance at level I, strenuous activity, without any symptoms, is normal. Patients who are symptomatic at level I activity but not level II activities would be graded "nearly normal"[29].

Range of Motion: Passive range of motion is recorded on the form for the index limb and opposite or normal limb. Values are record for hyperextension /zero point/flexion, (e.g., 10 degrees of hyperextension, 150 degrees of flexion = 10/0/150) [29]. Hyperextension is recorded as a positive number and a flexion contracture as a negative number. Extension is graded from 0 degrees even if the patient has hyperextension of the normal knee[29].

Ligament Examination: The Lachman test, total anteroposterior translation at 70 degrees, and medial and lateral joint opening may be assessed with manual, instrumented or stress x-ray examination.[29] A standard force of 134N (30 lbs) is used in the

instrumented examination. The numerical values for the side-to-side difference are rounded off to the nearest millimeter, and the appropriate box is marked.

The quality of the end point during the Lachman test is also assessed with the International Knee Documentation Committee questionnaire. The end point affects the grading when the involved knee has three to five millimeters more anterior laxity than the normal knee. In this case, a soft end point results in an "abnormal" grade rather than a "nearly normal" grade.

The profile of the injured knee to the normal knee is compared next by palpating the femoral tibial step off to estimate 70 degrees posterior sag. A positive test may be confirmed by noting that contraction of the quadriceps pulls the tibia anteriorly.

The pivot shift and reverse pivot shift tests are performed with the patient supine, with the hip in 10 to 20 degrees of abduction, and the tibia in neutral rotation using either the Losee, Noyes or Jakobs techniques. The greatest amount of subluxation produced with any of these tests is recorded[29].

Compartment Findings: Patellofemoral crepitation is elicited by extension against slight resistance. Medial and lateral compartment crepitation is elicited by extending the knee from a flexed position with a varus and then a valgus stress, (i.e., McMurray test.) Grading in this category is based on intensity and pain[29].

Harvest Site Pathology: Evaluation of the autograft harvest anatomical site includes assessment of tenderness, redness, irritation or numbness [29].

X-ray Findings: A bilateral posterior-anterior weight-bearing roentgenogram at 35 to 45 degrees of knee flexion (tunnel view) is used to evaluate the narrowing of the medial and lateral joint spaces. The Merchant view at 45 degrees is used to document patellofemoral

narrowing. A mild grade indicates minimal changes, e.g., small osteophytes, slight sclerosis or flattening of the femoral condyle, with a joint space is wider than 4 millimeters. A moderate grade may have those changes and joint space narrowing, e.g., a joint space of 2 to 4 millimeters wide. Severe changes include significant joint space narrowing, in specific, a tibiofemoral joint space of less than 2 millimeters.

Functional Testing: The patient is asked to perform a one-leg hop for distance on the index and normal side. Three trials for each leg are recorded and averaged. A ratio of the surgical to normal knee is calculated. Each category is given an overall grade of A (normal), B (nearly normal), C (abnormal), or D (severely abnormal).

All of the patients completed the ***Activities of Daily Living Scale of Knee Outcome Survey*** questionnaire,[29] which includes questions about their return to sports activity, and any symptoms that could be related to the lesion of the knee.

PHYSICAL EXAMINATION

Postoperatively, both knees of all 200 subjects were examined clinically and graded by one evaluator (WFM). The alignment, varus-valgus stability at 0 and 30 deg, Lachman, anterior and posterior drawer tests, and pivot shift tests were performed.[4,35,52,53,63] The American Medical Association ligament injury grading system was used to categorize knee instabilities: Grade 1 (0 to 5 millimeters), Grade 2 (6 to 10 millimeters), and Grade 3 (>10 millimeters). The pivot shift phenomenon was graded as trace, 1+ (slip), 2+ (jump), and 3+ (transient lock) in the position of abduction and tibial external rotation to maximize the pivot shift sign.[4,63]

Active range of motion was measured with a standard goniometer. Knee flexion contractures were assessed with the patient in the prone position, and the heel height difference was measured in centimeters[74]. Thigh girth measurements were made at eight centimeters proximal to the patella. Patellofemoral crepitation (arthritis) was palpated as the patients actively extended his or her knee; the degree of the crepitus was subjectively graded as 0 (absent), 1+ (mild), 2+ (moderate), or 3+ (severe) and compared with the contralateral knee. [78]

ARTHROMETRIC EVALUATION:

KT-2000 arthrometer values:

The KT-2000 arthrometer has been used to characterize patient populations with normal and anterior cruciate ligament-deficient knees postoperatively.[22,78] Arthrometric evaluation is a useful adjunct to physical examination, providing objective information regarding anteroposterior translations. One evaluator (WFM) performed the KT- 2000 arthrometric evaluations on all surgical patients using maximum anterior force at 30 degrees of knee flexion with a force of 134 N. An objective KT- 2000 arthrometric surgical outcome failure was defined as manual maximum difference greater than or equal to 5 millimeters.

The KT-2000 arthrometer manual maximum test. The relaxed legs of the patient were supported at approximately 30 degrees of flexion. Pushing with a 134N load posteriorly and then releasing the force stabilizes the patellar sensor pad. While the patellar sensor is stabilized with one hand, the other hand applies a strong anterior

displacement force directly to the proximal calf to produce the maximum anterior displacement. Care must be taken that the knee is not extended. [The proximal load application allows a force of 134N while not extending the knee. Tibial displacement is read off the arthrometer dial, and measured to the nearest millimeter.

Statistical analysis

In order to compare the International Knee Documentation Committee Knee questionnaire score components between the acute and chronic groups, nine dependent variables were evaluated: patient subjective assessment, symptoms, tibiofemoral joint range of motion, ligament examination, compartment finding, harvest site pathology, X-ray finding, functional tests and KT-2000 arthrometric evaluation.

The analysis began with calculation of the omnibus MANOVA and in case of significant differences; we performed separate univariate ANOVAs to determine the source of these differences. Tukey's post-hoc test was used for testing simple main effects. The alpha level used in the analysis was set at .05.

For statistical comparison, chi-square tests were used to analyze the non-parametric data, using A and B against C and D (normal or nearly normal versus abnormal or severely abnormal) in the International Knee Documentation Score evaluation form.

A data base software program for an IBM-compatible computer was used. Statistical analyses were performed using the SPSSX software package (SSPS, Inc., Chicago, IL)

RESULTS

International Knee Documentation Score Scores

The International Knee Documentation Score assessment combines the patient's symptoms and signs to evaluate the final category for each patient. Each category is given an overall grade of A "normal", B "nearly normal", C "abnormal", or D "severely abnormal". Overall, 99 percent of patients (99 of 100) in the acute group were assessed as normal or nearly normal (grade A or B), while 96 percent (96 of 100) in the chronic group were categorized as normal or nearly normal (grade A or B). [7] There were statistically significant differences between the acute and chronic group in the final score (^{2} 2= 6.43, p =0.04) Fig. 3.1.

Category 1 (Subjective Functional Assessment).

No statistically significant differences were detected in the patients' subjective assessment of their knee function (p = .60) between the acute and chronic group. In the acute reconstruction group, 97 percent of patients (97 of 100), and in the chronic reconstruction group, 99 percent of patients rated their knee function as "normal" (A) or "nearly normal" (B).

Category 2 (Symptoms).

Acute group had statistically significant higher impedance of knee effusion than the chronic group (p = .03). Ninety-two percent (92 of 100) of the acute group and 92 percent of the chronic group reported no pain during moderate or strenuous activities.

Ninety-six percent of the acute group and 97 percent of the chronic group reported no swelling during moderate or strenuous activities. For partial giving way, there were 98 percent of the acute group and 97 percent of the chronic group without symptoms during moderate or strenuous activities. Ninety-nine percent of the subjects in both groups reported no full giving way during moderate or strenuous activities.

Category 3 (Range of Motion).

There were no differences in tibiofemoral joint range of motion between the acute and chronic surgery groups ($p = .62$). Full extension, or a 3-degree or less difference from the opposite limb (an International Knee Documentation Committee grade of A), was recorded in 95 percent (95 of 100) of the acute group and 96 percent (96 of 100) of the chronic group. Loss of extension of 3 to 5 degrees was present in 5 percent of acute patients and four patients had loss of extension of 3 to 5 degrees in the chronic group. Full flexion or a 5 degrees or less difference in range of motion (A) was present in 96 percent of in acute reconstruction group, while 99 percent of the chronic group had full flexion. The remaining patient in each group lacked 6 to 15 degrees of flexion.

Category 4 (Ligament Evaluation).

No statistically significant difference was detected between the acute and chronic surgery groups with regard to tests of knee joint laxity evaluation, including Lachman test ($p = .29$), pivot shift ($p = .11$) and the reverse pivot shift ($p = .24$).

Lachman testing demonstrated 87 percent (87 of 100) of the acute group and 94 percent (94 of 100) of the chronic group had grade 0 laxity in their anterior cruciate

ligament reconstructed knee, according to the International Knee Documentation Committee evaluation. Thirteen percent of the patients in the acute group and 6 percent (6 of 100) in the chronic tendon group had grade 1 laxity (3 millimeters displacement). No patients in ether groups had grade 2 or grade 3 laxity (International Knee Documentation Committee grade of C).

Pivot shift test results found that 92 percent (92 of 100) of the acute patients and 95 percent (95 of 100) of the chronic patients had a negative, or grade 0, result. The remaining 8 percent of the patients in the acute group and 5 percent in the chronic group demonstrated a grade 1+ pivot shift.

Reverse pivot shift testing showed 97 percent (97 of 100) of the acute patients, 100 percent of the chronic patients demonstrated a negative or grade 0 result. The remaining 3 percent in the acute group had a grade 1+ reverse pivot shift.

Category 5 (Compartment findings)

Patellofemoral joint crepitus was much more prevalent among the chronic reconstruction patients than the acute surgery group ($p = 0.0001$). The patellofemoral joint was graded "normal" in 95 percent (95 of 100) of the patients in the acute group while only 62 percent (62 of 100) in the chronic group. Five per cent of the acute group and 38 percent of the patients in the chronic group had mild to moderate patellofemoral crepitation.

Similarly, the chronic group had a significant greater by incidence of medial compartment crepitus ($p=0.0001$) than did the acute surgery group. Ninety-four per cent of the acute group did not have any medial compartment crepitation, while 62 percent of

the chronic group had normal tibiofemoral compartment findings. Ninety percent of the acute group and 87 percent in the chronic group had normal lateral compartment crepitation at follow-up. The remaining patients in each group were graded as mild to moderate crepitus in both compartments.

Category 6 (Harvest site)

Patients in the acute group had significantly more harvest site pathology than did the chronic group (p=0.001). Tenderness, numbness, and irritation were absent in 74 percent (74 of 100) of the acute group and 79 percent (79 of 100) of the chronic group; however, mild patellar tendon symptoms were noted in 26 percent of the acute group and 21 percent of the chronic group.

Category 7 (Radiological findings)

We did find a highly significant difference between the acute and chronic group with respect radiological findings to the tibiofemoral medial joint space arthritic changes (acute group had better results than the chronic group, p=0.0001). The International Knee Documentation Committee grade of A (normal radiological report) was assigned to the medial joint space for 96 of 100 (96 percent) patients in the acute group and 84 of 100 (84 percent) patients in the chronic group. Three patients from acute group and twelve patients from the chronic group were noted to have moderate radiological changes. Four patients were categorized as having a severe radiological change in the chronic group while only one patient in acute group had a severe radiological change.

The chronic group also had a greater incidence and severity of lateral tibiofemoral joint space arthritic changes (p=0.0001). Ninety-six of the acute group and 83 percent of the chronic group had a normal lateral joint space; three patients in the acute group and thirteen patients from the chronic group were noted to have moderate radiological changes. Four patients in chronic the reconstruction group were categorized as having severe radiological changes. The overall x-ray results in the acute group had better radiological outcome than the chronic group. Fig. 3.1.

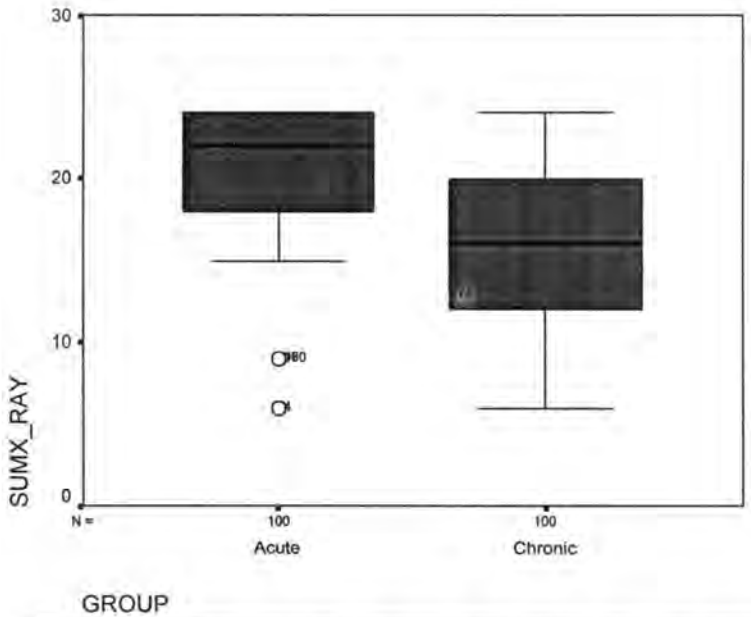

Fig. 3.1. X-ray score differences between the acute and chronic reconstruction groups (maximum = 28 points)

Patellofemoral joint arthritic changes were much more common among the chronic patients than the acute group (p=0.0001). Normal radiological reports for the patellofemoral joint were given to 96 percent of the patients in the acute group and 84

percent in the chronic group. Three patients in the acute group and twelve patients in the chronic group had moderate arthritic changes, while only one patient in the acute group and four patients in the chronic group were categorized as having severe radiological changes.

Category 8 (Functional tests)

No statistically significant difference was detected between the acute and chronic group in the International Knee Documentation Committee functional test category ($p = .43$). The single-leg was scored an International Knee Documentation Committee grade of A or B in 99 percent (99 of 100) of patients in the acute group and 96 percent (96 of 100) in the chronic group. The percentage of the patients assigned to the International Knee Documentation Committee grade A for the single-legged hop test (that is, 90 percent or more of the distance compared with the opposite side) was 91 percent (91 of 100) in the acute group and 90 percent (90 of 100) in the chronic group.

Knee arthrometer evaluation

No statistically significant difference was detected between the acute and chronic group in the KT-2000 ($p= .185$). Arthrometer data were available for all 200 patients who were tested in our institution. During the tests, maximum manual stress was applied with the knee in 30 degrees of flexion, and the reconstructed and normal knees of each patient were compared. The difference between the two knees was three millimeters or less in 63 patients (seventeen patients had 2 millimeter difference, while 46 patients had 3 millimeter difference). Between three to five millimeters for thirty-six patients (fourteen

patients had a 4 millimeter difference, while twenty-two patients had a 5 millimeter difference) in the acute group and only one patient had more than a 5 millimeter difference, while in the chronic group, 62 of 100 patients had less than three millimeters difference between the two knees (twenty-three patients had 2 millimeter difference, while 38 patients had 3 millimeter difference), 34 patients had between 3 to 5 millimeters, (twenty-six patients had 4 millimeter difference, while eight patients had 5 millimeter difference) and four patients was more than 5 millimeter.

DISCUSSION

The primary objective of this study was to determine if clinical outcomes after anterior cruciate ligament reconstruction were affected by the timing of surgical reconstruction. To the best of our knowledge, no previous study has compared the postoperative results of acute and chronic reconstruction of isolated anterior cruciate ligament tears using arthroscopically-assisted techniques, particularly in this large a group of patients.

The current study of 200 patients had a follow-up period of sufficient duration (2.2 years) to be considered prognostic. Postoperatively, both knees of all 200 subjects were examined clinically and graded by one evaluator (WFM). Our patient population was young with an overall mean age for both groups of 32.2 years. There was an imbalance in the gender of the patients (predominantly male) due either to the cultural differences or the fact that not many women in the Middle East practice vigorous sports. Furthermore, the outcome assessment techniques were identical for each experimental

group, and the groups were comparable in age, sex, activity level, height, weight, side affected, condition of the contralateral knee, and indications for surgery.

There were several limitations inherent to retrospective studies that were encountered in the research process. The best-case scenario world has been to formulate a prospective experiment that randomly assigns patients to the treatment groups. In the present study we would have benefited from all patients having full pre-operative radiographic evaluations including C-T scan and MRI for comparative purposes. Additionally, a standardized series of imaging studies would have helped us to better evaluate the changes that occurred between surgery and follow-up, and the differences that exist between the patient's surgical and normal knee

Loss of secondary restraints has been shown to contribute to knee instability and increase the incidence of meniscal and articular surface damage with resultant arthrosis. [33] Early operative interventions may limit these sequellae, as significant benefits of acute reconstruction (less than 90 days post-injury) of anterior cruciate ligament ruptures have been reported. [9,33,79]

Our findings suggest that if anterior cruciate ligament reconstruction is delayed and patients increase their pre-surgery activity levels with an unstable symptomatic anterior cruciate ligament deficient knee, the resultant chronic condition may represent a different clinical entity than acute anterior cruciate ligament deficiency. Patients in our chronic reconstruction group who had surgery earlier had higher final International Knee Documentation Committee scores and better overall outcomes.

Early reconstruction of the anterior cruciate ligament should be advocated in young, active patients with high motivation levels to prevent or minimizing the incidence

of further instability or secondary degenerative lesions (Fig.3.2). Early reconstruction anterior cruciate ligament surgery in young, motivated athletes can be performed without a greater risk of loss of motion than in patients with late reconstruction if an aggressive rehabilitation program follows the procedure. Our findings suggest that earlier reconstruction of the anterior cruciate ligament deficient knee using patellar tendon autografts provide more optimal results.

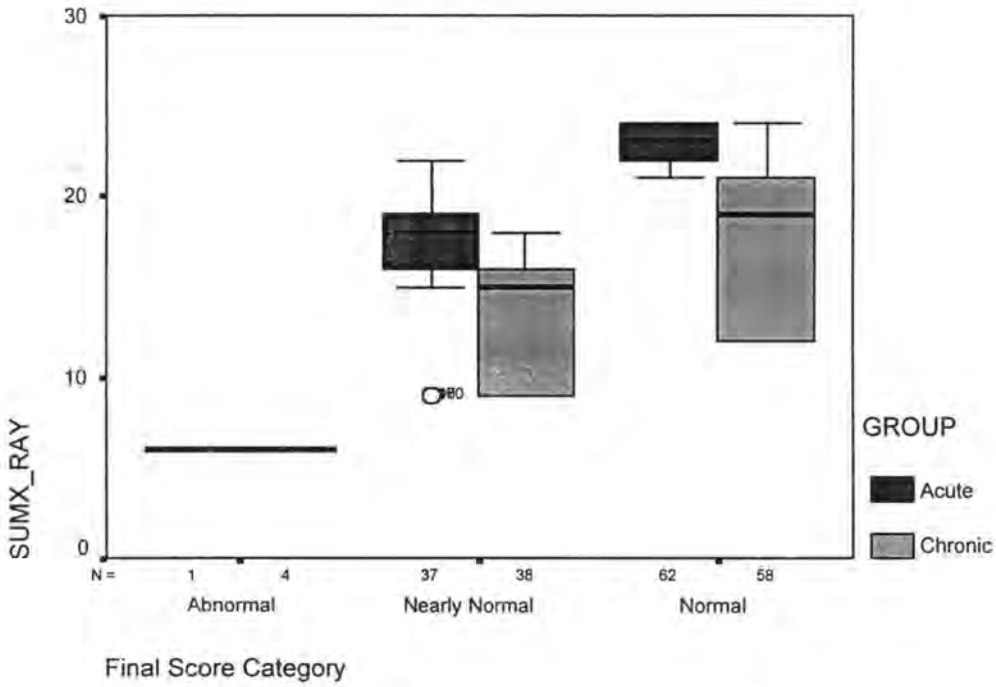

Fig. 3.2. IKDC Final score in relation to the sum of the X-ray findings.

One of the major goals of any ligamentous reconstruction is the prevention of long-term degenerative changes. The ultimate success of an anterior cruciate ligament reconstruction is based on the establishment of functional stability as well as the prevention of any other injury of the knee, and degeneration of the tibiofemoral joint. Our conclusions are supported by the better objective outcomes noted among the acute reconstruction group on Lachman and pivot shift tests. It is of note that 92 percent of our patients in the acute group had a negative pivot shift test, while only 87 percent had a negative Lachman; all the patients in the acute group had a negative anterior drawer test. In the chronic group 95 percent of the patients had a negative pivot shift test, 95 percent had a negative Lachman and also all the patients in the chronic group had a negative anterior drawer. Only one patient in the acute group and four patients in the chronic group had anterior knee translation more than 5 millimeters by the KT-2000 arthrometer.

Controversy persists regarding whether the most suitable period for reconstructing the anterior cruciate ligament is at the early stage or after the joint inflammation has subsided. O'Brien et al.[67] and Clancy et al. [19] have reported satisfactory postsurgical clinical and laxity testing results in more than 93 percent of their anterior cruciate ligament cases. Other authors have recommended reconstruction within 2 weeks of the injury, particularly in patients with high functional requirements. [84,85] This early surgical treatment may help prevent additional instability and reduce the risk of meniscal or articular cartilage lesions that can accelerate the development of degenerative joint disease. [84,85]

Recent work reported by Shelbourne et al. [79] suggests that delaying anterior cruciate ligament reconstructions for more than three weeks after acute injury may

decrease the incidence of arthrofibrosis. That particular study group, however, reported entirely on patients reconstructed with bone-central third patellar tendon-bone autograft via arthrotomy in contrast to pes anserine tendons. Although the current study reports on an arthroscopically-assisted technique that does not disturb the extensor mechanism, we concur with the suggestions offered in the study by Shelbourne and associates. Thus initial treatment must include administration of non-steroidal anti-inflammatory medications and the application of modalities such as ice, heat, ultrasonography, and electrical stimulation. Operative intervention can proceed once a nearly normal range of motion has returned and the effusion has been eliminated. A reconstruction of the ligament, augmented with an autogenous graft, has to be done before all of the joint reaction has resolved because it is difficult to perform a repair two weeks or more after the injury. At present most surgeons remove the remnant of the anterior cruciate ligament and replace it with some type of graft. The operation can be postponed until the inflammatory response has subsided and the timing is convenient for the patient. A delay of two months is probably not detrimental if the patient avoids activities that might cause reinjury and/or additional damage to the joint.

We found that our results are similar to Shelbourne and his colleagues[79] who reported that delaying the reconstruction by at least 3 weeks resulted in a significant decrease in the incidence of arthrofibrosis and, more specifically, decrease in the incidence of flexion contractures. An accelerated postoperative rehabilitation program can significantly decrease the incidence of arthrofibrosis in knees that are reconstructed sooner than three weeks after injury.[79] Delaying surgery does not adversely affect, but

actually gives improved results when compared with those of anterior cruciate ligaments that have been reconstructed at the acute stage. [79]

Despite the fact that we did not find a significantly higher incidence of arthrofibrosis in the acute group, the acute patients did have a slightly higher incidence of loss of motion. Ten percent of the patients had loss of extension up to 5 degrees in the acute group, while eight patients from the chronic group had limited extension up to 5 degrees (Fig. 3.3). Loss of flexion was recorded in four patients in the acute group and in one patient in the chronic group.

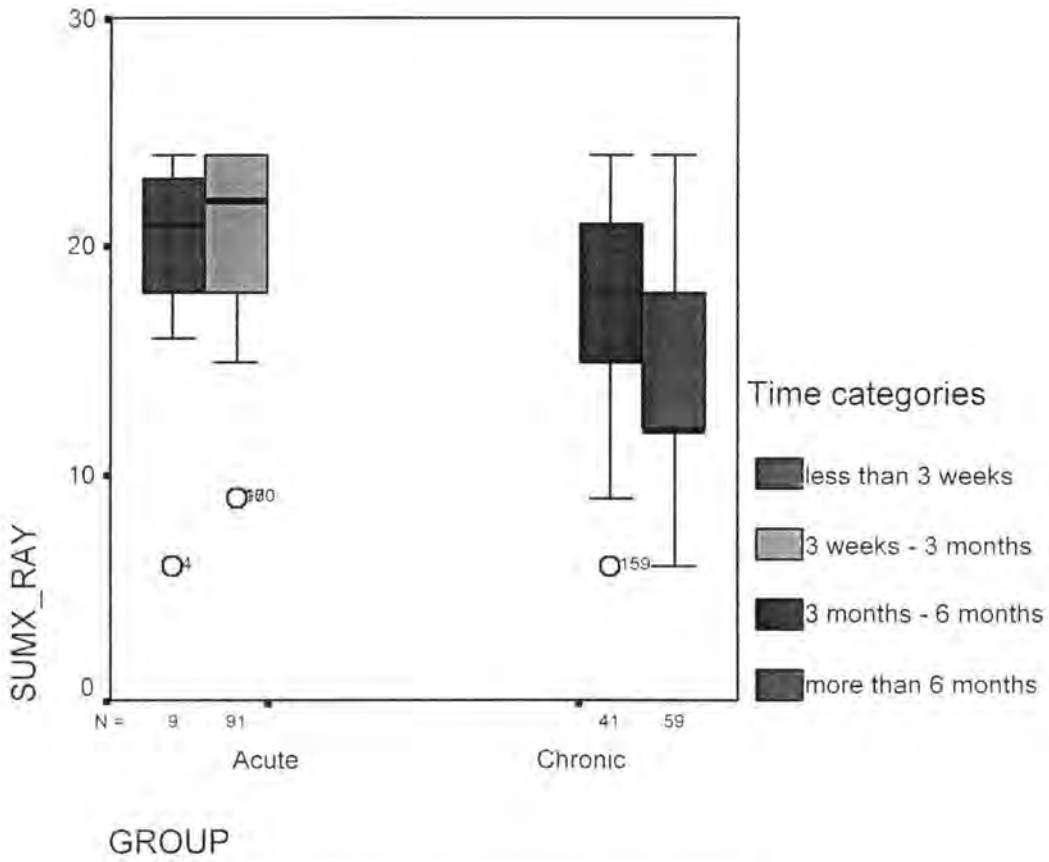

Fig. 3.3. X-ray score in relation to the time from injury to surgery

This difference between the groups referred to those patients who had their operation within three weeks after injury, disregarding the fact of arthrofibrosis. In the present study, the patients in the acute group had significantly higher frequency of swelling than did the chronic group. This finding may have been related to the timing of surgery.

The incidence of postoperative joint stiffness, considered by many authorsto be the most frequent complication in early treatment[37,38,79], was nearly identical in both groups. The aggressive rehabilitation protocol with complete extension immediately after the operation, mobilization of the knee on the second day, and full weight bearing on the seventh day was fundamental in preventing postoperative stiffness. Shelbourne et al. [78] demonstrated that in an early reconstruction group, modified rehabilitation reduced articular stiffness from 27 percent in patients who were treated with a conservative protocol to 8 percent in patients who underwent an aggressive rehabilitation program.

Other authors have shown that the late reconstruction prevents the onset of post-surgical stiffness. Strum et al. [81] observed that arthrofibrosis and subsequent flexion-extension deficits were present in 35 percent of patients (81 of 231) who were treated early, compared with 12 percent of patients (15 of 125) treated late. Mohtadi et al. [61] analyzing the complications after anterior cruciate ligament reconstruction based on the time elapsed between the injury and surgery, found articular stiffness in 65 percent of patients (13 of 19) treated within 2 weeks after injury. Articular stiffness was found in 37 percent of patients (4 of 12) who had surgery more than 6 weeks after injury. The

correlations between surgery performed within 14 days of injury and postoperative articular arthrofibrosis led them to recommend delaying the operation until posttraumatic inflammation resolves. Harner et al. [40] pointed out that the flexion-extension deficit is greater for patients who had early anterior cruciate ligament reconstruction (16 of 43, 37.2 percent) compared with patients who were treated late (11 of 201, six percent). Wasilewski and colleague[84] demonstrated a significantly slower recovery time for the early anterior cruciate ligament reconstruction compared with the late treatment. Opinions and results among studies differ partly because of the differences in patient selection, in postoperative treatment, and in the method of presenting results.

In this study, extension and flexion contracture did correlate (r= .857)with those patients that had their operation within 3 weeks after injury disregarding the fact of arthrofibrosis.

The arthroscopic and radiographic evidence of chondral lesions were documented in this study remain as a possible etiologies for the variations of subjective and objective outcomes. The radiological findings in the medial and lateral joint spaces and the patellofemoral joint had negative correlations with the patients' ages, i.e., older patients had poorer (lower) radiological scores. Crepitus in the patellofemoral joint, and the medial and lateral joint spaces were correlated with the positive radiological signs detected by the x-ray examination.

Functional outcome, as measured by return to pre-injury activity participation, was better in our acute group and this finding supports the more objective data that address restoration of knee stability. The International Knee Documentation Committee scoring system more accurately reflects the patients' overall outcomes. Ninety-nine of the

100 knees in the acute group were rated as having normal or nearly normal function according to the scale of the International Knee Documentation Committee, compared with ninety-six of the 100 knees in the chronic group were rated as having normal or nearly normal. In both groups the functional results were excellents.

Finsterbush et al. [33]documented secondary damage after initial anterior cruciate ligament injury and found that over the course of one month to twenty years, 34 of 98 patients (35 percent) developed further intra-articular damage. Progression of laxity and further loss of secondary restraints may result during the interval from injury to surgery from the patient's attempts to increase activity or unwillingness to modify such activity.

Patients who have a chronic injury of the anterior cruciate ligament (>90 days postinjury) and have had one or more pivot-shift episodes can appreciate the problem created by the absence of the anterior cruciate ligament. However, a patient who has an acute injury is not aware of the implications of recurrent and/or progressive instability of the knee. Therefore, such patients often need careful counseling so that they can fully understand the seriousness of the problem.

The proper identification of candidates for surgery is another important but often underestimated factor in reducing postoperative complications. All of our patients were between 20 and 45 years old, moderately active persons involved in sports, highly motivated with the need to resume their activities as soon as possible, and respectful of medical advice. We observed that the patients who resumed sports activities the earliest had the best results without sacrificing laxity. Wilson and Scranton, [85] and Barber et al. [8] compared patients treated early or late and reported no significant differences in the functional results, including postoperative stiffness. Wilson and Scranton [85] and

Wasilewski et al. [84] reported more frequent meniscal and osteochondral lesions in patients who underwent late anterior cruciate ligament reconstruction.

Barber et al. [8] reported 5-year follow-up results for two groups of patients who had early and late reconstructions, and their findings were similar to our outcomes for the early reconstruction group, especially regarding stability. We agree with Wilson and Scranton[85] that early reconstruction in young and active athletes is necessary to prevent further lesions from developing.

Our findings suggest that earlier reconstruction of the anterior cruciate ligament-deficient knee using patellar tendon autografts may provide more optimal results.

CONCLUSIONS

Timing the anterior cruciate ligament reconstruction to allow for the reduction of the acute inflammatory process and subsequent participation in a preoperative rehabilitation program ($\geq$ 3 weeks post-injury) resulted in fewer cases of arthrofibrosis and blocked range of motion (extensor lag) when compared to those patients whose anterior cruciate ligament was reconstructed sooner than 3 weeks after injury. However, delays of as little as 3 months between isolated anterior cruciate ligament injury and reconstructive surgery had significant negative influences on clinical and functional results, and patient-reported outcomes. Similar to published reports of patients with injuries to the anterior cruciate ligament in combination with other static knee stabilizers, our findings in patients with isolated anterior cruciate ligament injuries support the recommendation that anterior cruciate ligament reconstructive surgery be performed as soon as possible following injury, but not within the initial 3 weeks.

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CHAPTER 4
SUMMARY AND RECOMMENDATIONS

In conclusion, we feel that this research investigation contributes significant new information to the orthopedic/sports medicine community concerning the acute and chronic surgical patients outcomes after isolated anterior cruciate ligament injury. To the best of our knowledge, no previous study has compared the postoperative results of acute and chronic reconstruction of isolated anterior cruciate ligament lesion using arthroscopically- assisted techniques, particularly in this large a group of patients.

Timing the anterior cruciate ligament reconstruction to allow for the reduction of the acute inflammatory process and subsequent participation in a pre-operative rehabilitation program ($\geq$ 3 weeks postinjury) resulted in fewer cases of arthrofibrosis and blocked range of motion (extensor lag) when compared to those patients whose anterior cruciate ligament was reconstructed sooner than 3 weeks after injury. Similar to published reports of patients with injuries to the anterior cruciate ligament in combination with other static knee stabilizers, our findings in patients with isolated anterior cruciate ligament injuries support the recommendation that anterior cruciate ligament reconstructive surgery be performed as soon as possible following injury, but not within the initial 3 weeks.

Delaying the reconstruction by at least 3 weeks resulted in a significant decrease in the incidence of arthrofibrosis and, more specifically, decreased the lack of full extension. An accelerated postoperative rehabilitation program can significantly decrease the incidence of arthrofibrosis in knees that are reconstructed sooner than 3 weeks after injury.[79] Delaying surgery does not adversely affect, but actually gives improved results

when compared with those of anterior cruciate ligaments that have been reconstructed at the acute stage.

Based on our findings, we recommend arthroscopically assisted bone-patellar tendon-bone autogenous grafts as an excellent choice for reconstruction of chronically isolated anterior cruciate ligament rupture, followed by an evaluation-based rehabilitation program that emphasizes immediate knee motion and protection against potentially high joint and ligament forces in the first few months after surgery.

RECOMMENDATIONS:

There were several limitations inherent to retrospective studies that were encountered in the research process. The best case scenario is to formulate a prospective experiment that randomly assigns patients to the treatment groups. In the present study we would have beneficial from all patients having full pre-operative radiographic evaluations including C-T scan and MRI for comparative purposes. Additionally, a standardized series of imaging studies would have helped us to better evaluate the changes that occurred between surgery and follow-up, and the differences that exist between the patient's surgical and normal knee.

There was an imbalance in the gender of the patients (predominantly male) due either to the cultural differences or the fact that not many women in the Middle East practice vigorous sports.

FUTURE RESEARCH DIRECTIONS:

Evaluation of same group of patients at intermediate and long term (5-10 years) follow-up to learn if the anterior cruciate ligament reconstruction has positively influenced the natural history of the knee, or it will have osteoarthritic changes outcome similar to unreconstructed knees.

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APPENDICES

APPENDIX A: REVIEW OF LITERATURE

ANATOMY OF ANTERIOR CRUCIATE LIGAMENT

The ACL courses from its origin in the posterolateral femoral condyle in the intercondylar notch obliquely across the knee joint to its insertion on the anteromedial portion of the tibia. There are two discrete ligamentous fascicles composing the ACL, the anteromedial and posterolateral bundles.

The anteromedial bundle inserts more anteriorly near the base of the anterior tibial spine. Its fibers are tense principally in flexion. The posterolateral bundle is greater in bulk and length and tends to relax in flexion and comes under progressively increasing tension as the knee joint is extended. This orientation of the individual fascicles makes a portion of the ligament tight in any position of the knee[8]

FEMORAL ORIGIN

The ACL fibers originate on the posteromedial surface of the latelral femoral condyle near the articular surface. The area of origin has been described as elliptical or oval. The posterior portions of the fibers tend to parallel the articular surface of the lateral femoral condyle. This bony origin is 16 to 24mm in diameters and is located well posterior in the intercondylar notch. (Arnoczky, 1983)[8] described this area as 24mm distal to the level of the adductor tubercle or 15mm anterior to the junction of the roof of the intercondylar notch and the posterior surface of the lateral femoral condyle.

TIBIAL INSERTION

The ACL courses obliquely in an anteromedial and distal direction to insert into the proximal tibia. The insertion is not on the anteromedial tibial spine but into a fossa anterior and lateral to the spine. This insertion is broad with dimensions of 11mm in width and 17mm in the anteroposterior direction. The tibial insertion sends variable fibers anteriorly to pass beneath the transverse meniscal ligament. A few fascicles also may insert into the anterior horn of the lateral meniscus.

MICROSTRUCTURE

Danylchuck et al [37] investigated the microstructure of human and bovine cruciate ligaments using scanning electron microscopy. The ACL is composed of fibrils of collagen of 150 to 250 (nm) in diameter that interlace to form complex 9 networks. Multiple networks of fibrils form individual fibres of one to 20 microns (um) in diameter that tend to parallel the axis of the ligament. Multiple of collagen fibres coalesce to form subfascicular units 100 to 250 um in diameter. Surrounding each subtascicular unit is a thin band of loose connective tissue, the endotendineum. Danylchuck et al. [37] exhibited three to twenty subfascicular units coalescing to form visible fasciculi of varying sizes. Each fascicule is surrounded by epitendeum, which is thicker than the endotendineum.

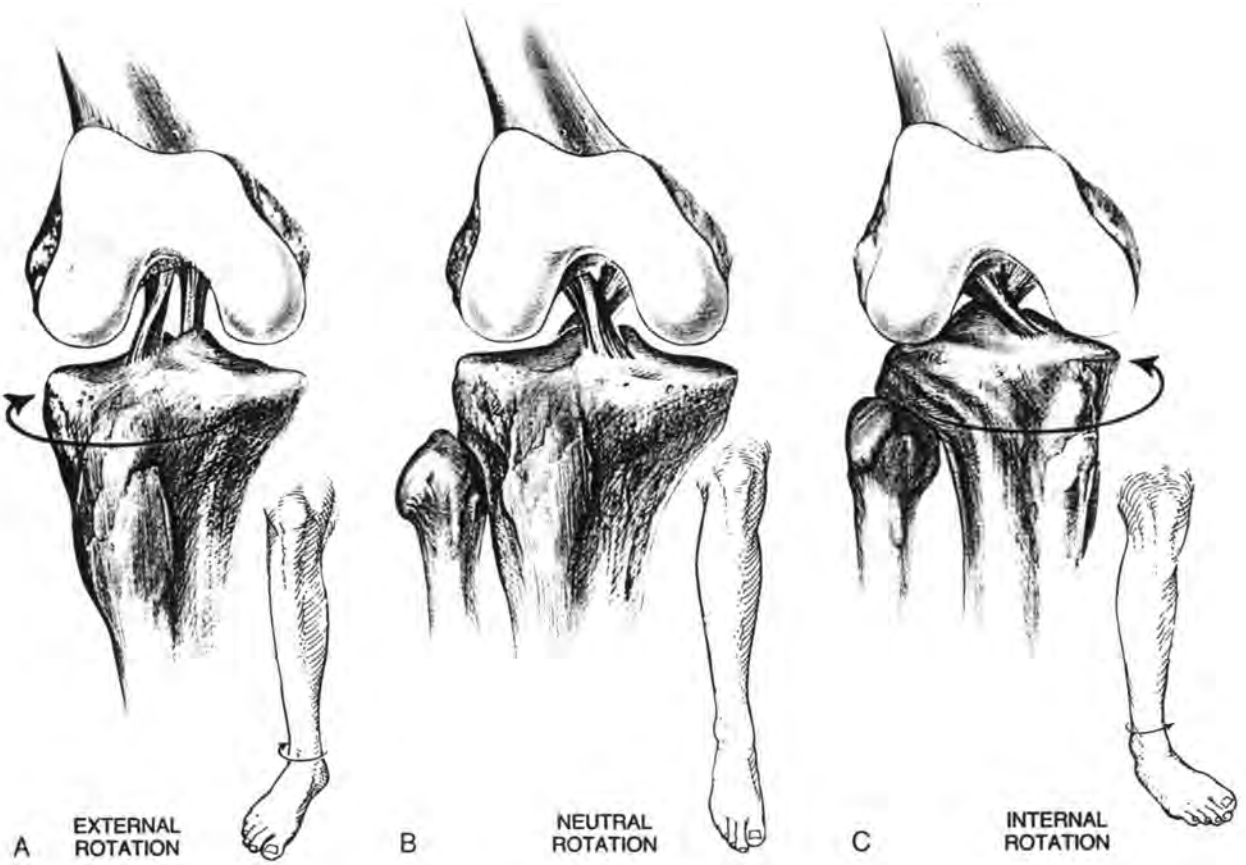

Fig. 1. Hip and knee flexed 90 degrees; tibia externally rotated, in neutral position, and internally rotated. Note tightening of the cruciates with internal rotation.

Danylchuck et al. [37] investigated the neural structures of the knee and found neural eisments within the ACL. These elements were primarily found within the ligament near its tibial attachment. Neural structures were also present in the synovial tissue surrounding the ACL. Danylchuck et al. [37] reviewed ten fresh specimens of ACL from knee that were free of diseases. The age of the specimen ranged from one week to 18 years. Each of the ACLs contained fusiform neural structures consisting of single axon wrapped in a fibrous capsule similar to Golgi tendon organ. The long axis of the structure was parallel to the ligament and was found in the fibrous fatty paratenon.

SURGICAL RELEVANCE

Reconstruction of ACL has emphasized reproduction of the normal anatomical locations of ACL. However one must not only understand the static anatomy of the joint but must have an appreciation of knee joint kinematics. The ACL like all ligaments guides joint motion by constraining abnormal motion. The guidance of kinematics is evidenced by the relative tension seen in various fascicles of composite ACL. While under tension, the individual fascicles exert a restraining effect against abnormal motion. Only by reconstructing each individual fascicle could the original anatomy be reproduced exactly. The goal of reconstruction must be reproduction of the functions of the normal ACL.

THE VASCULARITY OF THE ANTERIOR CRUCIATE LIGAMENT AND ASSOCIATED STRUCTURES

The cruciate ligaments possess a somewhat fragile blood supply as compared with extra-articular tissues. Following injury to the ACL, this intra-articular blood supply may be compromised and thus reparative and constructive procedures may be at risk [37].

ANTERIOR CRUCIATE LIGAMENT

The major blood supply to the ACL arises from the ligamentous branches of the middle genicular artery and from some terminal branches of the medial and lateral inferior genicular arteries[8,9].

A synovial fold that originates at the posterior inlet of the intercondylar notch and extends to the anterior tibial insertion of the ligament where it joins the synovial tissue of the joint capsule distal to the infrapatellar fat pad covers the ACL. The synovial membrane, which forms an envelope about the ligament, is rich with vessels that originate predominantly from the ligamentous branches of the middle genicular artery. A few smaller terminal branches of the lateral and medial inferior genicular arteries also contribute some vessels to this synovial plexus through its connection with the infrapatellar fat pad. The synovial vessels arborise to form a web like network of periligamentous vessels that ensheath the entire ligament. The periligamentous vessels then give rise to smaller connecting branches that penetrate the ligament transversely and anastomose with a network of the endoligamentous vessels. These vessels, with their supporting connective tissues, are oriented in a longitudinal direction and lie parallel to the, collagen bundles within the ligament[11].

The blood supply of the ACL is predominantly of soft tissue origin. While the middle genicular artery gives off additional branches to the distal femoral epiphysis and proximal tibial epiphysis, the ligamentous osseous junction of the anterior cruciate ligament does not contribute significantly to the vascular scheme of the ligament itself[11].

INFRAPATELLAR FAT PAD

The infrapatellar fat pad plays an important role in the vascular scheme of the cruciate ligaments. The infrapatellar fat pad is supplied by the transverse infrapatellar anatomosis of the medial and lateral inferior genicular arteries. These arteries arborize into a web like network of vessels that permeate the entire infrapatellar fat pad. The extent of this vascularization is variable and is dependent on the size of the infrapatellar fat pad[9].

PATELLAR TENDON

The patellar tendon receives its blood supply from two major sources: The infrapatellar fat pad and the retinacular tissues. The medial inferior genicular artery and recurrent tibial artery supply the retinaculum. The anterior portion of the patellar tendon is supplied through its length by vessels from the retinaculum and the posterior portion of the tendon receives vessels from the infrapatellar fat pad. These vessels originate at the proximal and mid portion of the patellar tendon and course inferiorly on the posterior surface of the tendon [9].

A vascular leash that supports the medial portion of the patellar tendon has been described (Paulos et al, 1983). This vascular bundle is made up of vessels from the,

medial inferior genicular artery and provides vessels to both anterior and posterior surfaces of the medial third of the patellar tendon.

VASCULAR RESPONSE OF THE ACL TO INJURY AND REPAIR

Primary repair of ACL injuries in the knee is often difficult and yields inconsistent results. The specific biological factors that may contribute to the problem are not clearly understood. Considerable experimental work has been done on anterior cruciate ligament healing, but the role of ligamentous vasculature has only been implied. Experimental studies have shown that, in dog a surgically created lesion of the ACL results in a significant vascular response throughout the ligament. This response arises from the soft tissues (intrapatellar fat pad & synovium) that surround the ligament. When these vascular soft tissues are removed at the time of injury the intraligamentous vascular response is minimal and delayed. These finding would suggest the preservation and use of the soft tissue of the joint in the repair of the ACL lesions in an attempt to optimize the vascular response of the ligament[11].

Studies have shown that although the ACL is capable of a vascular response following injury, spontaneous repair (or healing by secondary intention) does not occur. This may result from synovial fluid dilution of the hematoma following injury, which prevents the formation of a fibrin clot and thus initiation of the healing mechanism. Another theory suggests that the dynamic nature of the fascicles of the ACL through the range of motion prohibit the spontaneous union of this fibres[11]. The observations stated above have given support to the primary repair of certain ACL lesions but the long-term efficacy of such procedures is still a matter of debate[11].

FUNCTIONS OF THE ACL

Biomechanical data have disclosed five principal functions of the ACL. The first function is that the ACL resists anterior tibial translation on the femur in flexion. Second, the ACL prevents hyperextension of the knee. Third, it provides a check to internal axial rotation and thereby affords rotatory knee control. Fourth, it is a secondary restraint resisting both valgus and varus in all degrees of flexion. Fifth, tension in the ACL fine-tunes the screwhome stabilization of the joint as it approaches terminal extension[41].

The internal tension of the ACL is not constant in all range of knee motion. The ACL is taut between full knee extension and 20 degrees of flexion. It relaxes between 20 and 70 degrees being most lax at approximately 40 degrees. From 70 to 90 degrees the ligament increases in tension. Anterior tibial displacement on the femur in neutral rotation and flexion (anterior drawer sign) cannot be elicited unless the anterior medial bundle is torn. Eighty five percent of the restraining force to the anterior tibial displacement at both 30 degrees (Lachman test) and 90 degrees (anterior drawer test) of flexion is provided by ACL[26]. The ACL also prevents hyperextension of the knee. Tears of ACL are reproduced when hyperextension forces are applied to cadaveric knees in an attempt to simulate total knee dislocation. Forced hyperextension concentrates stress in the mid substance of the ligament, specially the anteromedial bundle as it emerges from under the intercondylar shelf, genu recurvatum can be produced after selective section of ACL[7].

The ACL tightens with maximal internal rotation of the tibia. Therefore it is believed that the ACL acts to check internal tibial rotation. When the ACL is sectioned, its absence allows about 8 deg of excessive internal rotation in terminal extension. The

fibers of the iliotibial band in its intra-articular course are approximately parallel to the fibers of the ACL and are also important in resisting internal rotation forces[7].

The ACL also offers a secondary restraint to excessive valgus and varus stress, significant only after collateral ligament compromise. In this function, both cruciate ligaments act in concert through all ranges of motion. They offer somewhat more resistance to valgus force than to varus arc[75].

Finally, the ACL fine-tunes the screw home motion as the knee approaches terminal extension. Stability is of great importance in this range, especially to the athlete in the process of deceleration or acute change in direction.

The ACL acts in synergy with all the stabilizing elements of the knee joint. If the ACL is ruptured or plastically elongated, the synchronous rolling-gliding movement of the knee disintegrates.

PATHOLOGY OF ACL TEARS

MECHANISM OF INJURY

The mechanism of injury is a detailed description of what happened at the time of injury. Disagreement still exists as to the mechanism of the so-called isolated ACL disruption. All of the supporting structures about the knee function in concert. The injury to the other structures apart from ACL may be minimal and thus heal with conservative measures, leaving what is apparently an isolated injury. Mechanisms that reported as possibly able to disrupt the ACL with minimal injury of other supporting structures are hyperextension, marked internal rotation of the tibia on the femur and pure deceleration. Non-contact injuries can occur during running with sudden changes in

direction. Landing on the leg as well can produce very high forces across the knee. The most common contact injury is a combination of deceleration, valgus and external rotation of the leg. An example of this mechanism is landing on the slightly flexed knee while pivoting away from the planted leg[34].

The most common contact injury is one in which the leg is fixed to the ground in slight flexion and the force is applied to the lateral and posterolateral aspect of the knee. This mechanism results in abduction and flexion forces on the knee and the femur is internally rotated by the shift of the body on the fixed tibia. The severity of the lesion may vary from a mild sprain to a complete disruption of a single ligament or a combination of ligaments.

In hyperextension injury the force is applied to the anterior aspect of the extended knee. This is likely to tear the ACL, especially if the leg is internally rotated.

Hyperflexion injuries although rare may occur if a player has his leg pinned after him resulting in stress on the ACL[34].

TERMINOLOGY OF KNEE LAXITY

Stability is the patient interpretation of a joint ability to accept and-apply load without allowing abnormal motion. Instability is the patient description of abnormal knee movement under an applied load. Laxity is a movement elicited during examination and is either normal or abnormal. Abnormal laxity can be graded I, II, or III: Grade I is 0 to 5mm of displacement, Grade II is 5 to 10mm displacement, grade III is more than 10mm displacement. These define only the magnitude (amount) of the laxity. It is also important to assign the direction of the abnormal movement. This turns the scale measure of displacement into a vector.

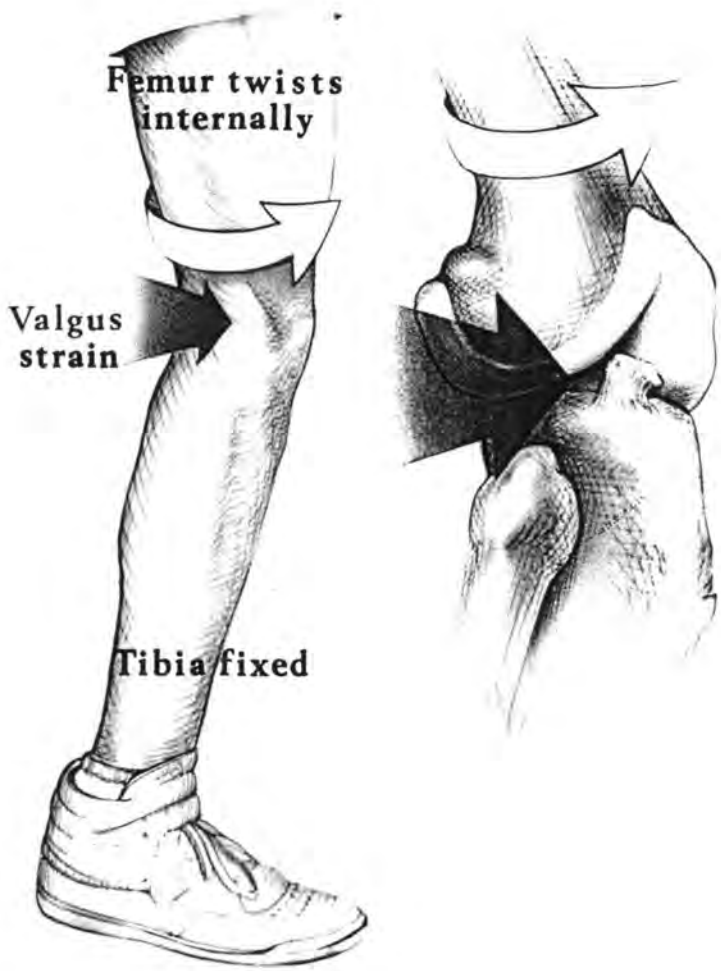

Fig. 2. The subluxed right knee reduces during a pivot shift dysfunction. Note the direction of the twist, the slight knee flexion, and the axial loading of the lateral compartment of the joint.

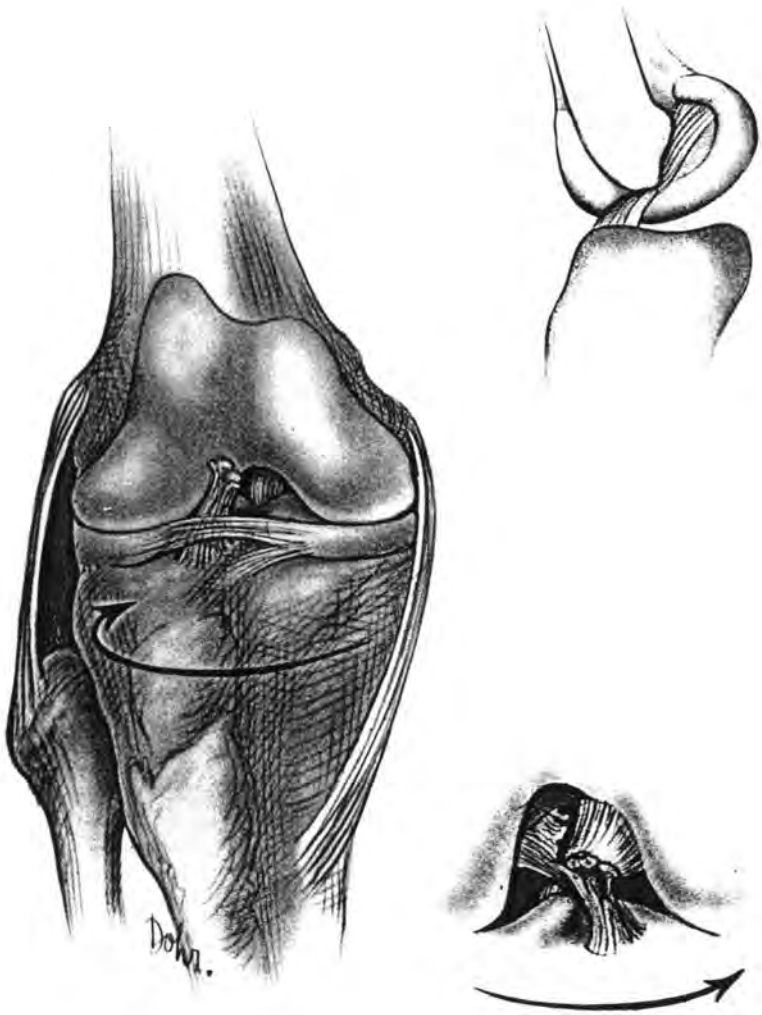

Fig. 3. The ACL is at risk in hyperextension, where it may be jeopardized by the sharp intercondylar ridge. Also, it is at risk with rotation, where it may be tented over the medial or lateral confines of the notch, or the PCL.

The potential direction of these vectors of abnormal movement can be linear, rotational or a combination of the two. They can be described using the six degrees of freedom. There are three linear translations and three rotations in the knee[11]. The translations are anterior-posterior, proximal-distal (distraction-compression) and medial-lateral. The three rotations are varus-valgus, internal-external and flexion-extension. A translation movement means that every point of the moving object simultaneously has the same velocity and direction of motion. Rotation is the pivoting or turning of an object about an axis. Translocation is a change in position, this may be a combination of translation and rotation[22].

TESTS DEMONSTRATING TRANSLATION

1- **Anterior drawer test** with the knee in 90 degrees of flexion: This test is performed with the patient in the supine position, the hip is flexed approximately 45 degrees, the knee is flexed 90 degrees and the patient's tibia is in neutral rotation with the foot flat on the table. The examiner hands are then placed with the fingers over the patient's hamstrings and the gastrocnemius heads; the thumbs are placed on the tibial plateau and the joint line. The leg is stabilized either by ulnar border of the examiner arm placed on the medial side against the

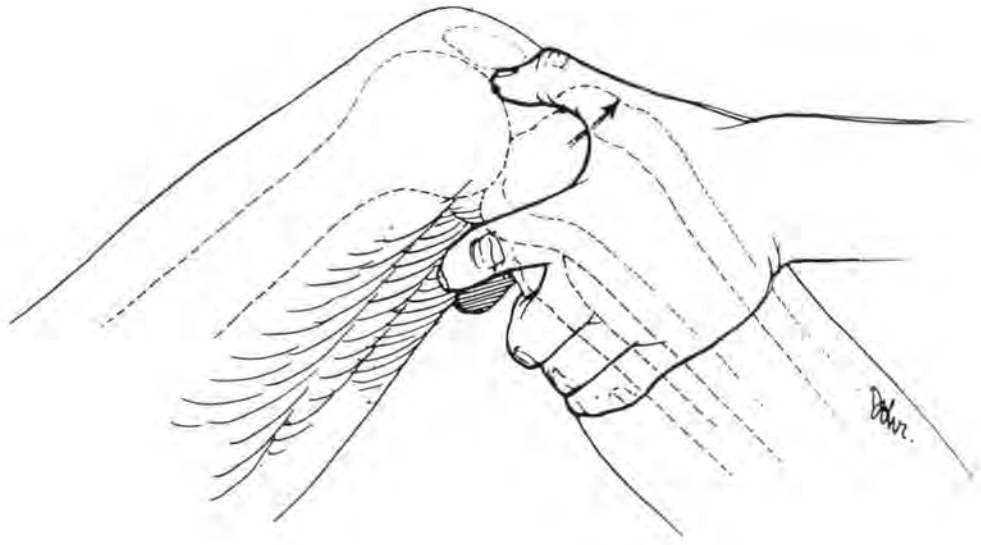

Fig.4. AP glide with thumbs measuring the translation of the tibia on the femur.

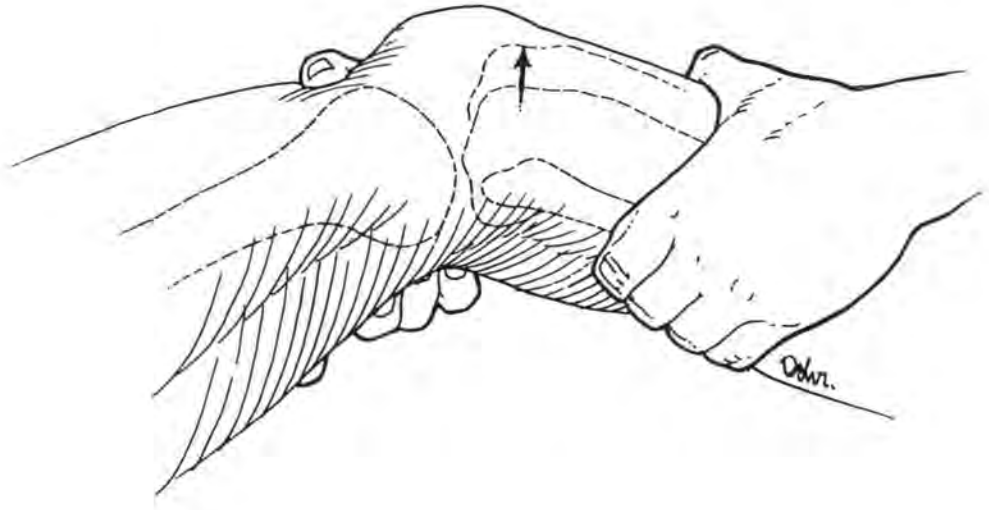

Fig.5. The Lachman test.

anterior aspect of the patient leg, or the examiner sits over the patient foot. A smooth steady pull is then made in an anterior direction. This is repeated with the leg in internal and then external rotation. The resulting displacements are recorded.

2-Lachman test: This test is performed with the patient supine and the knee is in approximately from 15 to 20 degrees of flexion. The examiner uses one hand to stabilize the patient femur by grasping the distal thigh just proximal to the patella. With the other hand the examiner grasps the tibia just distal to the tibial tubercle. Firm pressure is then applied to the posterior aspect of the tibia to produce an anterior translation. The amount of anterior translation is recorded. If test is positive, it means that the tibia underwent an anterior subluxation. Three key points of emphasis to the Lachman test are:

1) This test has to be done bilaterally to compare with the healthy side.

2) Be sure that it is an anterior translation and not a reduction of a posteriorly displaced tibia.

3) The end point of the test varies from (hard) implying a firm definite stop to a (soft or mushy) a less distinct and less sudden stop.

TESTS DEMONSTRATING ANTEROLATERAL ROTATORY LAXITY

The pivot shift is synonymous with anterolateral instability. Losee (1983)[68] reported on 95 knees operated on to eliminate the pivot shift; all revealed lesions of ACL.

A positive pivot shift test indicate not only ACL insufficiency but also a physiologic or patliologic laxity of the secondary extra - articular ligament restraints. Arnoczky et al.[11] estimates that 10 to 20% of knees with an anterior cruciate tear do not have a fully positive test due to the associated tightness of the secondary ligament restraints.

1) THE FLEXION ROTATION DRAWER TEST:

It combines the pivot shift test and the Lachman test. The patient lies in supine position and his knee is in 20 degrees of flexion and neutral. The examiner index finger of one hand is placed along the lateral join line of the patient and the other fingers support the lateral calf. The examiner index finger of the opposite hand is placed along the medial joint line with the other fingers also supporting the calf muscles. Both thumbs of the examiner are placed along the anterior tibia, and the patient's ankle rests on the examiner side. In this position if the tibia is held firm, the femur will translate posteriorily and externally rotate. The patient knee is then gently flexed as the examiner thumbs push the tibia posteriorly. The test is positive if the, femur internally rotates as it assumes the reduced position. The femur will sublux if the knee is gently extended and the tibia is slipped anteriorly.

2) THE SLOCUM TEST

This test has the advantage over the previous test in getting complete quadriceps relaxation and the greater ease of the performance on a large or muscular patient. The patient lies over the healthy side with the lower hip and knee flexed enough to stay clear of the upper leg. The upper hip and pelvis are rotated posteriorly until the weight is born by the heel of the upper leg with the knee free of the table. The knee is then placed in 10 degrees flexion. It will sag into valgus and the tibia will rotate internally and translate

anteriorly. The examiner's hands are positioned of the lateral side of the knee region. The examiner hand, which is near to the patient foot, is placed with the thumb behind the fibula and the index finger along the joint fine. The other hand grasps the distal femur with the thumb over the lateral femoral condyle. While applying equal pressure with both hands the patient knee is gently pushed to flexion. Wlien the knee is flexed past about 25 degrees the anteriorly subluxed tibia will reduce by moving posteriorly and by rotating externally, if anterolateral rotatory laxity is present. This reduction is usually palpable but may be subtle with lesser laxity.

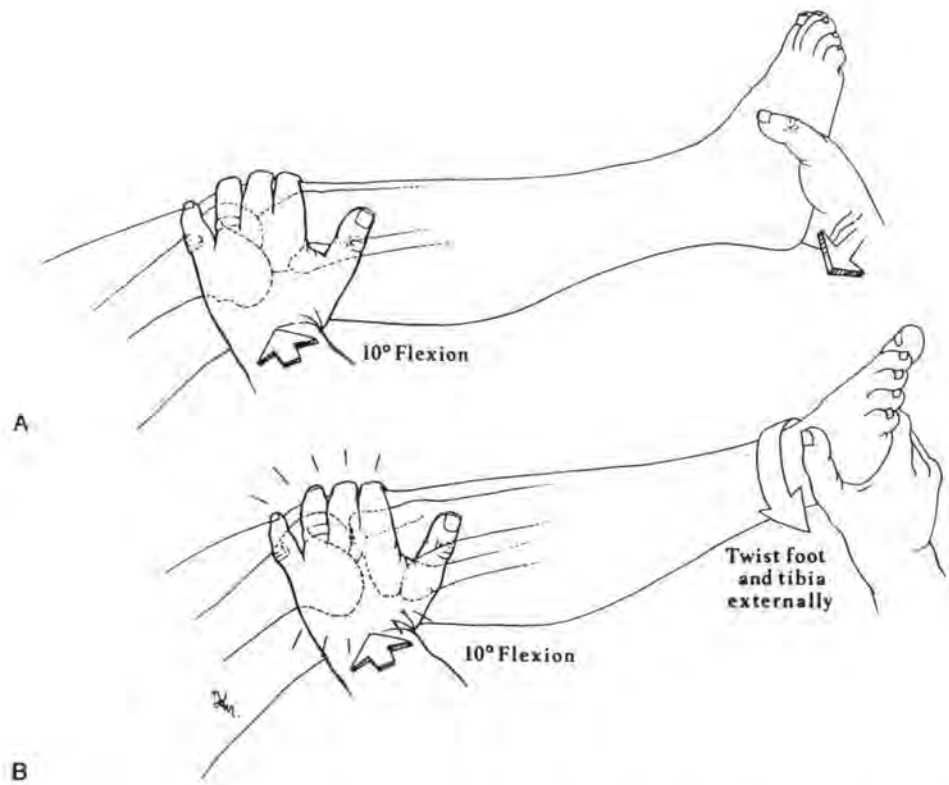

Fig. 6. Test for the pivot shift by externally twisting the tibia to reduce the subluxed knee, **(A)** Flex the knee 10'. Allow gravity to drop the lateral femoral condyle posteriorly. Assist this by internally twisting the foot. Forcefully compress the lateral joint Compartment by pushing the knee and pulling the foot. **(B)** Externally twist the foot with the tibia to cause an impinging reduction of the knee that the patient will recognize and relate to the dysfunction illustrated in Fig. 7.

3) THE LOSEE TEST

In this test the patient is in supine position, his foot is supported by one hand of the examiner and the leg is slightly externally rotated and braced against the examiner's abdomen. As the knee is placed in 30 degrees flexion, the tibial subluxation is reduced. The examiner's other hand is placed with the fingers over the patella and the thumb posterior to the fibular head. The abdomen of the examiner then applies a valgus strain. The knee is then slowly extended and the leg is allowed to, go into internal rotation. The fibular head is pushed anteriorly with the examiner's thumb, and the fingers push the femur posteriorly. If the test is positive, the tibial plateau subluxes anteriorly just short of full extension and the patient recognize this as his symptom.

MECHANICS OF THE STABILITY TESTS OF THE KNEE

The articular surface undergoes a combination of rolling and gliding movements as the knee flexes and extends. These movements are controlled by a combination of the forces of the muscle - tendon units, the ligamentous constraints, and the bony geometry[22]. For each joint position and for each direction of motion certain ligaments will provide most of the restraints against abnormal movement. These are designated as the primary restraints by (Butler & Noyes, et al, 1980) [26]. The primary restraints protect the secondary restraints from excessive force.

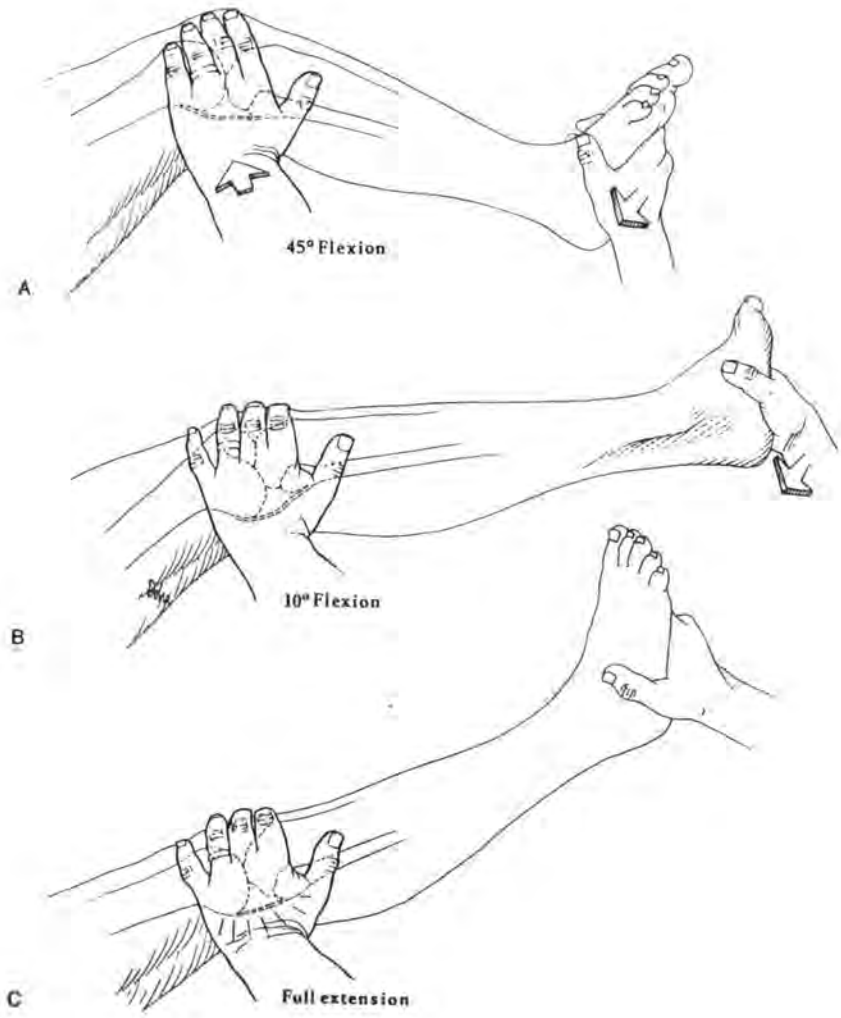

Fig. 7. Losee's test for the pivot shift by extending the knee from a reduced to a subluxed position. **(A)** The 45' flexed knee is reduced with the foot and -tibia twisted externally. Push the knee and pull the foot to compress the lateral joint compartment. **(B)** Let the knee extend while maintaining strong lateral compartment compression. Let the tibia twist internally as the joint subluxes with a thud between 20' and 10'. **(C)** Complete extension quietly reduces the knee as the posterior capsule tightens.

The primary and secondary restraints act in concert to guide the motion of the knee. In a normal knee flexed 90 degrees 440 Newton (N) are required to reduce an anterior translation of 5mm. If the anterior cruciate ligament is tr67nsected, a 90 N force is required to displace the tibia anteriorly 5mm at 90 degrees of flexion as a result of the secondary restraints. At 30 degrees of flexion the forces are 330 N and 90 N respectively. Jonsson et al, (1982) [63] stated that the Lachman test is more sensitive than the anterior drawer test. The reasons stated are that the knee is held in a position more comfortable for the patient that the mechanical advantage of the hamstrings is negated, and that the contact area of the lateral tibial plateau is slightly convex in this position. These three factors interact to reduce the coefficient of static friction.

The joint geometry and the ligaments determine the relationship between gliding and rolling movements. The cruciate ligaments are the dominant ligamentous restraints controlling this ratio[22]. In the anterior cruciate deficient knee rolling movement predominates during early flexion. This causes the tibia to sublux anteriorly. The great radius of curvature of the lateral femoral condyle and the convexity of the lateral tibial plateau contribute to the relatively great amount of anterior displacement of the lateral tibia] plateau (internal rotation). It is important to remember that both the medial and lateral side's subluxes anteriorly.

The iliotibial band plays a central role in the pivot shift phenomenon. In the normal knee the iliotibial band acts as knee extensor when the knee is extended because its mean line of force is anterior to the flexion axis of the knee. When the knee is fully flexed the iliotibial band mean line of force is posterior to the flexion axis of the knee and it acts as a knee flexor. There is a critical point between 20 and 30 degrees of flexion

when the mean line of force intersects with the central axis. Flexion past this point converts the extension function of the iliotibial band to flexion. If the knee ligaments are intact this is a smooth transition.

Fetto & Marshall (1979)[47] said that loss of ACL is necessary for the production of the pivot shift phenomenon. As the anterior cruciate deficient knee is flexed from full extension, the femur rolls on the tibial plateau. This produces an anterior translation of the tibia. Tension on the iliotibial band is increased because it is abnormally lengthened during this phase. When the knee flexion angle passes the critical Point, the iliotibial band suddenly becomes a knee flexor and the direction of the force pulls the tibia Posteriorly into the reduced Position. The sudden reduction is (the pivot shift). It is accentuated by lateral and Posterolateral capsular laxity. Internal rotation will increase the reduction phenomenon because it increases the original subluxation. For the same reasons external rotation may eliminate the pivot shift because of decreased subluxation.

DIAGNOSIS OF THE ACL DEFICIENT KNEE BY DIFFERENT IMAGING MODALITIES

RADIOGRAPHIC DIAGNOSIS

Radiographically the condition of the ACL can be suggested from routine views and diagnosed with either single or double contrast orthography and/or computed tomography. An avulsion of the insertion of the anterior cruciate ligament is diagnosed radiographically on the lateral view by identification of the corticated osseous fragment superior and anterior to the tibial spine. Rarely the ligament is avulsed from its femoral

attachment and in such conditions the avulsed osseous fragment is observed in tunnel view, superiorly within the condylar notch. Also an avulsion of the anterior menisco-capsular attachment of the lateral meniscus is usually associated with a tear of the ACL and in such conditions, the avulsed osseous fragment is observed in the anteroposterior or tunnel views adjacent to the lateral tibia plateau and is known as the lateral capsular sign or Segond fracture[68]. If the lateral capsular sign is present, it is highly suspicious but not pathognomonic injury to anterior cruciate ligament[73].

The presence of a notch defect in the lateral femoral condyle is suggestive of chronic injury to the ACL. The notch may be visualized on either lateral or the internal oblique radiographic projection, The notch defect is thought to originate during the pivot shift when the posterolateral tibial articular margin impinged into the lateral femoral condyle producing a compression fracture. Comparative radiographs of both knees have to be done to differentiate a notch defect from a normal grove of the lateral femoral condyle[73].

The condition of the ACL can be diagnosed by orthography. Arthrography involved the intra- articular injection of positive contrast medium, which coats the synovial surface of the cruciate ligaments, the menisci and the articular cartilage so that these structures can be examined radiographically. Immediately following the injection and passive flexion of the knee 3 - 4 times, the cruciate ligaments are examined. The films to evaluate the cruciate ligaments are obtained before the menisci are examined, because the synovium absorbs the contrast medium faster than the meniscal fibrocartilage. A delay between the time of injection and the radiographic, examination

results in an ill-defined and fuzzy contrast medium coating, which interferes with interpretation. The ACL is evaluated in two positions, a horizontal cross table lateral view and fluoroscopic spot films. For both views, the knee is flexed 45 to 70 degrees, the ligament is stressed with a simulated anterior drawer manoeuvre, and the radiographs are slightly overpenetrated. The status of the ACL is interpreted from both views as follows :

A) Intact: When the anterior synovial edge is uruler straight.

B) Torn or absent: If the synovial edge is not demonstrated, is actually angled or if there is contrast medium pooling in the location of the ligament.

C) Torn with an intact synovium: If the anterior synovial edge is wavy and lumpy.

D) Lax or attenuated but intact synovium: If the anterior synovial edge is bowed concave anteriorly.

MAGNITIC RESONANCE IMAGING (MRI)

The magnetic resonance imaging has been reported to be an accurate, non invasive diagnostic tool for evaluating the ACL. It has been proved that magnetic resonance imaging is very reliable in evaluating ACL[18].

The intact ACL characteristically has two or three dark bands, which run longitudinally, it is presumed to be ruptured if it is not visualized or appear as a diffuse, amorphous area of high signal (Turner et al, 1985). Sometimes, however characterization may be difficult. There may be a suggestion of a band on one image but, because it is not seen clearly, diagnosis remains uncertain. There was a highly significant association (88% to 94%) between a ruptured ACL and a sigmoid shape PCL[18]. The accuracy of MRI in assessing the ACL has been variously quoted to be between 78% and 93%[18].

The accuracy of diagnosing complete tear of ACL ranges from 93% to 100%. However, the accuracy is reduced in case Of acute injury (66%). Partial tear however could not be demonstrated. Accuracy rate may be 50%. False positive and false negative may be obtained[28].

ARTHROSCOPIC DIAGNOSIS OF ACL TEARS

There are two important uses of arthroscopy in cases of torn ACL. The first is diagnostic. It is indispensable in recent injuries. Chronic lesions are somewhat easier to assess. The continuity of the ligament can be excellently assessed from the anterolateral portal. The type of tear is detained (complete or incomplete), the site can also be seen. When as is frequently the case, the ligament is ruptured in its upper third, its fiber's can be seen lying on the tibial plateau in cauliflower fashion. Sometimes the only findings are small stubs at the attachments, though complete absorption of the ruptured ligament is possible. However, in many cases inadequate ligament is present[84].

Probing is helpful in examining partial tear. Anterior drawer test can be done under arthoscopic viewing. Associated lesions as rneniscal tears and cartilage injuries or degeneration can also be assessed.

The second use is therapeutic. Dealing with meniscal injuries and excision of ACL tears which may cause impingement and giving way[84].

FACTORS AFFECTING MANAGEMENT OF CHRONIC ACL TEARS

Several treatment options exist including surgical or non-surgical. Among the surgical options there are: An intra- articular big operation or an extra - articular relatively simple one. Thus the patients must understand the natural history of the ACL deficient knees as well as the possible benefits and risks of surgical intervention.

Non operative management of the ACL rupture includes patient education, physical therapy and selective bracing. Many factors come into consideration if this method is to give patient satisfaction. The patient age, activity level and socio-economic factors contribute to this choice. Many patients have a fear of surgery or are willing to "wait and see" what the results will be without surgery. (Noyes et al, 1983) [83] reported that a large percentage of patients do quiet well with this type of management if they are willing to change their life style in accordance with their level of instability. Disability from ligament instability is often a very subjective and individual manifestation. This management will best serve certain patients. They usually learn to compensate for the loss of their ACL. They may experience no apparent deficits and thus be able to function adequately in the activities of daily living. The majority of ACL injuries fall into this category and they require no surgical reconstruction.

The second approach is an extension of the first non-surgical one. The ACL tear is Usually associated with other injuries in the knee e.g. meniscal tears, articular cartilage damage, chondromalacia and degenerative arthritis. Because internal derangement other than anterior cruciate tears may magnify the disability present, some surgeon may prefer to perform limited arthoscopic surgery without an ACL reconstruction[38]. Dealing with meniscal tears and debriding cartilage defects can increase the chances for success of non-surgical management of the ACL tear.

Finally the surgeon may choose to perform an arthoscopic evaluation with intraarticular arthroscopic surgery, as indicated followed by an anterior cruciate reconstruction. This is the more conventional and traditional operative approach.

Numerous procedures for stabilisation of the anterior cruciate deficient knee are present in the literatures. These include intra- articular either open or arthoscopic methods and extra - articular methods

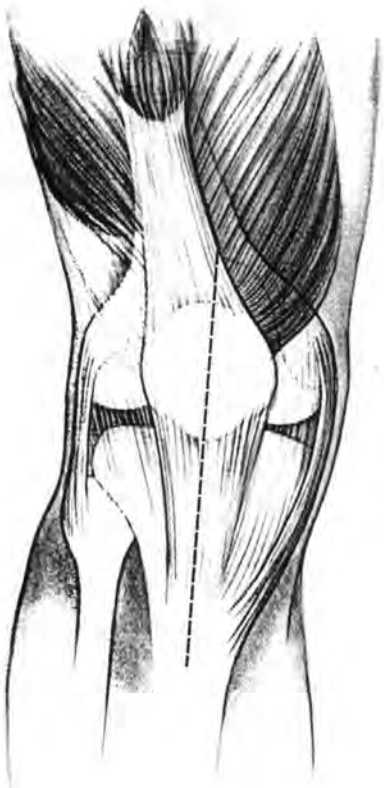

Fig. 8. A straight midline incision is adequate to visualize the pathology in the patient after the triad is diagnosed. The incision should extend from approximately 5 cm above the superior pole of the patella to the insertion of the superficial MCL on the tibia. It may be placed 5 cm medial or lateral to the midline as physical examination dictates.

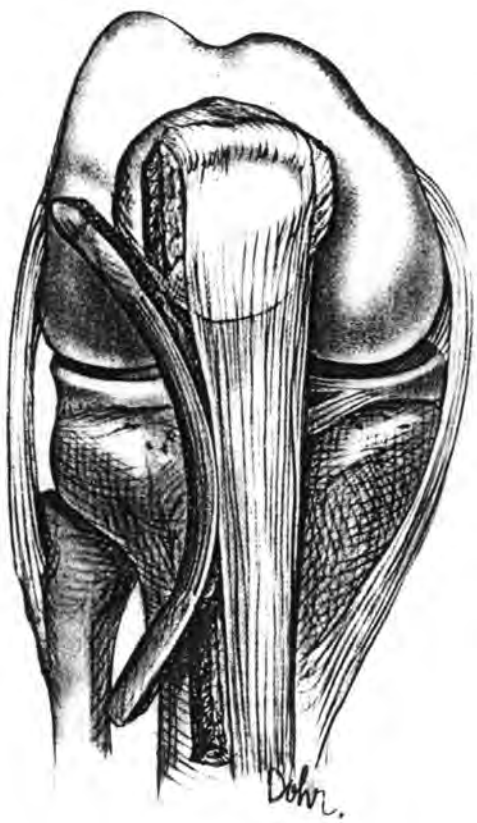

Fig. 9. The ACL lesion is repaired with a tendon graft from the lateral third of the patella tendon.

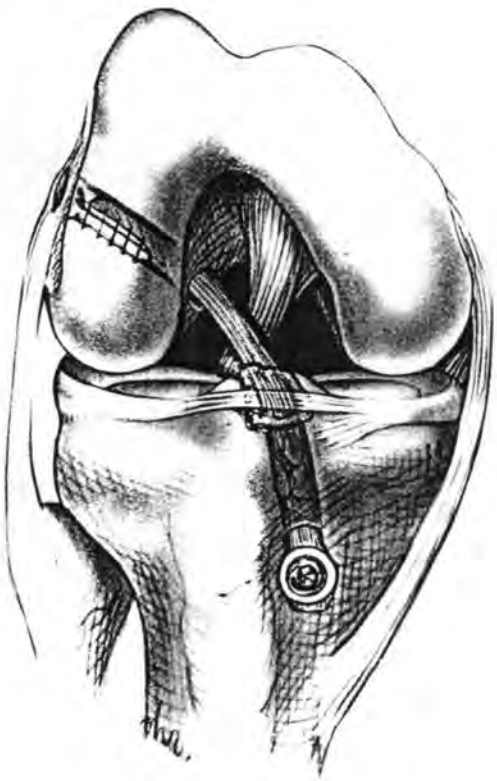

Fig. 10. After augmentation of the ACL, sutures should be placed in the tendon and the isometricitn, checked with a tensiometer through a range of motion.

Fig. 11. The lateral third of the patella tendon is longer than the other parts of the tendon. The graft may be secured with an AO screw external to the tibial canal. Bone graft is added to the canal. The synovium can be Transferred to cover the free ACL graft-a vascularized pedicle (Hewson).

APPENDIX B:

EVALUATION FORMS

KNEE LIGAMENT STANDARD EVALUATION FORM

The first part of the form establishes demographic information, history of prior surgery, findings of the index procedure, current status of the menisci (i.e., normal, 1/3 removed, 2/3 removed or complete removal), morphotype and knee alignment. For activity, the patient selects the highest activity level, which he/she is able to perform; pre-injury, pretreatment, and post treatment. This data is recorded but not graded.

The evaluation includes eight groups, each of which is assigned one of four grades. The eight groups are:

1.Patient Subjective Assessment;

How does your knee function? The patient is asked to rate the involved knee compared to the normal knee or what is perceived as normal.

2. Symptoms:

Grade at the highest activity level at which the patient thinks he/she would be able to function without significant symptoms, even if they were not actually performing activities at this level. Exclude 0 to slight symptoms. Performance at level I, strenuous activity, without a symptom is normal. Patients who are symptomatic at level I activity but not level 11 activities would be graded nearly normal.

3. Range of Motion:

Passive range of motion is recorded on the form for the index side and opposite or normal side. Record values for hyperextension/zcro point/flexion, (e.g. 10 degrees of hyperextension, 150 degrees of flexion = 10/0/150). Hyperextension is recorded as a positive number and a flexion contracture as a negative number. Extension is graded from 0 degrees even if the patient has hyperextension of the normal knee.

4. Ligament Examination:

*The Lachman test, total AP translation at 70 degrees and medial and lateral joint opening may be assessed with manual, instrumented or stress x-ray examination. Only one should be graded, preferably a "measured displacement". A standard force of 30 lbs. (134N) is used in the instrumented examination. The numerical values for the side to side difference are rounded off, and the appropriate box is marked.

*The end point is assessed in the Lachman test. The end point affects the grading when the index knee has 3-5 mm. more anterior laxity than the normal knee. In this case, a soft end point results in an abnormal grade rather than a nearly normal grade.

*The 70-degree posterior sag is estimated by comparing the profile of the injured knee to the normal knee and palpating the femoral tibial stepoff. It may be confirmed by noting that contraction of the quadriceps pulls the tibia anteriorly.

The pivot shift and reverse pivot shift are performed with the patient supine, with the hip in 10-20 degrees of abduction and the tibia in neutral rotation using either the Losee, Noyes or Jakobs techniques. The greatest subluxation should be recorded.

5. Compartment Findings:

Patellofemoral crepitation is elicited by extension against slight resistance. Medial and lateral compartment crepitation is elicited by extending the knee from a flexed position with a varus and then a valgus stress (i.e., McMurray test). Grading is based on intensity and pain.

6. Harvest Sight Pathology:

Note tenderness, irritation or numbness at the autograft harvest site.

7. X-ray Findings:

A bilateral PA weight-bearing roentgenogram at 35-45 degrees of flexion (tunnel view) is used to evaluate narrowing of the medial and lateral joint spaces. The Merchant view at 45 degrees is used to document patellofemoral narrowing. A mild grade indicates minimal changes (e.g., small osteophytes, slight scloerosis or flattening of the femoral condyle), but the joint space is wider than 4 mm. A moderate grade may have those changes and joint space narrowing (e.g., a joint space of 2-4 mm. wide). Severe changes include signicant joint space narrowing (eg, a joint space of less than 2 mm).

8. Functional Test:

The patient is asked to perform a one-leg hop for distance on the index and normal side. Three trials for each leg are recorded and averaged. A ratio of the index to normal knee is calculated.

THE IKDC KNEE LIGAMENT STANDARD EVALUATION FORM

Patient Name_____ Date____/____/____ Medical Record#_____

Occupation_____ Sport: 1st Choice_____ 2nd Choice_____

Age_____ Sex_____ Ht_____ Wt_____ Involved Knee: ☐ Right ☐ Left Contralateral Normal: ☐ Yes ☐ No

Cause of Injury: ☐ADL ☐ Traffic ☐ Contact ☐ Noncontact

Date of Injury:____/____/____

Date of Index Operation:____/____/____

Procedure_____

Postop Dx_____

ACTIVITY

	Pre-injury	*Pre-Rx*	*Post-Rx*
I. Strenuous Activity jumping, pivoting, hard cutting (football,soccer)			
II. Moderate Activity heavy manual work (skiing, tennis)			
III. Light Activity light manual work (jogging, running)			
IV. Sedentary Activity (housework, ADL)			

Eventual change knee related: ☐ Yes ☐ No

PREVIOUS SURGERY

Arthroscopy: Date(1)_____ (2)_____ (3)_____

Meniscectomy: Dx _____ _____ _____

Stabilization: Procedure _____ _____ _____

MENISCAL STATUS

	N1	1/3	2/3	Total
Med				
Lat				

Morphotype: Lax____ Normal____ Tight____

Knee: Varus____ Normal____ Valgus____

EIGHT GROUPS	FOUR GRADES *A. Normal*	*B. Nearly Normal*	*C. Abnormal*	*D. Sev. Abnorm.*	* GROUP GRADE A	B	C	D
1. Patient Subjective Assessment								
How does your knee function?	☐ 0	☐ 1	☐ 2	☐ 3				
On a scale of 0 to 3, how does your knee affect your activity level?	☐ 0	☐ 1	☐ 2	☐ 3	☐	☐	☐	☐
2. SYMPTOMS								
(Grade at highest activity level with no significant symptoms. Exclude 0 to slight symptoms.)	I. Strenuous Activity	II. Moderate Activity	III. Light Activity	IV. Sedentary Activity				
Pain	☐	☐	☐	☐				
Swelling	☐	☐	☐	☐				
Partial Giving Way	☐	☐	☐	☐				
Full Giving Way	☐	☐	☐	☐	☐	☐	☐	☐
3. Range of Motion Ext/Flex: Index side:____/____/____		Opposite side:____/____/____						
Lack of extension (from 0°)	☐ <3°	☐ 3 to 5°	☐ 6 to 10°	☐ >10°				
△ Lack of flexion	☐ 0 to 5°	☐ 6 to 15°	☐ 16 to 25°	☐ >25°	☐	☐	☐	☐
4. Ligament Evaluation (manual, instrumented, x-ray)								
△ LACHMAN (25° flex)	☐ -1 to 2mm	☐ 3 to 5mm <-1 to -3 stiff	☐ 6 to 10mm <-3 stiff	☐ >10mm				
Endpoint: firm/soft	☐ firm		☐ soft					
△ Total A.P. Transl.(70° flex)	☐ 0 to 2mm	☐ 3 to 5mm	☐ 6 to 10mm	☐ >10mm				
△ Post. sag(70° flex)	☐ 0 to 2mm	☐ 3 to 5mm	☐ 6 to 10mm	☐ >10mm				
△ Med jt opening(20° flex)(valgus rot)	☐ 0 to 2mm	☐ 3 to 5mm	☐ 6 to 10mm	☐ >10mm				
△ Lat jt opening(20° flex)(varus rot)	☐ 0 to 2mm	☐ 3 to 5mm	☐ 6 to 10mm	☐ >10mm				
△ Pivot shift	☐ equal	☐ + (glide)	☐ ++(clunk)	☐ +++ (gross)				
△ Reverse pivot shift	☐ equal	☐ glide	☐ marked	☐ gross	☐	☐	☐	☐
5. Compartmental Findings			crepitation with	crepitation with				
△ Crepitus patellofemoral	☐ none	☐ moderate	☐ mild pain	☐ >mild pain				
△ Crepitus medial compartment	☐ none	☐ moderate	☐ mild pain	☐ >mild pain				
△ Creptius lateral compartment	☐ none	☐ moderate	☐ mild pain	☐ >mild pain				
6. Harvest Sight Pathology	☐ none	☐ mild	☐ moderate	☐ severe				
7. X-Ray Findings								
Med Joint space	☐ none	☐ mild	☐ moderate	☐ severe				
Lat Joint space	☐ none	☐ mild	☐ moderate	☐ severe				
Patellofemoral	☐ none	☐ mild	☐ moderate	☐ severe				
8. Functional Test								
One leg hop (% of opposite side)	☐ ≥90%	☐ 89% to 76%	☐ 75% to 50%	☐ <50%				
****FINAL EVALUATION**					☐	☐	☐	☐

*Group Grade: The lowest grade within a group determines the group grade. **Final Evaluation: The worst group grade determines the final evaluation for acute and subacute patients. For chronic patients compare preoperative and postoperative evaluations. In a final evaluation, only the first 4 groups are evaluated but all groups must be documented.

△ Difference in involved knee compared to normal or what is assumed to be normal.

IKDC – INTERNATIONAL KNEE DOCUMENTATION COMMITTEE, Members of the Committee:
AOSSM: Anderson, AF, Clancy, WG, Daniel,D, Dehaven, KE, Fowler,PJ Feagin, J, Grood, ES, Noyes,FR, Terry,GC, Torzilli,P, Warren,RF.
ESKA: Chambat, P, Eriksson, E, Gillquist, I, Hefti, F, Huiskes, R, Jakob, RP, Moyen, B, Mueller, W, Staeubli, H, Vankampen, A.

Activities of Daily Living Scale of the Knee Outcome Survey Form

Instructions:

The following questionnaire is designed to determine the symptoms and limitations that you experience because of your knee while you perform your usual daily activities. Please answer each question by checking the statement that best describes you over the last 1 to 2 days. For a given question, more than one of the statements may describe you, but please mark ONLY the statement which best describes you during your usual daily activities.

Symptoms

1 .To what degree does pain in your knee affect your daily activity level?

-I never has pain in my knee.
-I have pain in my knee but it does not affect my daily activity.
-Pain affects my activity slightly.
-Pain affects my activity moderately.
-Pain affects my activity severely.
-Pain in my knee prevents me from performing all daily activities.

2.To what degree does grinding or grating of your knee affect your daily activity level?

- I never have grinding or grating in my knee.
- I have grinding or grating in my knee, but it does not affect my daily activity.
-Grinding or grating affects my activity slightly.
-Grinding or grating affects my activity moderately.
-Grinding or grating affects my activity severely.
-Grinding or grating in my knee prevents me from performing all daily activities.

3.To what degree does stiffness in your knee affect your daily activity level?

- I never have stiffness in my knee.
- I have stiffness in my knee, but it does not affect my daily activity.
-Stiffness affects my activity slightly.
-Stiffness affects my activity moderately.
-Stiffness affects my activity severely.
-Stiffness in my knee prevents me from performing all daily activities.

4.To what degree does swelling in your knee affect your daily activity level?

-I never have swelling in my knee.
-I have swelling in my knee, but it does not affect my daily activity.
-Swelling affects my activity slightly.
-Swelling affects my activity moderately.
-Swelling affects my activity severely.
-Swelling in my knee prevents me from performing all daily activities.

5.To what degree does slipping of your knee affect your daily activity level?

-I never have slipping of my knee.
- I have slipping of my knee, but it does not affect my daily activity.
-Slipping of my knee affects my activity slightly.
-Slipping of my knee affects my activity moderately.
-Slipping of my knee affects my activity severely.
-Slipping of my knee prevents me from performing all daily activities.

6.To what degree does buckling of your knee affect your daily activity level?

-I never have buckling of my knee,
-I have buckling of my knee, but it does not affect my daily activity level.
-Buckling of my knee affects my activity slightly-
-Buckling of my knee affects my activity moderately.
-Buckling of my knee affects my activity severely.
-Buckling of my knee prevents me from performing all daily activities.

7.To what degree does weakness or lack of strength of your leg affect your daily activity level?

-My leg never feels weak.
-My leg feels weak, but it does not affect my daily activity.
-Weakness affects my activity slightly.
-Weakness affects my activity moderately.
-Weakness affects my activity severely.
-Weakness of my leg prevents me from performing all daily activities.

Functional Disability with Activities of Daily Living

8.How does your knee affects your ability to walk?

- My knee does not affect my ability to walk.
- I have pain in my knee when walking, but it does not limit my ability to walk.
-My knee prevents me from walking more than 1 mile
-My knee prevents me from walking more than 1/2 mile.

-My knee prevents me from walking more than 1 block.
-My knee prevents me from walking.

9.Because of your knee, do you walk with crutches or a cane?
-I can walk without crutches or a cane.
-My knee causes me to walk with one crutch or a cane.
-My knee causes me to walk with two crutches.
-Because of my knee, I cannot walk, even with crutches.

10.Does your knee cause you to limp when you walk?
- I can walk without a limp.
- Sometimes my knee causes me to walk with a limp.
- Because of my knee, I cannot walk without a *limp.*

11.How does your knee affects your ability to go up stairs?
- My knee does not affect my ability to go up stairs. -
-I have pain in my knee when going up stairs, but it does not limit my ability to go up stairs.
-I am able to go up stairs normally, but I need to rely on use of a railing.
-I am able to go up stairs one step at a time with the use of a railing.
-I have to use crutches or a cane to go up stairs.

12. How does your knee affect your ability to go down stairs?

- My knee does not affect my ability to go down stairs.
-I have pain in my knee when going down stairs, but it does not limit my ability to go down stairs.
-I am able to go down stairs normally, but I need to rely on use of a railing.
-I am able to go down stairs one step at a time with the use of a railing.
-I have to use crutches or a cane to go down stairs.
-I cannot go down stairs.

13.How does your knee affect your ability to stand?
- My knee does not affect my ability to stand. I can stand for unlimited amounts of time.
-I have pain in my knee when standing, but it does not limit my ability to stand.
-Because of my knee, I cannot stand for more than 1 hour.
-Because of my knee, I cannot stand for more than 1 12 hour.
-Because of my knee, I cannot stand for more than 1 0 minutes.
-I cannot stand because of my knee.

114. **How does your knee affect your ability to kneel on the front of your knee?**
- My knee does not affect my ability to kneel on the front of my knee.
- I can kneel for unlimited amounts of time.
-I have pain when kneeling on the front of my knee, but it does not limit my ability to kneel.
-I cannot kneel on the front of my knee for more than 1 hour.
-I cannot kneel on the front of my knee for more than 1/2 hour.
-I cannot kneel on the front of my knee for more than 1 0 minutes.
-I cannot kneel on the front of my knee.

115. How does your knee affect your ability to squat?
- My knee does not affect my ability to squat. I can squat all the way down.
-I have pain when squatting, but I can still squat all the way down,
-I cannot squat more than 3/4 of the way down.
-I cannot squat more than halfway down.
-I cannot squat more than 1/4 of the way down.
-I cannot squat at all.

116. How does your knee affect your ability to s it with your knee bent?
- My knee does not affect my ability to sit with my knee bent.
- I can sit for unlimited amounts of time.
-I have pain when sitting with my knee bent, but it does not limit my ability to sit.
-I cannot sit with my knee bent for more than 1 hour.
-I cannot sit with my knee bent for more than 1/2 hour.
- I cannot sit with my knee bent for more than 10 minutes.
-I cannot sit with my knee bent.

17, How does your knee affect your ability to rise from a chair?
-My knee does not affect my ability to rise from a chair.

-I have pain when rising from the seated position, but it does not affect my ability to rise from the seated position.
-Because of my knee, I can only rise from a chair if I use my hands and arms to assist.
-Because of my knee, I cannot rise from a chair,

18. How would you rate your current level of knee function during your *usual daily activities* on a scale from 0 to 1 00, with 1 00 being your level of knee function prior to your injury?

19- How would you rate the overall function of your knee during your usual daily activities?

-Normal
-Nearly normal
-Abnormal
-Severely abnormal

20- As a result of your knee injury, how would you r ate your current level of daily activity?

-Normal
-Nearly normal
-Abnormal
-Severely abnormal

21-Since initiation of treatment for your knee, how would you describe your progress?
-Greatly improved
-Somewhat improved
-Neither improved/worsened
-Somewhat worse
-Greatly worse

Activities of daily living scale of the Knee Outcome Survey (From Irrgang, 1,1 M.R SafTan, and F.H. Fu: The knee: Ligamentous and meniscal injuries. In Zachazewski, I.E., D.]. Magee, and W.S. Quillen leds 1:Athletic Injuries and Rehabilitation Philadelphia, W.B. Saunders Co., 1996, pp 683-684,)

Changes in Daily Activity Level
Please use the following scale to answer questions A-C below.

1 = I was able to perform *unlimited physical work,* which included lifting and climbing.
2 = I was able to perform *limited physical work,* which included lifting and climbing.
3 = I was able to perform *unlimited light activities,* which included walking on level surfaces and stairs.
4 = I was able to perform *limited light activities,* which included walking on level surfaces and stairs.
5 = I was *unable to perform light activities,* which included walking on level surfaces and stairs.

A. - *Prior to your knee injury,* how would you describe your usual daily activity? Please indicate only the **HIGHEST** level of activity that described you before your knee injury.

B. - *Prior to surgery or treatment* of your knee, how would you describe your usual daily activity? Please indicate only the **HIGHEST** level of activity that described you prior to surgery or treatment to your knee.

C. - How would you describe your *current level* of daily activity? Please indicate only the **HIGHEST** level of activity that describes you over the last 1 to 2 days.

Appendix C: Glossary

A

ACL Anterior cruciate ligament. *(See under* Ligament.)

ACL augmentation Reinforcement of the ACL by stenting, whether with autogenous graft, allograft, or prosthetic material. Augmentation may be performed for acute or chronic ACL insufficiency.

Activities of daily living (ADL) Those tasks deemed necessary to maintain one's daily lifestyle, but not including sport participation.

Adhesions See Stiffness.

ADL See Activities of daily living.

Age, gender A patient's age and gender may be critical determinants of the activity level, which in turn dictates the rate of deterioration of the unstable knee. Age and gender are specified in the case studies of *The Crucial Ligaments* to emphasize how they may affect the choice of treatment.

Ankylosis See Stiffness.

Antalgic gait A gait characterized by shifting of the shoulders to unload the painful knee. An excellent diagnostic sign.

Anterior cruciate ligament (ACL) *See under* Ligament.

Anthropometric evaluation Athletes cannot be categorized as mesomorphs, endomorphs, or ectomorphs in a classic fashion, but some athletes are more "at risk" because of a body habitus that is disadvantageous to their sport.

AP Anteroposterior.

Arthritis, degenerative No absolutely satisfactory term exists to describe the deterioration of a joint the kinematics of which have been violated. *Degenerative arthritis* adequately reflects the osteophytosis and joint space narrowing and flattening visible on radiography. *Degenerative arthritis* in the knee is used synonymously with 11 traumatic arthritis" and "gonarthrosis."

Arthrometer An instrument that measures relative laxity. Although still in the development phases, laxity arthrometers are a useful clinical adjunct. Current examples are KT-100, Stryker Knee Ligament Test, and Genucom.

Athlete A player in organized sport(s), team or individual, or a participant in recreational sports activities.
Ellite athlete One who has been tested in competition and ranks persistently among the top finishers. The term is not age-dependent.
College athlete College athletes are usually 19 to 23 years old. Their epiphyses are closed, and they are nearly skeletally mature.
High school athlete High school athletes are usually 16 to 19 years old; they frequently have open epiphyses and are skeletally immature.

Athlete-at-risk The athlete who, whether by sport, physical ability, body habits, or fatigue, is at greater risk for injury or reinjury.

Avulsion The ligament may tear partially or completely within its collagenous portion or may "avulse" from the bone, with or without a bony or cliondral attachment.

B

Bracing/braces, knee Braces (orthotics) are still relatively unscientific. Most knee braces have hinged joints, and some have proved efficacious; however, reinjury may occur despite bracing. Neither preventive nor prophylactic bracing is of proven worth.

C

Chondromalacia An objective term meaning softening of cartilage. In' common usage, it connotes the parapatellar pain that is a frequently concomitant of internal derangement of the knee.

Clancy operation (procedure) Variation of the Jones procedure. (See jones procedure.)

Conservative care *See* Nonoperative care.

Course of action The therapeutic course that the surgeon chooses on the basis of the given facts, the patient's desires, and the surgeon's best judgment,

CPM Continuous passive motion.

Cutting An abrupt change of direction in sport.

Cutting sports Sports such as soccer, football, and tennis, which require abrupt changes of direction that impose rotational torque on the knee. It is more difficult for patients with ACL insufficiency to regain elite status in the cutting sports.

D

Dashboard injury Injury caused by impact with the dashboard of a car. The term implies that the injun occurs by abrupt deceleration with the knee and hip flexed 90', making the posterior cruciate, posterior capsule, popliteal artery, femur, and femoral neck vulnerable to injury.

Degenerative arthritis See Arthritis, degenerative.

Degrees of Freedom* A term used to refer to the types of distinct and independent motions that are possible. Each separate, independent motion is one degree of freedom. In three dimensions, there are six independent motions or degrees of freedom. Three of the six degrees of freedom are translations, and three are rotations. The three rotational degrees of freedom in the knee are (1) flexion-extension rotation, (2) adduction-abduction rotation, and (3) internal-external tibial rotation. The three translational degrees of freedom are (1) anteroposterior translation, (2) caudad-cephalad translation (which produces joint distraction and compression), and (3) mediolateral translation.

Dislocation* A malposition of the bones forming a joint. In common usage, a dislocation involves a malposition so large that the normally opposed articular ing surfaces can no longer come in contact with each other.

Displacement* The net change in position that results from a motion; the difference between the initial and final positions.

Drawer test *See under* Test.

Drill guide A device to channel the surgical drill. It is essential for accuracy in restorative ligament surgery. Many drill guides are available, and there is no single universally accepted guide.

E

Effusion The escape of fluid from the blood vessels or lymphatics into tissues or a cavity. Often it is not known whether effusion in the knee is grossly hemorrhagic. *Mild, moderate, and tense* are subjective terms related to the pressure and distention caused by the effusion. An acute tear of the ACL usually results in a moderate effusion, whereas an intra-articular fracture will result in tense effusion if the capsule is compromised, neither of the above holds true.

Elastic limit The elastic limit of the normal ACL the amount by which it can be stretched without causing permanent deformation-is approximately 10 percent of its resting length. Deformation beyond this point may cause rupture.

Elite athlete *See under* Athlete.

End-points (soft, hard) The normal ACL and PCL firmly limit the AP glide of the knee and provide a hard end-point for the examiner. In contrast, when these ligaments are disrupted, the secondary restraints oppose the examiner, and their resiliency provides the examiner with a "softer" (less abrupt) end-point.

Examination under anesthesia (EUA) EUA is more revealing than ordinary examination because the state of the knee is not masked by muscle tension. it should be performed before inflation of the tourniquet. As always, the well leg should be examined first.

Extension The leg in extension is straight at its neutral position (O' flexion). in hyperextension, the knee is at its maximum bend past the neutral position.

F

Finochietto's sign The tibia subluxes so far anteriorly on the femur that the meniscus becomes trapped anterior to the femoral condyle.

Flexion (of the knee) A decrease in the distance between the heel and hip. Ninety degrees flexion means the leg is bent at a right angle.

Functional rehabilitation program. A rehabilitation program that involves agility training and purposeful adaptation in addition to the standard techniques. Such a program includes activities that promote endurance and strength through a range of motion.

H

Hemarthrosis Blood in a joint.

Hyperextensile joints This condition is not precisely defined, but it is known that people whose joints are inherently lax seem to have a less than satisfactory result after ligament repair. People who are "loose jointed" may sustain more injuries at sport. The work of Nicholas addressed this point, but subsequent work was unable to verify this trend. Nevertheless, the tests described by

Nicholas are useful to standardize loose versus tight jointedness.

Hyperextension The position of the knee at its maximum bend past the neutral (0'), straight-leg position.

I

Iliotibial tract A coalescence of fibers of the iliotibial band that serves as a lateral stabilizing structure.

Induration A feeling of hardness. The sensation the examiner can appreciate with the fingertips when there is fluid within the tissue elements and planes, which connotes injury or inflammation.

Instability* 1. A clinical sign, a condition of increased joint motion or mobility caused by ligament injury. 2. A symptom, a giving-way event during activity, it is preferable to say *giving way* when this meaning is intended. *(See also* Laxity.)

Intercondylar notch The anatomic indentation between the femoral condyles. it is variable in size and shape. The posterior outlet, in particular, is responsible for amputating the ACL when the knee is suddenly hyperextended and internally rotated.

Isokinctic (knee rehabilitation) Exercise and activities to restore endurance and agility. This is stage III in knee rehabilitation-gaining strength through range of motion. *(See also* Isometric, Isotonic knee rehabilitation.)

Isolated ACL This term is a misnomer. No ligament "lives" alone. One of the most fascinating aspects of knee care is the interrelationship and interdependency of the anatomic parts.

Isometric (knee rehabilitation) The first phase (stage 1) of knee rehabilitation in which muscles are strengthened without joint motion (concentric tightening of the quadriceps and hamstrings so as not to impart quadriceps thrust, which might jeopardize the ACL). *(See also* Isokinetic, isotonic knee rehabilitation.)

Isometric (surgical reconstruction of the ACL) The term *isomet?lc* implies that the distance between two points remains constant (through an arc of motion). If the ACL is replaced to its anatomic origin and insertion, the reconstruction is said to be isometric.

Isotonic (knee rehabilitation) Muscle contraction through a range of motion, progressively increasing the resistance or weight load. This constitutes stage 11 in knee rehabilitation. *(See also* Isokinctic, Isometric knee rehabilitation.)

J

Jakob test *See under* Test.

Jerk test *See under* Test.

Joint motion *See* Motion

Jones operation (procedure) The original procedure for using the middle third of the patella tendon as a graft to replace the ACL. Described by Dr. Kenneth Jones (see The Unstable Knee).

K

Knee bracing *See* Bracing.

Knee reconstruction The attempt to restore stability to the knee through ligamentous replacement, augmentation, or redirection.

Knee rehabilitation See Isometric, Isotonic, Isokinetic knee rehabilitation.

L

Lachman test *See under* Test.

Lateral collateral ligament (LCL) *See under* Ligament.

Lateral meniscocapsular ligaments *See under* Ligament.

Lateral tenodesis The MacIntosh, Losee, Andrews, and Ellison operations are examples of lateral teno deses of the iliotibial band, meant to restrain subluxation of the lateral compartment and thus complement the function of the ACL.

Laxity A general term meaning looseness. Laxity may be normal-the "normal physiologic laxity of the knee," or pathologic, such as the increased laxity after rupture of knee ligaments. We have excluded from this definition the common use of the term laxity to describe only abnormal looseness. Laxity in the knee may be physiologic or pathologic; it must be made clear which is meant when the term is used. The amount of laxity is a clinical sign-a descriptive term-used in differential diagnosis. A good synonym *is play.* Diagnosis is described ultimately in anatomic terms.

Global laxity Pathologic laxity in all planes of motion. It is a result of disruption and/or attritional tearing of both primary and secondary restraints about the knee.

Multiplanar laxity Connotes that there is a varus or valgus opening with a rotatory component.

Uniplanar laxity Laxity, such as results from a tear of the MCL, that allows pathologic opening (laxity) in only one plane (i.e., valgus opening without rotation).

Rotatory laxity Laxity in which there is a rotatory component, in addition to simple translation of the tibia on the femur. The combination of translation and rotation is one that should be appreciated by the examiner.

LCL Lateral collateral ligament. *(See under* Ligament.)

Ligament

Anterior cruciate ligament (ACL) This ligament is frequently described as consisting of two bands, anteromedial and posterolateral. In reality, it is a multistranded helicoid structure that limits anterior glide of the tibia on the femur.

Lateral collateral ligament (LCL) This ligament extends from the lateral femoral condyle to the fibula; it is a major secondary restraint.

Medial collateral ligament (MCL) This ligament consists of superficial and deep portions and also meniscotibial and meniscofemoral portions.

Medial and lateral meniscocapsular ligaments The secondary restraints for the ACL con-

sists of the lateral meniscus and the capsular portion of the arcuate complex, as well as the medial meniscus and the meniscotibial and meniscofemorat ligaments. These ligaments are the lateral secondary restraints when the ACL fails.

Medial pateflofemoral ligament This ligament inserts on the medial intermuscular septum beneath the vastus medialis obliquus and is frequently torn with patella luxation.
Posterior cruciate ligament (PCL) The PCL is often described as two bands in association with the ligaments of Humphry and Wrisberg. In reality, like the ACL, it is a continuum of fibers. More vertically oriented than the ACL and also thicker and stronger, it resists posterior glide of the tibia on the femur. Like the ACL, it is a primary restraint.
Posterior oblique capsular ligament (POL) The POL is a separate ligament. It is an important medial knee stabilizer.
Primary and secondary ligamentous restraints A concept emphasizing that for any displacement about the knee, there is a primary stabilizer backed by secondary ligamentous restraints. The ACL and PCL are usually considered the primary stabilizers of AP translation.

Ligament tensioning Ligaments have a proprioceptive function. They can be overtightened, and this is damaging to the joint surfaces. The tension on ligaments should be adjusted using tensioning devices during ligament reconstruction procedures.

Ligamentous restraints See Primary and secondary ligamentous restraints *under* Ligament.

Limits of motion *See under* Motion.

Losee test *See under* Test.

M

Macintosh test *See under* Test.

MCL Medial collateral ligament. *(See under* Ligament.)

Medial capsuloligamentous structures A term designed to imply that the meniscus and adjoining ligamentous structures are interrelated/and along with the lateral capsuloligamentous structures are the secondary restraints after loss of the ACL or PCL. Themedial capsuloligamentous structure consists of the medial meniscus, the meniscotibial and meniscofemoral ligaments, and the posterior oblique capsular ligament.

Medial collateral ligament (MCL) *See under* Ligament.
Medial meniscocapsular ligament *See under* Ligament.
Medial patellofemoral ligament *See under* Ligament.

Motion* The act or process of changing position or orientation. Motion is described by specifying the path of motion or the sequential positions and orientations that occur during the motion. Motion is a general term. There are two types of motion-translation and rotation. *(See aLo* Degrees of freedom.)
Limits of motion* The positions of the knee at its extremes of motion. The limits or extreme positions are determined by the ligaments and joint geome try. Because the ligaments can stretch, the limits depend to some extent on how much load is applied. Each degree of freedom has two limits of motion, one for each direction (sense). For example, for anteroposterior translation there is an anterior limit and a posterior limit. There are a total of 12 limits. *(See* Degrees of freedom.) The normal limit is

usually considered to be that shown by the uninjured knee. The limits of motion depend on the position of the knee. An example is the limit to adduction rotation. This limit increases as the knee is flexed because of increasing slack in the LCL. **Range of motion*** The maximum amount of motion, between two limits or extreme positions, that a joint can move.

N

Neutral position The position of the knee in which the leg is extended straight, with zero degrees of flexion at the knee.

Nonoperative care Often synonymous with "conservative care." Nonoperative care can be equally demanding and rewarding as operative care.

Noyes' test *See under* Test.

O

Objective Viewing events or phenomena as they exist impersonally or in an unprejudiced way; open to observation by oneself and others; opposite of subjective. The Lachman test should be objective. Arthrometers provide more objectivity than a manual test because the clinical measurements can be reliably reproduced. *(See also* Subjective.)

O'Donoghue's triad The "unhappy" triad. The classic injury of American football, consisting of disruption of the ACL, MCL, and medial meniscus. The term was coined in the early 1950s by the father of American sports medicine, Dr. Don O'Donoghue.

On-field examination Examination of an injured athlete by the physician, therapist, or trainer who comes on to the playing field to see the athlete before he or she is removed or resumes play. The on-field examination is clearly a manual examination.

Orthotics *See* Bracing.

Over-die-top procedure The direction of ACL graft material over the lateral femoral condyle. The isometricity of this placement has been questioned.

P

Pathologic laxity The *adjectivepatbologic* signifies abnormal excursion of the tibia on the femur in the injured knee compared with the well knee. Thus, a I + Lachman test signifies approximately, 5 mn, Of illcreased excursion of the injured leg o . ver the well leg, and implies an injury to the ACL. *(See also* Laxity.)

Patient selection The choice of which patients are candidates for ACL surgery and of the appropriate Surgical procedure. The patient's activit@, level is one of the key variables in the equation, and sometimes the most difficult to determine (or modify).

PCL Posterior cruciate ligament. *(See under* Ligament.)

Pivot shift test *See under* Test.

POL Posterior oblique ligament. *(See under* Ligament.)

POP The "pop" is the characteristic sound or feeling that the patient experiences when the ACL is torn. The pop is characteristic of ACL injury and is not associated with tears of other ligamentous or periarticular structures in the knee.

Position* The relative location and orientation of two objects. The position of the knee is described by the three rotational positions and three translational positions, which make up the six degrees of freedom. *(See also* Degrees of freedom.)

Posterior cruciate ligament (PCL) *See under* Ligament.
Posterior oblique ligament (POL) *See under* Ligament,

Primary ligamentous restraint See Primary and secondary ligamentous restraints under Ligament.

Prone Lachman test See Lachman test *under* Test.

Protective weightbearing The use of crutches for external support to unload the injured knee,

Q

Q-angle An anthropometric term coined bv Duchenne and popularized by James and others. The Q-angle relates to the alignment of the patella with the femur and tibia. The significance of the Q-angle has never been fully established.

R

Rehabilitation Those treatment modalities, exercises, and activities that we owe our patients after knee ligament surgery. Rehabilitation is that discipline that enhances return to function, which is the goal of the athlete and surgeon.

Reverse Lachman test *See* Lachman test *under* Test.

Rolling/gliding principle The motion of the femur on the tibia; an explanation of the geometry of the femoral condyles.

Rosenberg view The weight-bearing tunnel view that best visualizes weight-bearing surface of the knee joint. This view is useful in evaluating degenerative arthritic conditions of the knee,

Rotation* A type of motion or displacement in which all points on a body move in circular paths about a fixed axis.

S

Secondary ligamentous restraints See Primary and secondary ligamentous restraints under Ligament.

Shoe-turf fixation One of the reasons that ACL injuries are on the increase is increased efficiency of shoe-turf fixation, which allows more torque to be transmitted to the knee. The swivel heel introduced by Hanley was an attempt to negate this factor; perhaps we should return to this line of investigation.

Slocum test *See under* Test.

Sports medicine The medical care of those who participate in sport. The specific sport or the level of participation is unimportant.

The patient defines the discipline by his or her intense desire to "return to play."

Sprain A tear of the ligament. The severity of a sprain may be rated as grade I, II, or III.
Grade I sprain Mild, interstitial tear without dis ruption. Usually calls for symptomatic care.

Grade 11 sprain Moderate, some disruption of the ligament form. Usually requires some support for immobilization and attendant rehabilitation. **Grade III sprain** Severe, complete ligamentous disruption. May require surgical restoration. L*igament* disruption is synonymous with grade III sprain.

Stability As it relates to the knee, *stability* signifies the lack of pathologic motion.

Stiffness (ankylosis) Intra-articular surgery invites the formation of intra-ar-ticular adhesions and the contracture of the periarticular structures. These adhesions and contractures affect patella mobility. Contractures are particularly likely to form in the suprapatellar pouch and along the medial and lateral plicae, resulting in a relative patella baja. Adhesions must be guarded against, as they result in stiffness, ankylosis, and loss of mobility in the joint.

"Stretching out" When ligaments are replaced away from their anatomic origin or insertion, they are not isometric and may "stretch out" with range of motion.

Subjective Perceived by the individual. The patient's history is subjective. *(See also* Objective.)

Subluxation* Partial dislocation. A malposition in which the articulating surfaces can still contact each other, but the location of the contact on at least one bone is abnormal, In the knee, the direction of subluxation (anterior or posterior) and the tibiofemoral compartment involved (lateral or medial) should be specified.

Synovial steal Ilroceclure involving transfer of s\,noviuiii from the IICL to the ACI, to enhance revasCLIlarization subsequent to autogenous augmentation. Described by Hewson.

T

Tear, interstitial See Avulsion.
Tenderness Pain on touch or contact. Tenderness is elicited by a lighter touch than is used to detect induration. Tenderness may be used to outline the injured parts of the anatomic structures. The examiner should palpate each anatomic structure for tenderness,
Test

Drawer test The origin of this test is obscure, but it is generally performed with the knee flexed 90' and the examiner sitting on the patient's foot and demonstrating AP glide of the tibia on the femur. The test is best accomplished with the knee flexed 90', the leg dangling so that gravity assists the examiner, and the foot free so that the internal and external rotation of the compartments may be measured as the anterior Drawer is accomplished. The position of the hands is also important; the thumb should be able to measure the amount of tibial excursion on the femur.
Jakob test A reverse pivot shift test for posterolateral laxity.

jerk test A palpable "jerk" occurs during translation and rotation of the tibia on the femur. Described by Hughston.
Lachman test Measures the anteroposterior excursion of the tibia on the femur at 30' knee flexion. The end-point should be graded as hard or soft. Increased excursion and a soft end-point are pathognomonic of ACL incompetence. The standard Lachman test may be difficult to perform for an examiner with small hands, in which case the reverse or prone Lachman test may be used.
Prone/reverse Lachman test The patient is placed prone. The knee is flexed 30', and the tibia is translated on the femur. Gravity assists the examiner in this test, and the fingers may be placed at the joint line. Thus, posterolateral instability as well as AP excursion can be palpated (see Fig. 7, Section 1).

Losee test A virsion of the pivot-Shift test. A positive Losee test is usalllly pathognomonic of ACL insufficiency. A false- a false-negative re' positive result is rare, suit can be caused by muscle spasm or an incompetent MCL.
MacIntosh test A pivot shift test similar to the Losee test. It was described before the Losee test.
Noyes test The Noyes test is a flexion external rotation Drawer test. Because it is performed with the hip and knee flexed, the patient is usually well relaxed and gravity is on the side of the examiner. This test should be used to complemei-it the other lateral compartment tests.
Patella apprehension test Lateral excursion of the patella causes evident discomfort usually associated with recent patellar subluxation.
Slocum test A position that advantageously demonstrates lateral compartment subluxation in cases in which the patient's size or muscle guarding prohibits the free manipulation of the lower leg. The foot is fixed in this test, which may limit the subtleties available in the Losee test.

Test results Positive test results are preferably, reported in millimeters. They may be grossly or "on the field" classified as trace positive, 1+ (0-5 mm), 2+ (5-10 mm), or 3+ (greater than 10 mm).

Toe rises Toe rises (lifting the heels off the floor and transferring the body weight to the balls of the feet) is a useful exercise in the immediate postoperative period to stimulate gastrosoleus function. Toe rises can be performed with or without crutch support and may involve active planar flexion with the weight distributed as comfort dictates.

Translation* A type of motion or displacement in which all points of a body move parallel to a fixed line, When all object undergoes complex notions involving combined translations and rotations, *translation* refers to the motion of a single point. The location of object must be specified for the translation motion to be meaningful. In the knee, it has been customary to describe translation by the motion of a point on the tibia located midway between the medial and lateral margins (edges) of the joint.
Compartmental translation The motion of a point located on the medial or lateral tibial plateau. The location of the point must be described for the translation to be meaningful. it can be shown that the translation of a central point located on the mediolateral midline (knee center) is always the average value of the medial and lateral.

V

Vastus medialis obliquus (VMO) A portion of the quadriceps muscle.

W

Weightbearing The portion of the body weight applied through the limb. it can be influenced by an antalgic gait or crutches. "Weightbearing to comfort" implies that the patient selects the amount of weight borne by the leg, and thereby the floor reaction force is imparted to the injured knee.

Well leg The uninjured leg. Sometimes the athlete does not have a normal knee with which to compare the injured knee. In this case, the examiner must rely on clinical acumen. in the case studies, the injured leg is compared with the other, "well," leg for Purposes of uniformity.

APPENDIX D:
THE APPROVAL OF THE OSU INSTITUTINAL REVIEW BOARD (IRB) FOR THE PROTECTION OF HUMAN SUBJECTS

1. SIGNIFICANCE OF THE STUDY:

The importance of the anterior cruciate ligament (ACL) in the maintenance of stability of the knee is well known[1]. Active individuals who have a torn ACL are frequently troubled by chronic instability and recurrent episodes of giving-way, which often are associated with knee injuries.

Our design will determine if the clinical outcomes after ACL reconstruction are affected by the timing of surgical stabilization as measured using the International Knee Documentation Committee (IKDC) score. The purpose of this retrospective study will be to evaluate and compare the long-term results of 2 groups of patients who have undergone ACL reconstruction using the IKDC score to quantify their functional outcomes. The IKDC score combines clinical and subjective questions, functional abilities, e.g., jumping, running, and ability to perform daily activities. Patients will be evaluated at approximately 3 years after surgery to identify functional outcome variables that correlate with a greater risk of functional impairment. In this study we will compare the results and the functional outcomes in two groups of patients.

Specific Aims: The study will accomplish the following specific aims:

1. The **primary aim** of this study is to determine the differences in functional outcomes between two distinct patient populations treated using the same surgical intervention.
2. The **secondary aim** of this study is to determine which functional outcome variables differ between the acute isolated and chronic isolated patient populations in order to determine the etiology of any long-term functional impairment.

Hypothesis: It is hypothesized that patients undergoing arthroscopically-assisted techniques of acute isolated ACL reconstruction will have better functional outcomes, represented by higher IKDC scores than the chronic isolated group. It is hypothesized that the differences in functional outcomes between the acute and chronic isolated groups will be attributed to decreased IKDC scores in the arthritic change category for the chronic isolated group.

2. METHODS AND PROCEDURES

Our design will determine if the clinical outcomes after ACL reconstruction are affected by the timing of surgical stabilization as measured using the IKDC score. The IKDC assessment combines symptoms and signs that include patient subjective assessment, symptoms, range of motion, ligament examination, signs of arthritis, graft

site pathology, x-ray findings, and functional tests. Each category is given an overall grade of A (normal), B (nearly normal), C (abnormal), or D (severely abnormal).

All of the patients will complete the ***Activities of Daily Living Scale of Knee Outcome Survey*** questionnaire, which includes questions about their return to sports activity, and any symptoms that could be related to the lesion of the knee.

As part of their postoperative care, both knees of all subjects were examined clinically and graded by one evaluator (WFM). The alignment of the leg, varus-valgus stability at zero and 30 degrees, Lachman, anterior and posterior drawer, and pivot shift tests were performed. The American Medical Association's grading system was used for knee instabilities: Grade 1 (0 to 5 mm), Grade 2 (6 to 10 mm), and Grade 3 (>10 mm). The pivot shift phenomenon was graded as trace, 1+ (slip), 2+ (jump), and 3+ (transient lock) in the position of abduction and tibial external rotation to maximize the pivot shift sign.[2, 3] Range of motion was measured by goniometer. Knee flexion contractures were assessed with the patient in the prone position, and the heel height differences were measured in centimeters. Thigh girth measurements were made 8 cm proximal to the patella. Patellofemoral arthritis was palpated as the patients actively extended their knee, and it was compared with the contralateral knee and subjectively graded as 0 (absent), 1+ (mild), 2+ (moderate), or 3+ (severe).

The KT-2000 arthrometer has been used and reported in studies to characterize patient populations with normal and ACL-deficient knees postoperatively. Arthrometric evaluation is a useful adjunct to physical examination, providing objective information regarding anteroposterior translations. One evaluator performed the KT- 2000 arthrometric evaluations on all patients using a maximum manual test with a maximum anterior force at 30 degrees of knee flexion with a force of 30 pounds.

To determine whether there were statistically significant differences between the acute and chronic groups or between the groups at the successive follow-up years, we will perform multivariate analyses of variance (MANOVA). To analyze the categorical data, chi-square tests will be used. Statistical analyses will be performed using the SPSSX software package (SSPS, Inc., Chicago, IL)

3. Benefits and/or risks to the subjects

Each participant in this study will receive, at no cost, a complete orthopedic evaluation of their ACL-reconstructed knee and be provided with a current assessment of the functional status of their knee. Each subject will be able to use this beneficial information to make personal decisions about continuing or modifying their activity level/work situation in order to avoid or delay the development of degenerative joint disease, a common condition among patients who have ruptured their ACL.

4. Subject population

Arthroscopic repair of the ACL reconstruction with patellar tendon autograft fixation was performed on 200 patients over a 23-month period (1995 to 1997) at Ain Shams University Hospitals and Cairo Medical Center in Egypt. These patients with isolated ACL injuries were extracted from larger groups (773 patients). The 100 in the

acute group represented 13% of the 773 patients, and the 100 in the chronic group represented 13% of the 773 patients. Thus, the ACL injuries that were not isolated were on the order of 74% to 76% of cases.

- **Group 1:** 100 patients with ***acute isolated*** ACL reconstruction, those patients who had less than 3 months after injury treated with arthroscopically assisted reconstruction using the mid-third of the patellar tendon
- **Group 2:** 100 patients with ***chronic isolated*** ACL reconstruction. Those patients who had more than 3 months after injury defined the chronic group treated with the same procedure.

The results of clinical assessment were based on the patients with grafts and contralateral ACLs apparently intact at 2 years. Those with rerupture, atraumatic failures, or contralateral ACL rupture were not suitable for formal testing and were recorded separately.
The indication for surgery was ACL rupture confirmed by clinical diagnosis in an otherwise healthy patient who experienced instability in daily activities or wished to maintain his or her pre-injury level of activity. The pre-injury activity levels were comparable between groups.

5. Informed consent document

See Appendix A.

6. Methods by which informed consent will be obtained

At the first visit to the physician's office, a verbal and written explanation of all testing procedures will be provided to the patient. The student investigator (WFM) will answer any and all questions the subject may have. The participant will then be asked to read and sign the informed consent form. A copy of the form will be given to the subject.

7. Method of maintaining subject confidentiality

The results of this investigation may be published, but the names or identities of the subjects
will not be revealed. A code number, rather than the subject's name, will be used to identify the data collected from each individual. The master copy of assigned code numbers will be kept secure by the researchers at all times.

8. Copy of questionnaire and IKDC score to be used in this study

9. Information regarding any other approvals, which have been or will be obtained.

Pre-operative informed consent was given by all the patients before their surgical procedures, in accordance with the policies of the teaching hospitals in Cairo, Egypt, where all patients receive treatment, surgery, prescription medications, and follow-up care at no charge.

References

1. Feagin JA Jr, Cud WW: Isolated tear of the anterior cruciate ligament: 5-year follow-up study. Am J Sports Med 4.,95-100, 1976
2. Noyes FR, Mooar PA, Matthews DS, et al: The symptomatic anterior cruciate-deficient knee. Part 1: The long-term functional disability in athletically active individuals. J Bone Joint Surg 65A: 154-162, 1983
3. Shelbourne KD, Klootwyk TE: The miniarthrotomy technique for anterior cruciate ligament reconstruction. Oper Tech Sports Med 1: 26-39, 1993

Appendix A
INFORMED CONSENT DOCUMENT

A. **Title: ISOLATED ANTERIOR CRUCIATE LIGAMENT DEFICIENCY: COMPARISON OF RESULTS FOLLOWING ACUTE AND CHRONIC ARTHROSCOPIC RECONSTRUCTION WITH PATELLAR TENDON AUTOGRAFT**

B. Investigators: Waleed F. Manzour, M.D, Ph.D.
Rod A. Harter, Ph.D., ATC

C. Purpose: Our design will determine if the clinical outcomes after ACL reconstruction is affected by the timing of surgical stabilization as measured using the International Knee Documentation Committee (IKDC) score. The purpose of this retrospective study will be: to evaluate and compare the long-term results of 2 groups of patients who have undergone ACL reconstruction using the IKDC evaluation score to quantify their functional outcomes. Patients will be evaluated at approximately 3 years after surgery to identify functional outcome variables that correlate with a greater risk of functional impairment. In this study we will compare the results and the functional outcomes in two groups.

D. Procedures: I understand that as a participant in this study the following things will happen:

1. Pre-study Screening:

Due to the fact that my medical history of ACL injury and reconstructive surgery I am eligible for this study if the following are true:

1- I am over the age of 18 years.
2- I am able to participate in all of the post-operative follow-up examinations.

2. What participants will do during the study,

My participation will involve number of evaluation sessions on different days including the assessment of the symptoms that persist in any knee following ACL surgery, my subjective assessment of the severity of my symptoms, knee joint range of motion, evaluation of my knee ligament by orthopedic surgeon, x-ray evaluation for degenerative/arthritic changes in my knee joint, evaluation of my knee's functional ability, and ligament laxity testing with a KT-2000 arthrometer.
I understand that these medical data from my patient file will be used in the study.

3. Foreseeable risks or discomforts.

a. I understand that there is no discomfort associated with this study as any post-operative follow up evaluation.

4. **Benefits to be expected from the research.**

I will receive, at no cost, a complete orthopedic evaluation of their ACL-reconstructed knee and be provided with a current assessment of the functional status of their knee. I will be able to use this beneficial information to make personal decisions about continuing or modifying their activity level/work situation in order to avoid or delay the development of degenerative joint disease, a common condition among patients who have ruptured their ACL.

E. Confidentiality.

The results of this investigation may be published, but my name or identity will not ever be revealed. A code number rather than my name will be used to identify the data collected from me as part of this study. Waleed F. Manzour will keep the master copy of assigned code numbers secure.

F. Compensation for Injury

I understand that Oregon State University does not provide a research subject with compensation or medical treatment in the event the subject is injured as a result of participation in this research project.

G. Voluntary Participation Statement.

I understand that my participation in this study is completely voluntary and that I may either refuse to participate or withdraw from the study at any time without penalty.

H. If You Have Questions.

1. Further questions about this research study, or research related injuries should be directed to Waleed F. Manzour, Oregon State University, Langton Hall 132, Corvallis, Oregon at (541) 737-2210 or Dr. Rod A. Harter, Langton Hall 226, Oregon State University, Corvallis, Oregon at (541) 737-6801.

2. If I have questions about my rights as a subject participating in this research, I should contact the IRB Coordinator, OSU Research Office, (541) 737-8008.

My signature below indicates that I have read and that I understand the procedures previously described and give my informed and voluntary consent to participate in this study. I understand that I will receive a signed copy of this consent form.

Subject's Signature: _____ Date: _____

Signature of Investigator: _____ Date: _____

وثيقة الموافقة على الاشتراك فى بحث

أ . العنوان : الإصابة المنعزلة للرباط الصليبى الأمامى:

• مقارنه بين النتائج المستحدثة بعد الإصابات المنعزلة الحادة والاصابات المنعزلة المزمنة المعالجة بواسطة المنظار الجراحى

ب . الباحثين :

أ . د : وليد فاروق منظور (أستاذ جراحة العظام)

أ . د : دود هارتر (أستاذ إصابات الملاعب)

ت . الغرض من الدراسة :

• هذا البحث سوف يشرح تحليل النتائج الإكلينيكية للمرض بعد عملية إعادة بناء الرباط الصليبى الأمامى للركبة ومدى تأثير مرور الوقت (التأخير) بين الإصابات وإجراء العملية مستخدما جداول التقييم الخاصة بالمجلس الدولى لإصابات الركبة (I K D C) .

• الغرض من هذا البحث هو تحليل النتائج المشبعة ومقارنة النتائج على ومقارنة النتائج على المدى البعيد لعدد مجموعتين من المرض مستخدما التقييم الخاص بالمجلس الدولى لإصابات وعلاج أمراض الركبة (I K DC)لتصنيفهم حسب النتائج الوظيفية للركبة

سوف يتم تقييم النتائج خلال حوالى ثلاثة أعوام من تاريخ إجراء العملية لمعرفة العناصر المؤثرة والتى تتطابق مع زيادة الخطورة وتأثيرها السلبى على نتائج العملية .

ث . الطرق المتبعة :

اقر بأننى سوف أشترك فى هذه الرسالة مما سوف يتبع ما يلى :

١-الدراسات الأولية :

بمراجعة التاريخ المرضى لإصابتى فى الرباط الصليبى الأمامى للركبة فأننى أعتبر من المرضى المناسبين للاشتراك فى هذه الدراسة لأننى :

(١) سنى أكبر من الثامنة عشرة

(٢) قادر على المشاركة فى جميع الاختبارات التى سوف تتم بعد إجراء العملية

٢- المطالبات من المشارك فى البحث :

*مشاركتى سوف تتكون من عدة جلسات لتقييم حالتى المرضية فى عدة أيام مختلفة والتى تتكون من الأعراض المستمرة بعد العملية وما مدى قوتها كما سوف يتم تقييم المدى الحركى للركبة ومدى قوة الأربطة الموجودة داخلها بواسطة أحد جراحى العظام أيضا سوف يشمل إجراء أشعة عادية (X -ray) على الركبة لمعرفة التغيرات المفصلية (Arthritic changes) التى قد تحدث ركبتى كما سوف يشمل تقيم الأربطة الداخلية للركبة بواسطة عدة اختبارات إكلينيكية ومعملية مستخدما أحد الأجهزة المعملية لقياس ثبات الركبة (K T - 2000)

• أقر بأننى على دراية تامة بأن هذه البيانات الطبية الموجودة فى ملفى الطبى سوف تستخدم فى هذا البحث وليس عندى مانع فى ذلك .

٣- المشقة أو الخطورة المتوقعة أثناء إجراء البحث :

أقر بأنة لا يوجد أى مشقة متوقعة مع أى من الاختبارات التى سوف تتم بعد العملية .

٤- الاستفادة المتوقعة من هذا البحث :

سوف أتلقى بلا مقابل مادى جميع الاختبارات والتقييم اللازمة لتقيم عملية إعادة بناء الرباط الصليبى الأمامى للركبة كما أعلم أنة بإمكان استخدام هذه المعلومات المدونة فى اتخاذ بعض القرارات الشخصية فى الاستمرار أو تعديل مستوى العمل والأنشطة التى أقوم به لتقرير مدى إمكانيتى من تجنب أو تأخير الأعراض الجانبية المترتبة عن هذه الإصابة مثل خشونة الركبة (degenerative joint disease) والتى عادة ما تكون شائعة بين المرضى المصابين بقطع فى الرباط الصليبى الأمامى للركبة .

ج . الخصوصية وسرية المعلومات :

النتائج المتوقعة فى هذا البحث سوف تنشر فى عدة مجلات علمية ومؤتمرات عالمية ولكن أسمى أو شخصيتى لن يتم التعارف عليها .سوف يتم عمل رقم كودى ليتم التعرف على المعلومات التى تم الحصول عليها منى كجزء من هذه الدراسة أ . د ./ وليد فاروق منظور سوف يحفظ النسخة الأصلية فى مكان آمن بمعرفتى الشخصية .

ح . التعويض عن الإصابة أثناء البحث :

أقر أن جامعة ولاية أورجون غير مسئولة عن أى تعويض مادى أو طبى إذا حدثه أية إصابة لى أثناء مشاركتى فى هذه الدراسة .

خ . المشارة التطوعية :

أقر أن مشاركتى فى هذه الدراسة مشاركة تطوعية ولى الحق فى أن أرفض المشاركة أو أنسحب من هذه الدراسة فى أى وقت أشاء من غير أى شروط جزائية يمكن أن أتعرض إليها .

د . فى حالة وجود أية أسئلة :

١- عند وجود أية أسئلة أو إصابة خلال المشاركة فى الدراسة يجب توجية الأسئلة إلى أ . د / وليد فاروق منظور - جامعة ولاية أورجون الولايات الأمريكية ت /٠٠١-٧٣٧-٢٢١٠ أو أ. د / دود هارتر ٢٢٦ لانجتون هول -كورفلس - أوريجون الولايات المتحدة الأمريكية -ت /٠٠١-٧٣٧-٦٨٠١

٢-عند وجود أية أسئلة عن حقوقى كأحد المشاركين فى هذه الدراسة يجب الإتصال برئيس مجلس إدارة المراجعة الإقليمى بجامعة ولاية أورجون ت/ ٠٠٨-٧٣٧-٥٤١

* بإمضائى على هذا الإقرار أقر بأننى أعلم ما يحتوية الإقرار من حقوق ووجبات وأقر بأننى موافق على كل ما سبق لشروط الموافقة الاشتراكى فى هذا البحث وأن هذه المشاركة مشاركة تطوعية وأعلم أننى سوف أحصل على صورة من هذا الإقرار .

إمضاء المريض _____ التاريخ _____

إمضاء الطبيب _____ التاريخ _____

APPENDIX E: INSTRUCTIONS TO AUTHORS

• The Journal of Bone and joint Surgery welcomes articles that contribute to orthopaedic science from all sources in all countries.

• Articles are accepted only for exclusive publication in The Journal of Bone and joint Surgery

Submission of Manuscript

When you send an article, it is essential that the following items be submitted:

1 .A **letter of transmittal** containing the following paragraph, signed by all authors: "In consideration of The Journal of Bone and Joint Surgery, Inc., reviewing and editing my (our) submission, the author(s) undersigned hereby transfer(s), assign(s), or otherwise convey(s) all copyright ownership to The Journal of Bone and Joint Surgery, Inc., and represent(s) that he or she (they) own(s) all rights to the material submitted. The author(s) further represent(s) that the article is original, that it is not under consideration by another journal, and that this material has not been previously published. This assignment is to take effect only in the event that such work is published in *The Journal"* If more than one author is listed on the manuscript, the following sentence must be included: "Each of the authors represents that he, or she, has read and approved the final manuscript."

2. The **original manuscript and three duplicate manuscripts complete with illustrations** (four complete sets). These *four* complete sets are necessary for reviewers. The editorial process cannot be started unless they are received. Manuscripts of accepted articles will not be returned.

3. **Two cover sheets** with each manuscript. The first sheet must contain the title of the manuscript and the name and address of each author; the second must include only the title of the manuscript. **Page headers** can include the title but not the authors' names. The institution at which the study was done cannot be mentioned in the text. If the manuscript is accepted for publication following blinded peer review, the institution may be inserted during the editorial process.

Preparation of Manuscript

Manuscripts must be typewritten; double-spaced with wide margins. In general, an article should consist of the following:

1. A **structured abstract** of approximately 300 words, but not exceeding 325 words, consisting of four paragraphs, with the headings *Background, Methods, Results, and Conclusions.* A fifth paragraph, with the heading *Clinical Relevance,* should be added for basic-science articles. The abstract will precede the text of the published paper. An abstract is not needed for case reports.

2. The **body,** which usually should consist of an introduction, a Materials and Methods section, a Results section, and a Discussion.

The **introduction** should state the problem that led to the study and the specific purpose of the study. It can include a brief review of the literature that is dealt with in the Discussion.

The **Materials and Methods** section should provide demographic data on the study population and define the period during which the study was conducted, the specific criteria for inclusion and exclusion of patients, the indications for the operative procedure, and the duration of follow-up.

The **Results** section should provide a detailed report on the data obtained during the study. *Results obtained after less than two years of follow-up are rarely accepted.* It is essential that all data in the text be consistent with those in the abstract and in any illustrations, legends, or tables.

The **Discussion** should include a review of the literature, with emphasis on previous findings that agree with those of the present study and previous findings that disagree with those of the present study. The Discussion should also state both the strengths and the weaknesses of the study.

3. **Illustrations, which** can be *black-and white glossy prints* of photographs and *original* drawings or charts. Color illustrations cannot be used unless, in the opinion of *The Journal,* they convey information not provided by a black-and-white prints.

If color is desired, send both color and black-and-white prints. On the back of each illustration, indicate the number of that illustration, mark the top plainly, and place a label listing the title of the paper (not the authors' names or the name of the institution). Send prints unmounted or mounted only with rubber cement: paste or glue will damage them. Drawings, charts, and lettering on prints usually should be done in black; use white on black backgrounds. Make lettering large enough to be read when drawings are reduced in size. Put dates or initials in legends, not on prints; handwriting should never appear on prints. Although The *Journal* discourages submission of illustrations that have been published elsewhere, when such illustrations are deemed essential the author must include *a letter, from the original holder of the copyright, granting permission to reprint the illustration.* Give full information about the previous publication, including the specific page on which the illustration appeared.

4. **Legends** for all illustrations submitted, listed in order and typed double-spaced. Explain what each illustration shows, rather than simply defining it as, for example, "a postoperative radiograph." Give magnification of all photomicrographs. Define all arrows and other such indicators appearing on the illustration. If an illustration is of a patient who is identified by a case number in the text or table, include that case number in the legend.

5. A **bibliography,** alphabetical and double-spaced, of references made in the text. Refer to bibliographies in this copy of *The Journal* and follow the style exactly. Titles of foreign-language articles and books should appear in that language. When citing a book, give the specific pages used unless the entire book was used. All references must be cited in the text.

When preparing a manuscript, the following conventions of **The Journal's Style** should be kept in mind:

1. Write out numbers of less than 100, except percentages, degrees, and decimals. The numerator and denominator should be included for all percentages. Round off the percentages when the denominator is less than 200. Percentages should not be used when the value of n is less than twenty.

2. All measurements should be given in SI units.

3. In general, neither abbreviations nor acronyms should be used.

4. Words placed in quotation marks, indicating that they have a meaning other than the one found in a dictionary, should be defined. While jargon is understood by others in the field, it may not be understood by those not in the field.

5. The word significant should be used only to describe statistical significance, A p value is required when this word is used.

Statistics

1. The statistical methods that were used must be described in the Materials and Methods section.

2. The statement that "no significant difference was found between two groups" cannot be made unless a power study was done and the value of alpha or beta is reported. A large number of patients (at least sixty, and often more, in each group or subgroup) is required to make such a statement, If no such power study was done, the author must state: "With the numbers available, no significant difference could be detected."

3. Ninety-five percent confidence intervals are required whenever the results of survivorship analysis are given in the text or in graphs.

4. Use of the word correlation requires reporting of the Pearson product-moment correlation coefficient r.

Informed Consent

All manuscripts dealing with a study of human subjects must include a statement that the subjects have given informed consent and the study has been approved by an institutional review board or a similar commettee. All studies should be carried out in accordance with the World Medical Association Declaration of Helsinki, as presented in *The Journal* (79-A: 1089-1098, July 1997).

All manuscripts dealing with experimental results in animals must include a statement that the study has been approved by an animal utilization study commettee. The authors should also include information about the management of postoperative pain.

Authorship

It is to be clearly understood that each author has participated in the design of the study, has contributed to the collection of the data, has participated in the writing of the manuscript, and assumes full responsibility for the content of the manuscript. Normally, no more than six authors should be listed; individuals who have contributed to only one segment of the manuscript or have contributed only cases should be credited in a footnote. *(The Journal does* not allow use of such footnotes to thank individuals who made secretarial, technical, or other contributions that were part of their normal jobs, for which they were compensated.) If extenuating circumstances prevail, the letter of transmittal should detail why the authors have taken exception to these recomillimetersendations and should state how each author has contributed to the manuscript.

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Review of Manuscripts

Manuscripts are evaluated by the editorial staff of *The Journal* and are sent to outside reviewers. A manuscript that has been rejected is usually returned in approximately six weeks. It may take more time to make a decision regarding a paper being considered for publication.

Conflict-of-Interest Policy

A conflict-of-interest statement is required for each manuscript that is accepted for publication. This statement will have no bearing on the editorial decision to publish, or not to publish, a manuscript. That decision will continue to be made solely on the value of the article to the readers of *The Journal* The following conflict-of-interest statement will be sent to the corresponding author with the edited manuscript when a decision has been made to publish that manuscript.

Check only one of the following five statements:

1. One or more of the authors has received or will receive benefits for personal or professional use from a comillimetersercial party related directly or indirectly to the subject of this article.

2. One or more of the authors has received or will receive benefits for personal or professional use from a comillimetersercial party related directly or indirectly to the subject of this article. In addition, benefits have been or will be directed to a research fund, foundation, educational institution, or other nonprofit organization with which one or more of the authors is associated.

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5. The authors of this manuscript have chosen not to furnish information to *The Journal* and its readers concerning any relationship that might exist between a comillimetersercial party and material contained in this manuscript that might represent a conflict of interest.

Check one of the following two statements.,

1. No funds were received in support of this study.

2. Funds were received in total or partial support of the research or clinical study presented in this article. The funding sources were:

The statements selected by the author or authors will be printed on the first page of the published article. The signature of each author is required. No article will be published until the completed form has been incorporated into the record kept on that manuscript in *The Journal office.*

Appendix F

Data for the first manuscript

	group	age	sex	ht	wt	invknee	cause
1	2.00	27.00	.00	179.00	86.00	1.00	2.00
2	2.00	29.00	.00	165.00	77.00	.00	2.00
3	2.00	27.00	.00	168.00	76.00	.00	2.00
4	2.00	28.00	1.00	167.00	78.00	.00	3.00
5	2.00	32.00	1.00	174.00	78.00	.00	1.00
6	2.00	31.00	1.00	174.00	87.00	1.00	2.00
7	2.00	27.00	1.00	168.00	86.00	1.00	2.00
8	2.00	32.00	1.00	172.00	77.00	1.00	2.00
9	2.00	33.00	1.00	168.00	80.00	.00	2.00
10	2.00	27.00	1.00	173.00	87.00	.00	2.00
11	2.00	28.00	1.00	177.00	81.00	.00	.00
12	2.00	29.00	1.00	179.00	95.00	.00	3.00
13	2.00	30.00	1.00	189.00	108.00	.00	3.00
14	2.00	30.00	1.00	188.00	117.00	.00	1.00
15	2.00	27.00	1.00	176.00	88.00	.00	3.00
16	2.00	27.00	1.00	175.00	89.00	.00	2.00
17	2.00	28.00	1.00	173.00	94.00	1.00	1.00
18	2.00	32.00	1.00	186.00	118.00	1.00	2.00
19	2.00	20.00	1.00	179.00	92.00	1.00	3.00
20	2.00	22.00	1.00	174.00	94.00	1.00	2.00
21	2.00	24.00	1.00	170.00	81.00	.00	2.00
22	2.00	28.00	1.00	167.00	88.00	.00	2.00
23	2.00	30.00	1.00	187.00	97.00	.00	3.00
24	2.00	27.00	1.00	167.00	78.00	.00	3.00
25	2.00	20.00	1.00	176.00	85.00	.00	2.00
26	2.00	22.00	1.00	180.00	102.00	.00	3.00
27	2.00	21.00	1.00	173.00	98.00	.00	.00
28	2.00	20.00	1.00	178.00	87.00	.00	2.00
29	2.00	23.00	1.00	168.00	88.00	.00	1.00
30	2.00	24.00	1.00	170.00	87.00	1.00	1.00
31	2.00	27.00	1.00	171.00	82.00	1.00	2.00
32	2.00	28.00	1.00	176.00	92.00	1.00	2.00
33	2.00	32.00	1.00	160.00	78.00	1.00	3.00
34	2.00	22.00	1.00	185.00	109.00	.00	2.00
35	2.00	40.00	1.00	186.00	98.00	.00	1.00
36	2.00	33.00	1.00	176.00	98.00	.00	2.00
37	2.00	32.00	1.00	170.00	85.00	.00	3.00

data 55 cases.sav

	date1	date2	function	activity	symptom1
1	04-JAN-95	01-NOV-95	4.00	4.00	4.00
2	09-JAN-95	07-SEP-95	4.00	4.00	3.00
3	11-JAN-95	03-AUG-95	4.00	3.00	4.00
4	17-JAN-95	16-NOV-95	4.00	4.00	4.00
5	24-JAN-95	25-JUL-95	4.00	4.00	3.00
6	05-FEB-95	28-JUN-95	4.00	4.00	4.00
7	05-FEB-95	29-JUN-95	4.00	3.00	4.00
8	06-FEB-95	18-DEC-95	4.00	3.00	3.00
9	10-FEB-95	30-JUN-95	3.00	4.00	3.00
10	07-MAR-95	02-MAR-96	4.00	4.00	4.00
11	08-MAR-95	17-JUL-96	4.00	4.00	4.00
12	10-MAR-95	28-SEP-95	4.00	4.00	4.00
13	11-MAR-95	29-DEC-95	3.00	4.00	3.00
14	15-MAR-95	14-AUG-95	4.00	4.00	3.00
15	17-MAR-95	05-SEP-95	3.00	4.00	3.00
16	23-MAR-95	06-NOV-95	3.00	4.00	4.00
17	02-APR-95	08-AUG-95	4.00	4.00	3.00
18	05-APR-95	17-AUG-95	4.00	4.00	4.00
19	08-APR-95	18-OCT-95	4.00	4.00	3.00
20	09-APR-95	22-AUG-95	4.00	3.00	4.00
21	10-APR-95	27-AUG-95	4.00	3.00	4.00
22	17-APR-95	28-AUG-95	3.00	4.00	3.00
23	23-APR-95	30-OCT-95	4.00	4.00	3.00
24	25-APR-95	21-DEC-95	4.00	4.00	4.00
25	27-APR-95	01-SEP-95	4.00	3.00	3.00
26	28-APR-95	04-SEP-95	4.00	4.00	4.00
27	29-APR-95	22-NOV-95	3.00	4.00	4.00
28	30-APR-95	27-AUG-95	4.00	3.00	4.00
29	02-MAY-95	28-AUG-95	4.00	4.00	4.00
30	05-MAY-95	30-OCT-95	4.00	3.00	4.00
31	08-MAY-95	30-AUG-95	3.00	4.00	4.00
32	11-MAY-95	01-OCT-95	4.00	3.00	4.00
33	13-MAY-95	04-DEC-95	4.00	4.00	3.00
34	22-MAY-95	05-APR-96	4.00	4.00	3.00
35	05-JUN-95	02-MAR-96	4.00	4.00	4.00
36	08-JUN-95	28-NOV-95	4.00	4.00	4.00
37	17-JUN-95	01-DEC-95	4.00	4.00	4.00

	symptom2	symptom3	symptom4	rom1	rom2	ligev1	ligev3
1	4.00	3.00	4.00	4.00	3.00	4.00	4.00
2	4.00	4.00	3.00	4.00	4.00	4.00	3.00
3	4.00	4.00	3.00	3.00	4.00	3.00	4.00
4	4.00	4.00	4.00	4.00	4.00	4.00	4.00
5	4.00	4.00	3.00	4.00	4.00	3.00	4.00
6	3.00	4.00	4.00	4.00	4.00	3.00	4.00
7	4.00	3.00	4.00	3.00	3.00	4.00	4.00
8	3.00	4.00	4.00	3.00	4.00	3.00	3.00
9	3.00	3.00	3.00	4.00	3.00	3.00	3.00
10	4.00	4.00	4.00	4.00	4.00	3.00	4.00
11	3.00	4.00	4.00	3.00	4.00	4.00	4.00
12	3.00	4.00	3.00	4.00	3.00	3.00	4.00
13	4.00	3.00	4.00	4.00	4.00	4.00	4.00
14	4.00	4.00	3.00	3.00	4.00	4.00	3.00
15	4.00	3.00	4.00	4.00	3.00	3.00	4.00
16	3.00	4.00	3.00	4.00	4.00	4.00	3.00
17	4.00	3.00	4.00	3.00	3.00	4.00	4.00
18	3.00	4.00	3.00	4.00	4.00	3.00	4.00
19	4.00	3.00	4.00	4.00	4.00	4.00	4.00
20	4.00	3.00	4.00	4.00	4.00	3.00	3.00
21	4.00	3.00	4.00	3.00	3.00	4.00	4.00
22	3.00	3.00	4.00	4.00	4.00	4.00	4.00
23	3.00	4.00	3.00	4.00	4.00	4.00	4.00
24	4.00	4.00	4.00	3.00	3.00	4.00	3.00
25	4.00	3.00	3.00	4.00	3.00	4.00	4.00
26	4.00	4.00	4.00	3.00	4.00	3.00	3.00
27	3.00	3.00	4.00	3.00	4.00	3.00	4.00
28	4.00	3.00	4.00	4.00	4.00	3.00	4.00
29	4.00	3.00	4.00	3.00	3.00	4.00	4.00
30	4.00	3.00	4.00	4.00	4.00	3.00	3.00
31	4.00	3.00	4.00	3.00	3.00	4.00	4.00
32	3.00	4.00	3.00	4.00	4.00	4.00	4.00
33	4.00	3.00	4.00	3.00	4.00	3.00	3.00
34	4.00	4.00	3.00	4.00	3.00	4.00	4.00
35	4.00	4.00	3.00	2.00	4.00	4.00	4.00
36	3.00	4.00	3.00	3.00	4.00	3.00	4.00
37	3.00	4.00	4.00	4.00	3.00	4.00	4.00

	ligev7	ligev8	kt2000	comp1	comp2	comp3	harv
1	4.00	3.00	4.00	3.00	3.00	3.00	4.00
2	4.00	4.00	4.00	2.00	2.00	3.00	4.00
3	3.00	3.00	4.00	3.00	3.00	4.00	3.00
4	4.00	4.00	4.00	3.00	3.00	3.00	4.00
5	4.00	3.00	4.00	4.00	4.00	4.00	4.00
6	4.00	3.00	4.00	3.00	3.00	3.00	4.00
7	3.00	4.00	3.00	3.00	3.00	3.00	4.00
8	4.00	4.00	3.00	3.00	3.00	3.00	4.00
9	3.00	3.00	3.00	2.00	2.00	3.00	3.00
10	3.00	4.00	4.00	2.00	2.00	3.00	4.00
11	4.00	4.00	4.00	3.00	3.00	2.00	4.00
12	3.00	3.00	4.00	3.00	3.00	4.00	4.00
13	4.00	4.00	3.00	4.00	4.00	2.00	4.00
14	4.00	3.00	3.00	3.00	3.00	4.00	4.00
15	4.00	3.00	4.00	4.00	4.00	3.00	3.00
16	4.00	4.00	4.00	2.00	2.00	3.00	4.00
17	4.00	3.00	4.00	4.00	4.00	4.00	4.00
18	4.00	4.00	4.00	4.00	4.00	4.00	4.00
19	3.00	4.00	4.00	4.00	4.00	3.00	4.00
20	4.00	4.00	4.00	4.00	4.00	3.00	4.00
21	4.00	3.00	3.00	4.00	4.00	4.00	3.00
22	4.00	3.00	4.00	3.00	3.00	4.00	4.00
23	3.00	4.00	4.00	4.00	4.00	4.00	4.00
24	3.00	4.00	4.00	3.00	3.00	2.00	4.00
25	4.00	4.00	3.00	4.00	4.00	4.00	4.00
26	4.00	4.00	3.00	4.00	4.00	4.00	3.00
27	3.00	3.00	4.00	4.00	4.00	3.00	4.00
28	4.00	3.00	4.00	3.00	3.00	4.00	4.00
29	3.00	3.00	4.00	3.00	3.00	4.00	3.00
30	3.00	4.00	4.00	3.00	3.00	4.00	3.00
31	4.00	3.00	4.00	4.00	4.00	3.00	4.00
32	4.00	4.00	3.00	3.00	3.00	4.00	4.00
33	4.00	4.00	4.00	4.00	4.00	4.00	3.00
34	3.00	4.00	4.00	2.00	2.00	3.00	4.00
35	4.00	4.00	4.00	2.00	2.00	2.00	1.00
36	4.00	4.00	3.00	4.00	4.00	4.00	4.00
37	4.00	3.00	4.00	4.00	4.00	4.00	4.00

data 55 cases.sav

	x_ray1	x_ray2	x_ray3	func	score	follow	cat
1	4.00	5.00	4.00	7.00	82.00	28.00	4.00
2	4.00	4.00	4.00	8.00	80.00	30.76	4.00
3	7.00	7.00	7.00	8.00	88.00	24.00	4.00
4	4.00	5.00	5.00	8.00	87.00	33.02	4.00
5	6.00	6.00	6.00	8.00	90.00	26.96	4.00
6	6.00	6.00	6.00	7.00	87.00	24.10	4.00
7	6.00	6.00	6.00	7.00	84.00	24.07	4.00
8	6.00	6.00	6.00	8.00	84.00	25.10	4.00
9	5.00	6.00	6.00	6.00	74.00	26.50	3.00
10	4.00	4.00	4.00	8.00	81.00	24.20	4.00
11	4.00	4.00	4.00	8.00	82.00	24.50	4.00
12	6.00	6.00	7.00	8.00	87.00	24.53	4.00
13	4.00	4.00	4.00	8.00	82.00	24.64	4.00
14	7.00	6.00	6.00	8.00	87.00	24.00	4.00
15	7.00	7.00	6.00	7.00	87.00	24.64	4.00
16	4.00	4.00	4.00	8.00	79.00	27.83	4.00
17	7.00	7.00	7.00	7.00	91.00	41.00	4.00
18	6.00	7.00	8.00	7.00	93.00	25.50	4.00
19	7.00	7.00	7.00	8.00	93.00	25.00	4.00
20	7.00	7.00	7.00	7.00	91.00	24.00	4.00
21	7.00	7.00	8.00	7.00	90.00	32.09	4.00
22	6.00	7.00	7.00	7.00	88.00	24.12	4.00
23	7.00	6.00	7.00	8.00	92.00	31.10	4.00
24	4.00	4.00	4.00	8.00	80.00	25.00	4.00
25	7.00	7.00	6.00	7.00	89.00	24.05	4.00
26	6.00	6.00	7.00	7.00	89.00	26.00	4.00
27	6.00	7.00	8.00	7.00	88.00	25.46	4.00
28	7.00	6.00	6.00	7.00	88.00	26.40	4.00
29	8.00	8.00	7.00	8.00	91.00	31.11	4.00
30	6.00	8.00	7.00	8.00	89.00	24.80	4.00
31	8.00	7.00	6.00	8.00	91.00	28.61	4.00
32	7.00	8.00	6.00	8.00	91.00	26.50	4.00
33	7.00	6.00	8.00	8.00	91.00	24.50	4.00
34	4.00	4.00	4.00	8.00	79.00	24.00	4.00
35	3.00	3.00	3.00	7.00	72.00	24.00	3.00
36	6.00	6.00	6.00	7.00	88.00	34.51	4.00
37	6.00	6.00	6.00	8.00	91.00	27.46	4.00

data 55 cases.sav

	t	ray	sumx_ray	category	crepitus
1	301.00	13.00	13.00	3.00	9.00
2	241.00	12.00	12.00	3.00	7.00
3	204.00	21.00	21.00	3.00	10.00
4	303.00	14.00	14.00	3.00	9.00
5	182.00	18.00	18.00	3.00	12.00
6	143.00	18.00	18.00	3.00	9.00
7	144.00	18.00	18.00	3.00	9.00
8	315.00	18.00	18.00	3.00	9.00
9	140.00	17.00	17.00	2.00	7.00
10	361.00	12.00	12.00	3.00	7.00
11	497.00	12.00	12.00	3.00	8.00
12	202.00	19.00	19.00	3.00	10.00
13	293.00	12.00	12.00	3.00	10.00
14	152.00	19.00	19.00	3.00	10.00
15	172.00	20.00	20.00	3.00	11.00
16	228.00	12.00	12.00	3.00	7.00
17	128.00	21.00	21.00	3.00	12.00
18	134.00	21.00	21.00	3.00	12.00
19	193.00	21.00	21.00	3.00	11.00
20	135.00	21.00	21.00	3.00	11.00
21	139.00	22.00	22.00	3.00	12.00
22	133.00	20.00	20.00	3.00	10.00
23	190.00	20.00	20.00	3.00	12.00
24	240.00	12.00	12.00	3.00	8.00
25	127.00	20.00	20.00	3.00	12.00
26	129.00	19.00	19.00	3.00	12.00
27	207.00	21.00	21.00	3.00	11.00
28	119.00	19.00	19.00	3.00	10.00
29	118.00	23.00	23.00	3.00	10.00
30	178.00	21.00	21.00	3.00	10.00
31	114.00	21.00	21.00	3.00	11.00
32	143.00	21.00	21.00	3.00	10.00
33	205.00	21.00	21.00	3.00	12.00
34	319.00	12.00	12.00	3.00	7.00
35	271.00	9.00	9.00	2.00	6.00
36	173.00	18.00	18.00	3.00	12.00
37	167.00	18.00	18.00	3.00	12.00

	group	age	sex	ht	wt	invknee	cause
38	2.00	20.00	1.00	175.00	87.00	.00	2.00
39	2.00	24.00	1.00	172.00	88.00	.00	.00
40	2.00	21.00	1.00	180.00	102.00	.00	1.00
41	2.00	23.00	1.00	188.00	113.00	.00	2.00
42	2.00	33.00	1.00	170.00	98.00	.00	1.00
43	2.00	29.00	1.00	175.00	99.00	.00	2.00
44	2.00	26.00	1.00	170.00	91.00	.00	2.00
45	2.00	25.00	1.00	172.00	78.00	.00	.00
46	2.00	33.00	1.00	166.00	87.00	.00	2.00
47	2.00	22.00	1.00	179.00	100.00	.00	2.00
48	2.00	27.00	1.00	178.00	91.00	.00	2.00
49	2.00	29.00	1.00	176.00	87.00	.00	2.00
50	2.00	30.00	1.00	170.00	91.00	.00	1.00
51	2.00	31.00	1.00	180.00	92.00	.00	2.00
52	2.00	21.00	1.00	173.00	78.00	.00	2.00
53	2.00	23.00	1.00	175.00	87.00	.00	1.00
54	2.00	33.00	1.00	200.00	122.00	.00	2.00
55	2.00	22.00	1.00	176.00	91.00	.00	2.00

	date1	date2	function	activity	symptom1
38	28-JUN-95	04-OCT-95	3.00	4.00	3.00
39	29-JUN-95	01-FEB-96	3.00	4.00	4.00
40	30-JUN-95	04-MAR-96	4.00	4.00	3.00
41	03-JUL-95	06-JUL-96	4.00	4.00	4.00
42	10-JUL-95	07-APR-96	4.00	4.00	4.00
43	22-JUL-95	05-MAY-96	4.00	4.00	4.00
44	26-JUL-95	27-APR-96	4.00	3.00	4.00
45	28-JUL-95	17-MAY-96	4.00	4.00	4.00
46	06-AUG-95	12-MAR-96	4.00	3.00	4.00
47	17-AUG-95	08-APR-96	4.00	4.00	3.00
48	22-AUG-95	17-JUN-96	4.00	4.00	3.00
49	27-AUG-95	28-FEB-96	3.00	3.00	4.00
50	27-AUG-95	19-MAY-96	4.00	4.00	4.00
51	29-AUG-95	17-MAR-96	4.00	4.00	3.00
52	30-AUG-95	18-FEB-96	4.00	4.00	4.00
53	30-AUG-95	26-FEB-96	3.00	4.00	4.00
54	07-SEP-95	17-MAY-96	4.00	3.00	4.00
55	09-SEP-95	12-MAR-96	4.00	4.00	4.00

	symptom2	symptom3	symptom4	rom1	rom2	ligev1	ligev3
38	4.00	3.00	4.00	3.00	4.00	4.00	3.00
39	4.00	4.00	4.00	4.00	4.00	4.00	3.00
40	4.00	4.00	4.00	4.00	4.00	3.00	4.00
41	4.00	4.00	4.00	3.00	4.00	4.00	4.00
42	4.00	4.00	3.00	4.00	4.00	4.00	3.00
43	4.00	4.00	3.00	4.00	4.00	4.00	3.00
44	4.00	3.00	4.00	4.00	4.00	4.00	3.00
45	4.00	3.00	4.00	4.00	4.00	4.00	4.00
46	3.00	3.00	3.00	4.00	4.00	4.00	3.00
47	4.00	4.00	3.00	3.00	4.00	3.00	3.00
48	4.00	4.00	4.00	3.00	4.00	4.00	4.00
49	3.00	4.00	4.00	4.00	4.00	4.00	4.00
50	4.00	4.00	3.00	3.00	3.00	3.00	3.00
51	4.00	4.00	4.00	3.00	3.00	4.00	4.00
52	4.00	3.00	3.00	3.00	4.00	4.00	3.00
53	3.00	4.00	4.00	3.00	3.00	3.00	4.00
54	4.00	4.00	4.00	4.00	3.00	4.00	3.00
55	3.00	4.00	4.00	3.00	3.00	4.00	4.00

	ligev7	ligev8	kt2000	comp1	comp2	comp3	harv
38	4.00	3.00	3.00	4.00	4.00	4.00	4.00
39	3.00	4.00	3.00	4.00	4.00	4.00	4.00
40	4.00	4.00	4.00	2.00	2.00	4.00	4.00
41	3.00	4.00	3.00	3.00	3.00	3.00	4.00
42	4.00	3.00	4.00	3.00	3.00	2.00	4.00
43	4.00	4.00	4.00	4.00	3.00	3.00	4.00
44	4.00	4.00	3.00	4.00	4.00	3.00	4.00
45	4.00	4.00	4.00	3.00	3.00	3.00	4.00
46	4.00	4.00	4.00	4.00	4.00	3.00	4.00
47	4.00	4.00	3.00	4.00	4.00	4.00	4.00
48	4.00	4.00	4.00	2.00	2.00	3.00	4.00
49	4.00	3.00	3.00	2.00	2.00	2.00	4.00
50	3.00	4.00	4.00	3.00	3.00	3.00	4.00
51	4.00	3.00	3.00	4.00	4.00	3.00	4.00
52	3.00	4.00	4.00	4.00	4.00	4.00	3.00
53	3.00	3.00	4.00	4.00	4.00	3.00	4.00
54	4.00	4.00	4.00	4.00	4.00	4.00	4.00
55	4.00	4.00	3.00	3.00	3.00	4.00	4.00

	x_ray1	x_ray2	x_ray3	func	score	follow	cat
38	8.00	7.00	6.00	7.00	89.00	26.20	4.00
39	8.00	7.00	6.00	8.00	93.00	28.00	4.00
40	4.00	4.00	4.00	8.00	82.00	24.00	4.00
41	4.00	4.00	4.00	8.00	82.00	24.60	4.00
42	4.00	4.00	4.00	8.00	81.00	26.00	4.00
43	4.00	4.00	4.00	8.00	84.00	24.20	4.00
44	6.00	6.00	6.00	7.00	88.00	25.02	4.00
45	4.00	4.00	4.00	8.00	84.00	24.56	4.00
46	7.00	7.00	8.00	7.00	91.00	27.80	4.00
47	8.00	8.00	8.00	8.00	94.00	25.79	4.00
48	4.00	4.00	4.00	8.00	81.00	26.92	4.00
49	6.00	6.00	6.00	8.00	83.00	26.00	4.00
50	4.00	4.00	4.00	8.00	79.00	24.20	4.00
51	8.00	8.00	8.00	8.00	94.00	26.77	4.00
52	8.00	8.00	8.00	8.00	94.00	25.20	4.00
53	8.00	7.00	8.00	8.00	91.00	26.14	4.00
54	8.00	8.00	8.00	8.00	97.00	30.00	4.00
55	8.00	8.00	7.00	8.00	93.00	40.20	4.00

	t	ray	sumx_ray	category	crepitus
38	98.00	21.00	21.00	3.00	12.00
39	217.00	21.00	21.00	3.00	12.00
40	248.00	12.00	12.00	3.00	8.00
41	369.00	12.00	12.00	3.00	9.00
42	272.00	12.00	12.00	3.00	8.00
43	288.00	12.00	12.00	3.00	10.00
44	276.00	18.00	18.00	3.00	11.00
45	294.00	12.00	12.00	3.00	9.00
46	219.00	22.00	22.00	3.00	11.00
47	235.00	24.00	24.00	3.00	12.00
48	300.00	12.00	12.00	3.00	7.00
49	185.00	18.00	18.00	3.00	6.00
50	266.00	12.00	12.00	3.00	9.00
51	201.00	24.00	24.00	3.00	11.00
52	172.00	24.00	24.00	3.00	12.00
53	180.00	23.00	23.00	3.00	11.00
54	253.00	24.00	24.00	3.00	12.00
55	185.00	23.00	23.00	3.00	10.00

Appendix G

Data for the second manuscript

	group	age	sex	ht	wt	invknee	cause
1	1.00	24.00	.00	170.00	68.00	.00	2.00
2	1.00	38.00	.00	176.00	75.00	1.00	2.00
3	1.00	41.00	1.00	173.00	85.00	.00	3.00
4	1.00	45.00	1.00	187.00	120.00	1.00	3.00
5	1.00	43.00	1.00	180.00	84.00	1.00	3.00
6	1.00	42.00	1.00	182.00	87.00	1.00	2.00
7	1.00	41.00	1.00	179.00	90.00	.00	2.00
8	1.00	27.00	1.00	177.00	78.00	.00	.00
9	1.00	28.00	1.00	176.00	68.00	.00	1.00
10	1.00	29.00	1.00	174.00	85.00	.00	1.00
11	1.00	30.00	1.00	168.00	84.00	.00	1.00
12	1.00	31.00	1.00	182.00	100.00	.00	1.00
13	1.00	32.00	1.00	173.00	80.00	.00	1.00
14	1.00	33.00	1.00	176.00	87.00	1.00	1.00
15	1.00	34.00	1.00	178.00	84.00	1.00	1.00
16	1.00	35.00	1.00	179.00	92.00	1.00	.00
17	1.00	35.00	1.00	180.00	98.00	1.00	1.00
18	1.00	33.00	1.00	174.00	84.00	1.00	1.00
19	1.00	32.00	1.00	169.00	85.00	1.00	1.00
20	1.00	31.00	1.00	182.00	92.00	1.00	1.00
21	1.00	25.00	1.00	181.00	93.00	1.00	1.00
22	1.00	26.00	1.00	179.00	94.00	.00	1.00
23	1.00	29.00	1.00	176.00	87.00	1.00	3.00
24	1.00	26.00	1.00	173.00	77.00	1.00	.00
25	1.00	27.00	1.00	167.00	82.00	1.00	1.00
26	1.00	27.00	1.00	180.00	105.00	.00	1.00
27	1.00	29.00	1.00	183.00	94.00	.00	1.00
28	1.00	30.00	1.00	176.00	87.00	.00	1.00
29	1.00	31.00	1.00	156.00	66.00	.00	1.00
30	1.00	29.00	1.00	162.00	78.00	.00	3.00
31	1.00	31.00	1.00	172.00	74.00	.00	1.00
32	1.00	30.00	1.00	174.00	78.00	.00	1.00
33	1.00	35.00	1.00	181.00	95.00	.00	1.00
34	1.00	34.00	1.00	192.00	105.00	.00	1.00
35	1.00	33.00	1.00	172.00	88.00	1.00	1.00
36	1.00	31.00	1.00	176.00	92.00	1.00	1.00
37	1.00	30.00	1.00	175.00	97.00	1.00	1.00

	date1	date2	function	activity	symptom1	symptom2
1	23-JAN-95	25-MAR-95	4.00	4.00	4.00	3.00
2	13-JAN-95	11-APR-95	3.00	3.00	3.00	3.00
3	15-JAN-95	13-APR-95	4.00	4.00	3.00	4.00
4	18-JAN-95	27-JAN-95	2.00	2.00	2.00	2.00
5	18-JAN-95	28-FEB-95	3.00	3.00	3.00	3.00
6	20-JAN-95	01-MAR-95	4.00	3.00	4.00	2.00
7	21-JAN-95	06-APR-95	3.00	4.00	3.00	3.00
8	23-JAN-95	05-MAR-95	4.00	4.00	3.00	3.00
9	23-JAN-95	07-APR-95	4.00	4.00	4.00	3.00
10	25-JAN-95	23-FEB-95	3.00	4.00	4.00	3.00
11	26-JAN-95	10-MAR-95	4.00	4.00	4.00	4.00
12	28-JAN-95	13-APR-95	3.00	4.00	4.00	3.00
13	01-FEB-95	15-MAR-95	4.00	4.00	4.00	4.00
14	03-FEB-95	18-APR-95	3.00	3.00	3.00	3.00
15	03-FEB-95	18-FEB-95	3.00	3.00	4.00	3.00
16	05-FEB-95	01-APR-95	4.00	3.00	3.00	4.00
17	05-FEB-95	03-MAY-95	3.00	3.00	3.00	3.00
18	06-FEB-95	03-APR-95	3.00	3.00	4.00	3.00
19	10-FEB-95	28-APR-95	4.00	4.00	4.00	3.00
20	12-FEB-95	01-MAR-95	4.00	3.00	4.00	3.00
21	17-FEB-95	17-APR-95	4.00	4.00	4.00	4.00
22	20-FEB-95	10-APR-95	4.00	4.00	4.00	4.00
23	23-FEB-95	19-MAY-95	4.00	3.00	4.00	3.00
24	23-FEB-95	18-APR-95	4.00	4.00	4.00	3.00
25	28-FEB-95	12-MAR-95	4.00	4.00	4.00	3.00
26	03-MAR-95	25-APR-95	4.00	4.00	3.00	4.00
27	06-MAR-95	02-JUN-95	3.00	4.00	4.00	3.00
28	06-MAR-95	29-APR-95	4.00	4.00	4.00	4.00
29	07-MAR-95	02-MAY-95	4.00	4.00	3.00	4.00
30	08-MAR-95	20-MAR-95	3.00	4.00	4.00	3.00
31	10-MAR-95	30-MAY-95	4.00	4.00	3.00	4.00
32	13-MAR-95	07-MAY-95	4.00	4.00	4.00	3.00
33	15-MAR-95	12-JUN-95	3.00	3.00	2.00	4.00
34	18-MAR-95	18-MAY-95	4.00	4.00	4.00	3.00
35	27-MAR-95	19-JUN-95	4.00	4.00	3.00	3.00
36	01-APR-95	19-MAY-95	4.00	4.00	4.00	4.00
37	03-APR-95	17-MAY-95	4.00	4.00	4.00	3.00

	symptom3	symptom4	rom1	rom2	ligev1	ligev3	ligev7
1	4.00	4.00	4.00	4.00	3.00	4.00	3.00
2	3.00	3.00	3.00	3.00	3.00	3.00	3.00
3	4.00	4.00	4.00	3.00	3.00	4.00	4.00
4	2.00	3.00	1.00	1.00	2.00	3.00	1.00
5	3.00	3.00	3.00	3.00	2.00	3.00	2.00
6	3.00	3.00	3.00	4.00	2.00	3.00	2.00
7	3.00	3.00	3.00	3.00	2.00	3.00	2.00
8	4.00	4.00	3.00	4.00	4.00	3.00	4.00
9	3.00	4.00	3.00	3.00	4.00	4.00	3.00
10	4.00	4.00	3.00	3.00	4.00	3.00	4.00
11	4.00	3.00	4.00	4.00	3.00	4.00	3.00
12	4.00	4.00	3.00	3.00	4.00	3.00	4.00
13	4.00	3.00	4.00	4.00	3.00	4.00	4.00
14	3.00	3.00	3.00	3.00	3.00	3.00	3.00
15	4.00	3.00	3.00	3.00	4.00	3.00	4.00
16	3.00	3.00	4.00	3.00	3.00	3.00	3.00
17	4.00	3.00	3.00	3.00	3.00	3.00	4.00
18	3.00	3.00	3.00	4.00	3.00	3.00	3.00
19	4.00	4.00	4.00	4.00	4.00	3.00	4.00
20	4.00	4.00	3.00	3.00	4.00	4.00	4.00
21	3.00	4.00	4.00	4.00	3.00	4.00	4.00
22	4.00	3.00	3.00	4.00	4.00	4.00	4.00
23	4.00	4.00	3.00	3.00	3.00	3.00	4.00
24	3.00	4.00	4.00	4.00	3.00	3.00	4.00
25	4.00	4.00	3.00	3.00	4.00	4.00	4.00
26	4.00	3.00	4.00	4.00	3.00	4.00	4.00
27	3.00	4.00	3.00	3.00	3.00	3.00	4.00
28	4.00	3.00	4.00	4.00	4.00	3.00	4.00
29	4.00	4.00	3.00	4.00	3.00	3.00	3.00
30	4.00	4.00	3.00	3.00	4.00	4.00	3.00
31	4.00	4.00	4.00	3.00	4.00	4.00	4.00
32	4.00	4.00	4.00	3.00	4.00	4.00	3.00
33	3.00	2.00	3.00	4.00	3.00	3.00	3.00
34	4.00	4.00	3.00	4.00	3.00	3.00	4.00
35	4.00	3.00	4.00	4.00	4.00	4.00	3.00
36	4.00	4.00	4.00	4.00	3.00	3.00	3.00
37	4.00	4.00	3.00	3.00	4.00	4.00	4.00

	ligev8	kt2000	comp1	comp2	comp3	harv	x_ray1
1	3.00	4.00	3.00	4.00	3.00	3.00	8.00
2	3.00	4.00	3.00	4.00	3.00	4.00	5.00
3	4.00	3.00	4.00	4.00	4.00	4.00	8.00
4	1.00	2.00	1.00	3.00	3.00	1.00	2.00
5	3.00	3.00	2.00	3.00	2.00	1.00	6.00
6	3.00	3.00	3.00	3.00	3.00	1.00	5.00
7	3.00	3.00	3.00	3.00	3.00	1.00	6.00
8	4.00	4.00	3.00	3.00	4.00	4.00	7.00
9	3.00	4.00	4.00	3.00	3.00	4.00	7.00
10	4.00	3.00	4.00	4.00	4.00	4.00	8.00
11	4.00	4.00	3.00	3.00	4.00	4.00	8.00
12	3.00	3.00	4.00	4.00	3.00	4.00	7.00
13	4.00	4.00	4.00	4.00	4.00	4.00	7.00
14	3.00	3.00	3.00	3.00	3.00	3.00	6.00
15	3.00	3.00	3.00	3.00	4.00	1.00	5.00
16	3.00	4.00	3.00	3.00	2.00	3.00	5.00
17	3.00	3.00	3.00	2.00	3.00	3.00	6.00
18	3.00	3.00	2.00	3.00	2.00	3.00	6.00
19	3.00	3.00	4.00	4.00	4.00	4.00	8.00
20	4.00	4.00	4.00	3.00	4.00	4.00	8.00
21	4.00	3.00	4.00	4.00	4.00	3.00	8.00
22	3.00	4.00	4.00	3.00	3.00	4.00	8.00
23	4.00	4.00	4.00	4.00	4.00	3.00	8.00
24	4.00	3.00	4.00	4.00	4.00	4.00	7.00
25	3.00	4.00	3.00	4.00	4.00	3.00	7.00
26	3.00	3.00	4.00	4.00	3.00	4.00	7.00
27	4.00	3.00	4.00	4.00	4.00	4.00	8.00
28	3.00	4.00	4.00	4.00	3.00	3.00	8.00
29	4.00	3.00	3.00	3.00	4.00	4.00	8.00
30	4.00	4.00	4.00	3.00	4.00	4.00	8.00
31	3.00	4.00	4.00	3.00	4.00	4.00	8.00
32	4.00	4.00	3.00	3.00	3.00	3.00	7.00
33	3.00	3.00	4.00	3.00	3.00	3.00	6.00
34	4.00	4.00	4.00	4.00	3.00	4.00	8.00
35	4.00	4.00	3.00	4.00	4.00	4.00	8.00
36	4.00	3.00	4.00	4.00	3.00	3.00	8.00
37	4.00	4.00	4.00	3.00	4.00	4.00	8.00

	x_ray2	x_ray3	func	score	follow	t	cat1
1	8.00	8.00	8.00	93.00	24.15	61.00	4.00
2	5.00	5.00	5.00	74.00	28.64	88.00	3.00
3	8.00	8.00	7.00	95.00	30.11	88.00	4.00
4	2.00	2.00	2.00	40.00	24.20	9.00	2.00
5	6.00	6.00	6.00	69.00	31.27	41.00	3.00
6	5.00	5.00	6.00	70.00	25.00	40.00	3.00
7	5.00	6.00	6.00	71.00	31.77	75.00	3.00
8	7.00	7.00	8.00	91.00	26.00	41.00	4.00
9	8.00	7.00	8.00	90.00	30.61	74.00	4.00
10	8.00	7.00	8.00	93.00	26.00	29.00	4.00
11	8.00	8.00	7.00	94.00	25.00	43.00	4.00
12	8.00	7.00	8.00	90.00	25.91	75.00	4.00
13	8.00	7.00	8.00	96.00	24.50	42.00	4.00
14	5.00	5.00	6.00	73.00	24.00	74.00	3.00
15	5.00	6.00	5.00	75.00	25.28	15.00	3.00
16	5.00	5.00	5.00	74.00	26.00	55.00	3.00
17	5.00	6.00	6.00	75.00	25.00	87.00	3.00
18	6.00	6.00	6.00	75.00	26.35	56.00	3.00
19	8.00	8.00	8.00	96.00	27.79	77.00	4.00
20	7.00	8.00	8.00	94.00	24.40	17.00	4.00
21	8.00	8.00	8.00	96.00	24.20	59.00	4.00
22	8.00	8.00	8.00	95.00	25.00	49.00	4.00
23	8.00	8.00	8.00	93.00	45.00	85.00	4.00
24	8.00	7.00	8.00	93.00	30.21	54.00	4.00
25	8.00	8.00	7.00	92.00	24.02	12.00	4.00
26	8.00	8.00	8.00	93.00	26.42	53.00	4.00
27	8.00	8.00	8.00	92.00	24.23	88.00	4.00
28	8.00	8.00	8.00	95.00	27.16	54.00	4.00
29	8.00	7.00	7.00	90.00	36.59	56.00	4.00
30	8.00	8.00	8.00	94.00	24.30	12.00	4.00
31	8.00	8.00	8.00	96.00	24.18	81.00	4.00
32	7.00	8.00	8.00	91.00	24.50	55.00	4.00
33	5.00	6.00	6.00	75.00	28.43	89.00	3.00
34	8.00	8.00	8.00	95.00	28.00	61.00	4.00
35	8.00	8.00	8.00	95.00	24.50	84.00	4.00
36	7.00	8.00	8.00	93.00	24.00	48.00	4.00
37	8.00	8.00	8.00	96.00	29.26	44.00	4.00

	tc	filter_$	art
1	2.00	1	2.00
2	2.00	1	2.00
3	2.00	1	1.00
4	1.00	1	1.00
5	2.00	1	1.00
6	2.00	1	1.00
7	2.00	1	1.00
8	2.00	1	2.00
9	2.00	1	2.00
10	2.00	1	1.00
11	2.00	1	2.00
12	2.00	1	1.00
13	2.00	1	2.00
14	2.00	1	1.00
15	1.00	1	1.00
16	2.00	1	2.00
17	2.00	1	1.00
18	2.00	1	1.00
19	2.00	1	1.00
20	1.00	1	2.00
21	2.00	1	1.00
22	2.00	1	2.00
23	2.00	1	2.00
24	2.00	1	1.00
25	1.00	1	2.00
26	2.00	1	1.00
27	2.00	1	1.00
28	2.00	1	2.00
29	2.00	1	1.00
30	1.00	1	2.00
31	2.00	1	2.00
32	2.00	1	2.00
33	2.00	1	1.00
34	2.00	1	2.00
35	2.00	1	2.00
36	2.00	1	1.00
37	2.00	1	2.00

	group	age	sex	ht	wt	invknee	cause
38	1.00	35.00	1.00	183.00	104.00	1.00	3.00
39	1.00	26.00	1.00	180.00	102.00	.00	1.00
40	1.00	30.00	1.00	176.00	88.00	1.00	1.00
41	1.00	28.00	1.00	182.00	86.00	.00	1.00
42	1.00	29.00	1.00	183.00	97.00	1.00	1.00
43	1.00	30.00	1.00	185.00	95.00	.00	1.00
44	1.00	30.00	1.00	176.00	92.00	1.00	1.00
45	1.00	31.00	1.00	175.00	80.00	.00	1.00
46	1.00	26.00	1.00	173.00	88.00	.00	3.00
47	1.00	27.00	1.00	170.00	84.00	.00	1.00
48	1.00	30.00	1.00	176.00	78.00	.00	1.00
49	1.00	34.00	1.00	180.00	105.00	.00	1.00
50	1.00	35.00	1.00	180.00	112.00	.00	1.00
51	1.00	32.00	1.00	162.00	77.00	.00	1.00
52	1.00	33.00	1.00	164.00	85.00	.00	3.00
53	1.00	31.00	1.00	187.00	98.00	.00	3.00
54	1.00	28.00	1.00	178.00	92.00	.00	3.00
55	1.00	25.00	1.00	179.00	84.00	.00	3.00
56	1.00	25.00	1.00	181.00	98.00	.00	1.00
57	1.00	26.00	1.00	185.00	104.00	.00	1.00
58	1.00	31.00	1.00	182.00	98.00	.00	1.00
59	1.00	32.00	1.00	180.00	102.00	.00	1.00
60	1.00	35.00	1.00	179.00	92.00	1.00	1.00
61	1.00	34.00	1.00	176.00	94.00	1.00	1.00
62	1.00	34.00	1.00	171.00	87.00	1.00	1.00
63	1.00	31.00	1.00	173.00	85.00	.00	1.00
64	1.00	30.00	1.00	169.00	77.00	.00	1.00
65	1.00	26.00	1.00	167.00	92.00	.00	1.00
66	1.00	28.00	1.00	172.00	97.00	.00	1.00
67	1.00	28.00	1.00	189.00	108.00	.00	1.00
68	1.00	30.00	1.00	199.00	130.00	1.00	1.00
69	1.00	22.00	1.00	173.00	87.00	.00	1.00
70	1.00	21.00	1.00	185.00	102.00	.00	1.00
71	1.00	23.00	1.00	176.00	92.00	.00	1.00
72	1.00	24.00	1.00	175.00	97.00	.00	1.00
73	1.00	20.00	1.00	173.00	93.00	1.00	1.00
74	1.00	21.00	1.00	172.00	87.00	1.00	1.00

	date1	date2	function	activity	symptom1	symptom2
38	04-APR-95	22-JUN-95	4.00	3.00	3.00	3.00
39	05-APR-95	29-MAY-95	4.00	4.00	4.00	4.00
40	07-APR-95	21-APR-95	4.00	3.00	4.00	3.00
41	09-APR-95	30-MAY-95	4.00	4.00	3.00	4.00
42	10-APR-95	05-JUL-95	4.00	3.00	4.00	3.00
43	13-APR-95	05-JUN-95	3.00	4.00	3.00	3.00
44	18-APR-95	07-JUL-95	4.00	3.00	4.00	4.00
45	23-APR-95	09-MAY-95	4.00	4.00	3.00	3.00
46	25-APR-95	23-JUN-95	4.00	4.00	4.00	4.00
47	27-APR-95	10-JUL-95	4.00	3.00	4.00	3.00
48	29-APR-95	28-JUN-95	4.00	3.00	3.00	3.00
49	29-APR-95	29-JUN-95	3.00	3.00	2.00	4.00
50	30-APR-95	15-MAY-95	4.00	3.00	2.00	3.00
51	03-MAY-95	30-JUN-95	4.00	4.00	4.00	4.00
52	03-MAY-95	05-JUL-95	4.00	3.00	3.00	4.00
53	06-MAY-95	08-JUL-95	4.00	4.00	4.00	3.00
54	08-MAY-95	05-AUG-95	4.00	4.00	4.00	4.00
55	11-MAY-95	09-JUL-95	3.00	3.00	4.00	4.00
56	13-MAY-95	20-JUL-95	4.00	4.00	3.00	3.00
57	17-MAY-95	11-JUL-95	4.00	4.00	4.00	3.00
58	22-MAY-95	03-JUL-95	4.00	3.00	3.00	3.00
59	23-MAY-95	13-AUG-95	4.00	4.00	3.00	4.00
60	28-MAY-95	15-JUL-95	4.00	4.00	2.00	3.00
61	30-MAY-95	22-JUL-95	3.00	3.00	3.00	3.00
62	05-JUN-95	17-JUL-95	4.00	4.00	4.00	3.00
63	05-JUN-95	28-AUG-95	3.00	3.00	3.00	4.00
64	07-JUN-95	29-JUL-95	4.00	4.00	4.00	3.00
65	08-JUN-95	14-AUG-95	4.00	4.00	4.00	4.00
66	13-JUN-95	05-SEP-95	4.00	4.00	4.00	3.00
67	17-JUN-95	06-AUG-95	3.00	4.00	3.00	3.00
68	28-JUN-95	08-AUG-95	3.00	4.00	4.00	4.00
69	29-JUN-95	01-AUG-95	4.00	4.00	4.00	3.00
70	29-JUN-95	11-SEP-95	4.00	3.00	4.00	3.00
71	30-JUN-95	17-AUG-95	3.00	4.00	3.00	4.00
72	05-JUL-95	02-OCT-95	4.00	4.00	4.00	3.00
73	08-JUL-95	22-AUG-95	3.00	4.00	3.00	4.00
74	08-JUL-95	27-AUG-95	4.00	4.00	4.00	3.00

	symptom3	symptom4	rom1	rom2	ligev1	ligev3	ligev7
38	2.00	4.00	3.00	3.00	3.00	3.00	2.00
39	3.00	4.00	3.00	4.00	3.00	3.00	4.00
40	4.00	4.00	3.00	3.00	4.00	4.00	3.00
41	3.00	4.00	4.00	4.00	4.00	3.00	4.00
42	4.00	3.00	3.00	4.00	4.00	4.00	4.00
43	4.00	4.00	3.00	3.00	3.00	3.00	3.00
44	3.00	3.00	4.00	3.00	4.00	3.00	4.00
45	3.00	3.00	3.00	3.00	3.00	4.00	4.00
46	4.00	4.00	4.00	3.00	4.00	3.00	4.00
47	4.00	4.00	3.00	3.00	4.00	4.00	3.00
48	3.00	4.00	4.00	4.00	3.00	3.00	4.00
49	3.00	3.00	3.00	3.00	4.00	3.00	3.00
50	3.00	3.00	3.00	3.00	3.00	3.00	3.00
51	3.00	3.00	4.00	4.00	4.00	4.00	3.00
52	4.00	4.00	3.00	4.00	3.00	3.00	4.00
53	3.00	4.00	4.00	3.00	4.00	4.00	4.00
54	4.00	3.00	3.00	4.00	3.00	3.00	3.00
55	4.00	4.00	4.00	3.00	4.00	4.00	4.00
56	3.00	3.00	4.00	4.00	3.00	3.00	3.00
57	4.00	3.00	3.00	3.00	4.00	4.00	3.00
58	4.00	4.00	4.00	3.00	3.00	3.00	4.00
59	4.00	4.00	4.00	4.00	3.00	3.00	3.00
60	3.00	3.00	3.00	4.00	4.00	4.00	4.00
61	3.00	3.00	3.00	3.00	3.00	3.00	3.00
62	4.00	3.00	3.00	3.00	4.00	3.00	4.00
63	3.00	3.00	4.00	3.00	3.00	4.00	3.00
64	4.00	3.00	3.00	4.00	4.00	4.00	3.00
65	4.00	4.00	4.00	4.00	3.00	3.00	4.00
66	4.00	3.00	3.00	4.00	3.00	3.00	4.00
67	4.00	3.00	3.00	3.00	3.00	4.00	3.00
68	3.00	4.00	4.00	3.00	4.00	4.00	4.00
69	4.00	3.00	4.00	4.00	3.00	3.00	4.00
70	3.00	3.00	3.00	4.00	4.00	4.00	4.00
71	4.00	4.00	4.00	4.00	3.00	3.00	3.00
72	4.00	3.00	3.00	4.00	4.00	4.00	4.00
73	4.00	4.00	4.00	4.00	3.00	3.00	3.00
74	4.00	3.00	3.00	4.00	4.00	4.00	3.00

	ligev8	kt2000	comp1	comp2	comp3	harv	x_ray1
38	3.00	3.00	3.00	3.00	3.00	1.00	6.00
39	4.00	3.00	3.00	4.00	4.00	4.00	7.00
40	4.00	3.00	4.00	3.00	4.00	3.00	8.00
41	3.00	4.00	3.00	4.00	4.00	4.00	7.00
42	4.00	4.00	4.00	4.00	4.00	4.00	8.00
43	3.00	4.00	3.00	4.00	4.00	4.00	8.00
44	4.00	3.00	4.00	4.00	4.00	4.00	8.00
45	3.00	3.00	4.00	4.00	3.00	3.00	7.00
46	4.00	4.00	4.00	3.00	3.00	3.00	8.00
47	3.00	3.00	3.00	4.00	4.00	4.00	8.00
48	4.00	3.00	4.00	4.00	4.00	4.00	8.00
49	3.00	4.00	3.00	3.00	3.00	3.00	6.00
50	3.00	3.00	3.00	3.00	3.00	1.00	7.00
51	3.00	4.00	4.00	4.00	3.00	4.00	8.00
52	4.00	3.00	3.00	4.00	4.00	3.00	8.00
53	3.00	4.00	4.00	3.00	4.00	4.00	7.00
54	4.00	3.00	3.00	4.00	4.00	3.00	8.00
55	3.00	4.00	4.00	3.00	3.00	4.00	8.00
56	4.00	3.00	4.00	4.00	3.00	4.00	8.00
57	3.00	4.00	4.00	4.00	4.00	4.00	8.00
58	4.00	3.00	3.00	3.00	4.00	3.00	8.00
59	3.00	4.00	3.00	4.00	4.00	3.00	7.00
60	4.00	3.00	4.00	3.00	3.00	3.00	8.00
61	3.00	4.00	3.00	4.00	3.00	3.00	6.00
62	3.00	3.00	4.00	4.00	3.00	4.00	7.00
63	3.00	3.00	3.00	2.00	2.00	3.00	5.00
64	4.00	3.00	4.00	4.00	3.00	4.00	8.00
65	4.00	3.00	4.00	4.00	4.00	3.00	7.00
66	4.00	3.00	3.00	4.00	4.00	4.00	8.00
67	4.00	3.00	4.00	3.00	4.00	4.00	7.00
68	3.00	3.00	4.00	4.00	3.00	3.00	8.00
69	4.00	3.00	3.00	4.00	3.00	3.00	8.00
70	4.00	4.00	4.00	3.00	4.00	4.00	8.00
71	4.00	3.00	3.00	4.00	4.00	4.00	7.00
72	4.00	4.00	4.00	3.00	4.00	4.00	7.00
73	4.00	3.00	4.00	4.00	3.00	4.00	8.00
74	4.00	4.00	4.00	4.00	4.00	3.00	8.00

	x_ray2	x_ray3	func	score	follow	t	cat1
38	5.00	5.00	6.00	71.00	24.60	79.00	3.00
39	8.00	8.00	8.00	93.00	25.02	54.00	4.00
40	7.00	8.00	8.00	91.00	26.20	14.00	4.00
41	8.00	8.00	8.00	94.00	27.89	51.00	4.00
42	7.00	7.00	7.00	93.00	27.11	86.00	4.00
43	7.00	8.00	7.00	88.00	26.58	53.00	4.00
44	8.00	8.00	8.00	94.00	26.05	80.00	4.00
45	7.00	7.00	8.00	86.00	29.45	16.00	4.00
46	7.00	7.00	8.00	93.00	29.20	59.00	4.00
47	8.00	8.00	8.00	92.00	28.80	74.00	4.00
48	7.00	7.00	7.00	90.00	29.87	60.00	4.00
49	5.00	5.00	6.00	75.00	26.64	61.00	3.00
50	6.00	6.00	6.00	74.00	25.00	15.00	3.00
51	8.00	8.00	8.00	95.00	24.60	58.00	4.00
52	8.00	8.00	8.00	92.00	27.34	63.00	4.00
53	8.00	7.00	7.00	92.00	26.79	63.00	4.00
54	8.00	8.00	8.00	92.00	29.87	89.00	4.00
55	7.00	7.00	8.00	92.00	24.03	59.00	4.00
56	7.00	8.00	7.00	89.00	25.10	68.00	4.00
57	7.00	8.00	8.00	93.00	28.31	55.00	4.00
58	8.00	8.00	7.00	89.00	33.90	42.00	4.00
59	8.00	8.00	8.00	92.00	24.80	82.00	4.00
60	7.00	7.00	7.00	87.00	27.53	48.00	4.00
61	5.00	5.00	6.00	75.00	25.00	53.00	3.00
62	8.00	8.00	8.00	91.00	24.16	42.00	4.00
63	6.00	6.00	6.00	75.00	26.96	84.00	3.00
64	8.00	8.00	8.00	94.00	32.66	52.00	4.00
65	7.00	8.00	8.00	94.00	25.60	67.00	4.00
66	8.00	8.00	8.00	93.00	24.50	84.00	4.00
67	8.00	7.00	8.00	88.00	25.75	50.00	4.00
68	7.00	8.00	7.00	91.00	32.80	41.00	4.00
69	8.00	7.00	8.00	91.00	26.60	33.00	4.00
70	8.00	8.00	7.00	93.00	26.22	74.00	4.00
71	8.00	8.00	8.00	92.00	27.41	48.00	4.00
72	8.00	7.00	8.00	94.00	26.00	89.00	4.00
73	7.00	7.00	7.00	90.00	24.50	45.00	4.00
74	7.00	8.00	7.00	93.00	25.30	50.00	4.00

	tc	filter_$	art
38	2.00	1	1.00
39	2.00	1	1.00
40	1.00	1	1.00
41	2.00	1	2.00
42	2.00	1	2.00
43	2.00	1	2.00
44	2.00	1	1.00
45	1.00	1	1.00
46	2.00	1	2.00
47	2.00	1	1.00
48	2.00	1	1.00
49	2.00	1	2.00
50	1.00	1	1.00
51	2.00	1	2.00
52	2.00	1	1.00
53	2.00	1	2.00
54	2.00	1	1.00
55	2.00	1	2.00
56	2.00	1	1.00
57	2.00	1	2.00
58	2.00	1	1.00
59	2.00	1	2.00
60	2.00	1	1.00
61	2.00	1	2.00
62	2.00	1	1.00
63	2.00	1	1.00
64	2.00	1	1.00
65	2.00	1	1.00
66	2.00	1	1.00
67	2.00	1	1.00
68	2.00	1	1.00
69	2.00	1	1.00
70	2.00	1	2.00
71	2.00	1	1.00
72	2.00	1	2.00
73	2.00	1	1.00
74	2.00	1	2.00

	group	age	sex	ht	wt	invknee	cause
75	1.00	21.00	1.00	170.00	97.00	1.00	1.00
76	1.00	22.00	1.00	167.00	82.00	.00	1.00
77	1.00	36.00	1.00	168.00	88.00	.00	1.00
78	1.00	36.00	1.00	180.00	103.00	.00	1.00
79	1.00	38.00	1.00	182.00	104.00	.00	1.00
80	1.00	37.00	1.00	176.00	88.00	.00	1.00
81	1.00	40.00	1.00	175.00	91.00	1.00	1.00
82	1.00	43.00	1.00	183.00	90.00	1.00	1.00
83	1.00	41.00	1.00	180.00	98.00	.00	1.00
84	1.00	39.00	1.00	169.00	88.00	1.00	1.00
85	1.00	40.00	1.00	188.00	108.00	.00	1.00
86	1.00	41.00	1.00	177.00	98.00	1.00	1.00
87	1.00	41.00	1.00	187.00	97.00	.00	1.00
88	1.00	40.00	1.00	165.00	77.00	.00	1.00
89	1.00	38.00	1.00	168.00	88.00	.00	1.00
90	1.00	37.00	1.00	173.00	92.00	.00	1.00
91	1.00	37.00	1.00	172.00	82.00	.00	1.00
92	1.00	39.00	1.00	170.00	90.00	.00	1.00
93	1.00	36.00	1.00	177.00	88.00	.00	1.00
94	1.00	42.00	1.00	189.00	104.00	.00	1.00
95	1.00	45.00	1.00	167.00	88.00	.00	1.00
96	1.00	41.00	1.00	169.00	87.00	.00	1.00
97	1.00	45.00	1.00	165.00	82.00	.00	1.00
98	1.00	43.00	1.00	164.00	87.00	1.00	1.00
99	1.00	44.00	1.00	166.00	86.00	.00	1.00
100	1.00	44.00	1.00	187.00	103.00	.00	1.00
101	2.00	27.00	.00	179.00	86.00	1.00	2.00
102	2.00	35.00	.00	170.00	85.00	1.00	2.00
103	2.00	29.00	.00	165.00	77.00	.00	2.00
104	2.00	27.00	.00	168.00	76.00	.00	2.00
105	2.00	28.00	1.00	167.00	78.00	.00	3.00
106	2.00	35.00	1.00	176.00	74.00	.00	2.00
107	2.00	34.00	1.00	190.00	120.00	.00	1.00
108	2.00	33.00	1.00	176.00	88.00	.00	2.00
109	2.00	32.00	1.00	174.00	78.00	.00	1.00
110	2.00	37.00	1.00	182.00	95.00	.00	2.00
111	2.00	36.00	1.00	185.00	101.00	.00	2.00

	date1	date2	function	activity	symptom1	symptom2
75	09-JUL-95	28-AUG-95	4.00	4.00	4.00	3.00
76	10-JUL-95	28-AUG-95	4.00	4.00	3.00	3.00
77	11-JUL-95	25-JUL-95	3.00	3.00	3.00	1.00
78	13-JUL-95	30-AUG-95	4.00	3.00	4.00	3.00
79	13-JUL-95	01-SEP-95	3.00	4.00	3.00	3.00
80	18-JUL-95	04-SEP-95	4.00	4.00	3.00	3.00
81	22-JUL-95	22-AUG-95	3.00	3.00	3.00	2.00
82	27-JUL-95	27-AUG-95	4.00	3.00	4.00	4.00
83	28-JUL-95	28-AUG-95	3.00	3.00	3.00	3.00
84	29-JUL-95	25-AUG-95	3.00	3.00	3.00	3.00
85	04-AUG-95	30-OCT-95	4.00	3.00	3.00	3.00
86	05-AUG-95	30-AUG-95	3.00	4.00	2.00	4.00
87	06-AUG-95	01-OCT-95	3.00	3.00	3.00	3.00
88	08-AUG-95	04-SEP-95	3.00	3.00	3.00	3.00
89	09-AUG-95	01-NOV-95	3.00	3.00	3.00	4.00
90	11-AUG-95	08-NOV-95	3.00	3.00	2.00	3.00
91	17-AUG-95	14-NOV-95	3.00	3.00	3.00	3.00
92	18-AUG-95	15-NOV-95	4.00	3.00	4.00	3.00
93	22-AUG-95	18-NOV-95	3.00	3.00	3.00	4.00
94	27-AUG-95	24-NOV-95	4.00	3.00	3.00	3.00
95	28-AUG-95	22-NOV-95	2.00	2.00	4.00	4.00
96	28-AUG-95	21-NOV-95	3.00	3.00	3.00	3.00
97	30-AUG-95	28-NOV-95	4.00	4.00	2.00	4.00
98	30-AUG-95	18-OCT-95	3.00	3.00	3.00	3.00
99	02-SEP-95	01-DEC-95	3.00	3.00	3.00	3.00
100	04-SEP-95	04-OCT-95	2.00	2.00	4.00	4.00
101	04-JAN-95	01-NOV-95	4.00	4.00	4.00	4.00
102	07-JAN-95	04-AUG-95	3.00	3.00	3.00	3.00
103	09-JAN-95	07-SEP-95	4.00	4.00	3.00	4.00
104	11-JAN-95	03-AUG-95	4.00	3.00	4.00	4.00
105	17-JAN-95	16-NOV-95	4.00	4.00	4.00	4.00
106	20-JAN-95	28-DEC-95	3.00	3.00	3.00	3.00
107	21-JAN-95	13-SEP-95	4.00	3.00	4.00	4.00
108	23-JAN-95	24-AUG-95	3.00	3.00	3.00	3.00
109	24-JAN-95	25-JUL-95	4.00	4.00	3.00	4.00
110	25-JAN-95	05-JUL-95	3.00	4.00	4.00	3.00
111	28-JAN-95	05-JUN-95	3.00	3.00	3.00	3.00

	symptom3	symptom4	rom1	rom2	ligev1	ligev3	ligev7
75	4.00	4.00	4.00	3.00	3.00	3.00	4.00
76	4.00	3.00	3.00	3.00	4.00	4.00	4.00
77	3.00	3.00	3.00	3.00	3.00	3.00	3.00
78	4.00	4.00	3.00	3.00	4.00	3.00	4.00
79	3.00	3.00	3.00	3.00	3.00	3.00	1.00
80	4.00	3.00	3.00	3.00	2.00	4.00	4.00
81	3.00	3.00	3.00	3.00	2.00	3.00	3.00
82	3.00	3.00	3.00	3.00	2.00	4.00	3.00
83	3.00	3.00	3.00	3.00	3.00	3.00	4.00
84	4.00	3.00	3.00	3.00	1.00	3.00	3.00
85	3.00	3.00	2.00	3.00	2.00	3.00	3.00
86	3.00	3.00	3.00	4.00	2.00	4.00	3.00
87	4.00	3.00	2.00	3.00	2.00	3.00	4.00
88	3.00	3.00	3.00	3.00	3.00	3.00	3.00
89	3.00	3.00	3.00	3.00	3.00	4.00	3.00
90	3.00	3.00	4.00	3.00	3.00	3.00	3.00
91	3.00	3.00	3.00	3.00	3.00	3.00	4.00
92	3.00	3.00	3.00	3.00	3.00	3.00	1.00
93	3.00	3.00	4.00	3.00	3.00	3.00	3.00
94	3.00	3.00	1.00	2.00	3.00	3.00	3.00
95	4.00	3.00	2.00	4.00	4.00	4.00	4.00
96	3.00	3.00	2.00	2.00	3.00	3.00	3.00
97	4.00	3.00	1.00	4.00	4.00	4.00	4.00
98	3.00	3.00	2.00	2.00	2.00	3.00	3.00
99	3.00	3.00	1.00	3.00	2.00	3.00	3.00
100	4.00	3.00	1.00	4.00	4.00	4.00	2.00
101	3.00	4.00	4.00	3.00	4.00	4.00	4.00
102	3.00	3.00	3.00	3.00	3.00	3.00	3.00
103	4.00	3.00	4.00	4.00	4.00	3.00	4.00
104	4.00	3.00	3.00	4.00	3.00	4.00	3.00
105	4.00	4.00	4.00	4.00	4.00	4.00	4.00
106	3.00	3.00	3.00	3.00	3.00	3.00	3.00
107	3.00	3.00	3.00	3.00	3.00	3.00	3.00
108	4.00	3.00	4.00	3.00	3.00	3.00	3.00
109	4.00	3.00	4.00	4.00	3.00	4.00	4.00
110	3.00	3.00	3.00	3.00	4.00	3.00	3.00
111	3.00	3.00	4.00	3.00	3.00	4.00	4.00

	ligev8	kt2000	comp1	comp2	comp3	harv	x_ray1
75	3.00	3.00	4.00	3.00	3.00	3.00	8.00
76	2.00	4.00	2.00	3.00	2.00	3.00	8.00
77	4.00	3.00	3.00	3.00	3.00	3.00	6.00
78	3.00	4.00	4.00	4.00	3.00	4.00	8.00
79	3.00	3.00	3.00	3.00	3.00	3.00	6.00
80	4.00	3.00	3.00	4.00	4.00	3.00	8.00
81	3.00	3.00	3.00	3.00	3.00	1.00	6.00
82	3.00	4.00	3.00	3.00	3.00	1.00	6.00
83	3.00	3.00	4.00	3.00	3.00	1.00	7.00
84	4.00	3.00	3.00	3.00	2.00	3.00	6.00
85	3.00	3.00	3.00	2.00	2.00	1.00	7.00
86	4.00	3.00	3.00	3.00	3.00	1.00	6.00
87	3.00	4.00	3.00	3.00	3.00	1.00	5.00
88	3.00	3.00	4.00	2.00	2.00	1.00	5.00
89	3.00	3.00	3.00	3.00	3.00	1.00	6.00
90	3.00	3.00	3.00	3.00	3.00	1.00	6.00
91	3.00	3.00	3.00	2.00	2.00	1.00	7.00
92	3.00	3.00	3.00	3.00	3.00	1.00	7.00
93	3.00	3.00	3.00	2.00	2.00	1.00	8.00
94	3.00	3.00	3.00	3.00	3.00	1.00	7.00
95	4.00	4.00	4.00	3.00	3.00	1.00	3.00
96	3.00	2.00	3.00	3.00	3.00	1.00	6.00
97	4.00	4.00	4.00	3.00	3.00	1.00	3.00
98	3.00	3.00	1.00	3.00	3.00	1.00	7.00
99	3.00	3.00	3.00	3.00	3.00	1.00	7.00
100	1.00	4.00	4.00	3.00	3.00	1.00	3.00
101	3.00	4.00	3.00	3.00	3.00	4.00	4.00
102	3.00	3.00	3.00	3.00	3.00	3.00	6.00
103	4.00	4.00	2.00	2.00	3.00	4.00	4.00
104	3.00	4.00	3.00	3.00	4.00	3.00	7.00
105	4.00	4.00	3.00	3.00	3.00	4.00	4.00
106	3.00	3.00	2.00	2.00	3.00	3.00	4.00
107	3.00	3.00	3.00	3.00	3.00	3.00	4.00
108	4.00	4.00	2.00	2.00	3.00	3.00	5.00
109	3.00	4.00	4.00	4.00	4.00	4.00	6.00
110	4.00	3.00	2.00	2.00	3.00	3.00	5.00
111	3.00	4.00	2.00	2.00	3.00	3.00	5.00

	x_ray2	x_ray3	func	score	follow	t	cat1
75	8.00	7.00	8.00	90.00	25.21	50.00	4.00
76	8.00	8.00	8.00	87.00	24.50	49.00	4.00
77	6.00	6.00	7.00	75.00	27.23	14.00	3.00
78	8.00	8.00	8.00	93.00	25.09	48.00	4.00
79	6.00	6.00	7.00	75.00	27.20	50.00	3.00
80	8.00	8.00	8.00	90.00	25.00	48.00	4.00
81	6.00	6.00	7.00	72.00	25.20	31.00	3.00
82	5.00	6.00	4.00	74.00	26.11	31.00	3.00
83	6.00	6.00	4.00	74.00	24.98	31.00	3.00
84	6.00	6.00	7.00	75.00	26.74	27.00	3.00
85	7.00	5.00	7.00	72.00	24.89	87.00	3.00
86	7.00	6.00	4.00	75.00	24.00	25.00	3.00
87	6.00	7.00	4.00	72.00	27.50	56.00	3.00
88	6.00	6.00	7.00	72.00	24.50	27.00	3.00
89	5.00	6.00	7.00	75.00	24.70	84.00	3.00
90	7.00	6.00	7.00	75.00	27.74	89.00	3.00
91	6.00	6.00	7.00	74.00	40.08	89.00	3.00
92	7.00	6.00	6.00	75.00	26.28	89.00	3.00
93	7.00	7.00	4.00	75.00	24.00	88.00	3.00
94	5.00	6.00	7.00	72.00	24.76	89.00	3.00
95	3.00	3.00	4.00	69.00	26.40	86.00	3.00
96	7.00	8.00	7.00	74.00	24.80	85.00	3.00
97	3.00	3.00	4.00	70.00	24.64	90.00	3.00
98	6.00	7.00	8.00	72.00	25.10	49.00	3.00
99	6.00	6.00	7.00	72.00	30.72	90.00	3.00
100	3.00	3.00	4.00	63.00	24.00	30.00	3.00
101	5.00	4.00	7.00	82.00	28.00	301.00	4.00
102	6.00	5.00	7.00	75.00	27.00	209.00	3.00
103	4.00	4.00	8.00	80.00	30.76	241.00	4.00
104	7.00	7.00	8.00	88.00	24.00	204.00	4.00
105	5.00	5.00	8.00	87.00	33.02	303.00	4.00
106	4.00	4.00	7.00	68.00	24.00	342.00	3.00
107	4.00	4.00	6.00	72.00	25.60	235.00	3.00
108	5.00	6.00	6.00	75.00	24.00	213.00	3.00
109	6.00	6.00	8.00	90.00	26.96	182.00	4.00
110	5.00	5.00	7.00	75.00	25.12	161.00	3.00
111	6.00	5.00	6.00	75.00	24.50	128.00	3.00

	tc	filter_$	art
75	2.00	1	1.00
76	2.00	1	2.00
77	1.00	1	1.00
78	2.00	1	2.00
79	2.00	1	1.00
80	2.00	1	1.00
81	2.00	1	1.00
82	2.00	1	2.00
83	2.00	1	1.00
84	2.00	1	1.00
85	2.00	1	1.00
86	2.00	1	1.00
87	2.00	1	2.00
88	2.00	1	1.00
89	2.00	1	1.00
90	2.00	1	1.00
91	2.00	1	1.00
92	2.00	1	1.00
93	2.00	1	1.00
94	2.00	1	1.00
95	2.00	1	2.00
96	2.00	1	1.00
97	2.00	1	2.00
98	2.00	1	1.00
99	2.00	1	1.00
100	2.00	1	2.00
101	4.00	0	2.00
102	4.00	0	1.00
103	4.00	0	2.00
104	4.00	0	2.00
105	4.00	0	2.00
106	4.00	0	1.00
107	4.00	0	1.00
108	4.00	0	2.00
109	4.00	0	2.00
110	3.00	0	1.00
111	3.00	0	2.00

	group	age	sex	ht	wt	invknee	cause
112	2.00	35.00	1.00	168.00	77.00	.00	2.00
113	2.00	39.00	1.00	176.00	88.00	.00	2.00
114	2.00	38.00	1.00	181.00	92.00	.00	3.00
115	2.00	41.00	1.00	180.00	98.00	.00	2.00
116	2.00	31.00	1.00	174.00	87.00	1.00	2.00
117	2.00	27.00	1.00	168.00	86.00	1.00	2.00
118	2.00	32.00	1.00	172.00	77.00	1.00	2.00
119	2.00	33.00	1.00	168.00	80.00	.00	2.00
120	2.00	40.00	1.00	184.00	105.00	.00	2.00
121	2.00	41.00	1.00	173.00	92.00	.00	3.00
122	2.00	45.00	1.00	183.00	94.00	.00	1.00
123	2.00	46.00	1.00	186.00	103.00	.00	1.00
124	2.00	43.00	1.00	168.00	88.00	.00	1.00
125	2.00	34.00	1.00	190.00	118.00	1.00	1.00
126	2.00	43.00	1.00	186.00	107.00	1.00	2.00
127	2.00	33.00	1.00	165.00	88.00	.00	2.00
128	2.00	44.00	1.00	176.00	92.00	.00	2.00
129	2.00	27.00	1.00	173.00	87.00	.00	2.00
130	2.00	28.00	1.00	177.00	81.00	.00	.00
131	2.00	29.00	1.00	179.00	95.00	.00	3.00
132	2.00	30.00	1.00	189.00	108.00	.00	3.00
133	2.00	30.00	1.00	188.00	117.00	.00	1.00
134	2.00	27.00	1.00	176.00	88.00	.00	3.00
135	2.00	27.00	1.00	175.00	89.00	.00	2.00
136	2.00	28.00	1.00	173.00	94.00	1.00	1.00
137	2.00	35.00	1.00	163.00	87.00	1.00	2.00
138	2.00	37.00	1.00	177.00	91.00	1.00	.00
139	2.00	32.00	1.00	186.00	118.00	1.00	2.00
140	2.00	20.00	1.00	179.00	92.00	1.00	3.00
141	2.00	22.00	1.00	174.00	94.00	1.00	2.00
142	2.00	24.00	1.00	170.00	81.00	.00	2.00
143	2.00	26.00	1.00	178.00	97.00	1.00	2.00
144	2.00	28.00	1.00	167.00	88.00	.00	2.00
145	2.00	30.00	1.00	187.00	97.00	.00	3.00
146	2.00	27.00	1.00	167.00	78.00	.00	3.00
147	2.00	20.00	1.00	176.00	85.00	.00	2.00
148	2.00	22.00	1.00	180.00	102.00	.00	3.00

	date1	date2	function	activity	symptom1	symptom2
112	28-JAN-95	07-JUL-95	4.00	3.00	4.00	3.00
113	01-FEB-95	28-JUN-95	3.00	4.00	3.00	4.00
114	04-FEB-95	23-JUN-95	4.00	3.00	4.00	3.00
115	04-FEB-95	10-JUL-95	3.00	4.00	3.00	4.00
116	05-FEB-95	28-JUN-95	4.00	4.00	4.00	3.00
117	05-FEB-95	29-JUN-95	4.00	3.00	4.00	4.00
118	06-FEB-95	18-DEC-95	4.00	3.00	3.00	3.00
119	10-FEB-95	30-JUN-95	3.00	4.00	3.00	3.00
120	13-FEB-95	05-JUL-95	3.00	3.00	4.00	3.00
121	17-FEB-95	08-JUL-95	4.00	4.00	3.00	4.00
122	20-FEB-95	20-NOV-95	3.00	3.00	3.00	2.00
123	23-FEB-95	09-JUL-95	3.00	4.00	3.00	4.00
124	24-FEB-95	20-JUL-95	3.00	4.00	4.00	3.00
125	28-FEB-95	11-JUL-95	4.00	3.00	3.00	4.00
126	03-MAR-95	01-JAN-96	3.00	4.00	3.00	3.00
127	05-MAR-95	13-AUG-95	3.00	3.00	3.00	3.00
128	06-MAR-95	15-JUL-95	4.00	3.00	3.00	3.00
129	07-MAR-95	02-MAR-96	4.00	4.00	4.00	4.00
130	08-MAR-95	17-JUL-96	4.00	4.00	4.00	3.00
131	10-MAR-95	28-SEP-95	4.00	4.00	4.00	3.00
132	11-MAR-95	29-DEC-95	3.00	4.00	3.00	4.00
133	15-MAR-95	14-AUG-95	4.00	4.00	3.00	4.00
134	17-MAR-95	05-SEP-95	3.00	4.00	3.00	4.00
135	23-MAR-95	06-NOV-95	3.00	4.00	4.00	3.00
136	02-APR-95	08-AUG-95	4.00	4.00	3.00	4.00
137	03-APR-95	05-DEC-95	4.00	4.00	4.00	4.00
138	04-APR-95	11-SEP-95	3.00	3.00	3.00	3.00
139	05-APR-95	17-AUG-95	4.00	4.00	4.00	3.00
140	08-APR-95	18-OCT-95	4.00	4.00	3.00	4.00
141	09-APR-95	22-AUG-95	4.00	3.00	4.00	4.00
142	10-APR-95	27-AUG-95	4.00	3.00	4.00	4.00
143	13-APR-95	29-DEC-95	3.00	3.00	4.00	3.00
144	17-APR-95	28-AUG-95	3.00	4.00	3.00	3.00
145	23-APR-95	30-OCT-95	4.00	4.00	3.00	3.00
146	25-APR-95	21-DEC-95	4.00	4.00	4.00	4.00
147	27-APR-95	01-SEP-95	4.00	3.00	3.00	4.00
148	28-APR-95	04-SEP-95	4.00	4.00	4.00	4.00

	symptom3	symptom4	rom1	rom2	ligev1	ligev3	ligev7
112	3.00	3.00	3.00	4.00	4.00	3.00	3.00
113	3.00	3.00	3.00	3.00	3.00	4.00	4.00
114	4.00	3.00	4.00	3.00	3.00	3.00	3.00
115	3.00	3.00	3.00	3.00	3.00	3.00	3.00
116	4.00	4.00	4.00	4.00	3.00	4.00	4.00
117	3.00	4.00	3.00	3.00	4.00	4.00	3.00
118	4.00	4.00	3.00	4.00	3.00	3.00	4.00
119	3.00	3.00	4.00	3.00	3.00	3.00	3.00
120	4.00	3.00	3.00	4.00	3.00	3.00	3.00
121	3.00	3.00	3.00	3.00	3.00	4.00	3.00
122	2.00	3.00	1.00	3.00	2.00	3.00	1.00
123	3.00	3.00	4.00	4.00	3.00	3.00	3.00
124	4.00	3.00	3.00	3.00	4.00	3.00	3.00
125	3.00	3.00	4.00	3.00	3.00	4.00	3.00
126	4.00	3.00	4.00	4.00	3.00	3.00	4.00
127	4.00	3.00	3.00	3.00	3.00	3.00	4.00
128	3.00	3.00	3.00	3.00	3.00	3.00	3.00
129	4.00	4.00	4.00	4.00	3.00	4.00	3.00
130	4.00	4.00	3.00	4.00	4.00	4.00	4.00
131	4.00	3.00	4.00	3.00	3.00	4.00	3.00
132	3.00	4.00	4.00	4.00	4.00	4.00	4.00
133	4.00	3.00	3.00	4.00	4.00	3.00	4.00
134	3.00	4.00	4.00	3.00	3.00	4.00	4.00
135	4.00	3.00	4.00	4.00	4.00	3.00	4.00
136	3.00	4.00	3.00	3.00	4.00	4.00	4.00
137	4.00	3.00	4.00	4.00	3.00	3.00	4.00
138	4.00	3.00	4.00	3.00	3.00	3.00	4.00
139	4.00	3.00	4.00	4.00	3.00	4.00	4.00
140	3.00	4.00	4.00	4.00	4.00	4.00	3.00
141	3.00	4.00	4.00	4.00	3.00	3.00	4.00
142	3.00	4.00	3.00	3.00	4.00	4.00	4.00
143	4.00	4.00	3.00	3.00	3.00	3.00	4.00
144	3.00	4.00	4.00	4.00	4.00	4.00	4.00
145	4.00	3.00	4.00	4.00	4.00	4.00	3.00
146	4.00	4.00	3.00	3.00	4.00	3.00	3.00
147	3.00	3.00	4.00	3.00	4.00	4.00	4.00
148	4.00	4.00	3.00	4.00	3.00	3.00	4.00

	ligev8	kt2000	comp1	comp2	comp3	harv	x_ray1
112	3.00	3.00	2.00	2.00	3.00	3.00	5.00
113	4.00	3.00	2.00	2.00	3.00	3.00	5.00
114	3.00	4.00	2.00	2.00	3.00	3.00	5.00
115	4.00	3.00	2.00	2.00	3.00	3.00	3.00
116	3.00	4.00	3.00	3.00	3.00	4.00	6.00
117	4.00	3.00	3.00	3.00	3.00	4.00	6.00
118	4.00	3.00	3.00	3.00	3.00	4.00	6.00
119	3.00	3.00	2.00	2.00	3.00	3.00	5.00
120	4.00	3.00	2.00	2.00	3.00	3.00	5.00
121	3.00	3.00	2.00	2.00	3.00	3.00	6.00
122	3.00	1.00	3.00	3.00	3.00	1.00	2.00
123	4.00	3.00	2.00	2.00	3.00	1.00	3.00
124	3.00	3.00	2.00	2.00	3.00	1.00	5.00
125	3.00	4.00	2.00	2.00	3.00	3.00	5.00
126	4.00	3.00	3.00	3.00	3.00	1.00	3.00
127	3.00	3.00	2.00	2.00	4.00	3.00	6.00
128	3.00	3.00	2.00	2.00	4.00	1.00	3.00
129	4.00	4.00	2.00	2.00	3.00	4.00	4.00
130	4.00	4.00	3.00	3.00	2.00	4.00	4.00
131	3.00	4.00	3.00	3.00	4.00	4.00	6.00
132	4.00	3.00	4.00	4.00	2.00	4.00	4.00
133	3.00	3.00	3.00	3.00	4.00	4.00	7.00
134	3.00	4.00	4.00	4.00	3.00	3.00	7.00
135	4.00	4.00	2.00	2.00	3.00	4.00	4.00
136	3.00	4.00	4.00	4.00	4.00	4.00	7.00
137	3.00	3.00	2.00	2.00	2.00	4.00	4.00
138	4.00	3.00	2.00	2.00	4.00	3.00	6.00
139	4.00	4.00	4.00	4.00	4.00	4.00	6.00
140	4.00	4.00	4.00	4.00	3.00	4.00	7.00
141	4.00	4.00	4.00	4.00	3.00	4.00	7.00
142	3.00	3.00	4.00	4.00	4.00	3.00	7.00
143	4.00	4.00	3.00	3.00	3.00	4.00	5.00
144	3.00	4.00	3.00	3.00	4.00	4.00	6.00
145	4.00	4.00	4.00	4.00	4.00	4.00	7.00
146	4.00	4.00	3.00	3.00	2.00	4.00	4.00
147	4.00	3.00	4.00	4.00	4.00	4.00	7.00
148	4.00	3.00	4.00	4.00	4.00	3.00	6.00

	x_ray2	x_ray3	func	score	follow	t	cat1
112	6.00	5.00	6.00	75.00	40.60	160.00	3.00
113	5.00	5.00	6.00	75.00	24.60	147.00	3.00
114	5.00	5.00	6.00	75.00	26.18	139.00	3.00
115	3.00	3.00	6.00	67.00	28.11	156.00	3.00
116	6.00	6.00	7.00	87.00	24.10	143.00	4.00
117	6.00	6.00	7.00	84.00	24.07	144.00	4.00
118	6.00	6.00	8.00	84.00	25.10	315.00	4.00
119	6.00	6.00	6.00	74.00	26.50	140.00	3.00
120	5.00	6.00	6.00	75.00	24.96	142.00	3.00
121	5.00	5.00	6.00	75.00	31.86	141.00	3.00
122	2.00	2.00	2.00	48.00	29.92	273.00	2.00
123	3.00	3.00	4.00	65.00	24.10	136.00	3.00
124	6.00	6.00	4.00	72.00	24.83	146.00	3.00
125	5.00	5.00	6.00	75.00	24.51	133.00	3.00
126	3.00	3.00	4.00	68.00	24.10	304.00	3.00
127	5.00	6.00	6.00	75.00	25.20	161.00	3.00
128	3.00	3.00	4.00	62.00	27.00	131.00	3.00
129	4.00	4.00	8.00	81.00	24.20	361.00	4.00
130	4.00	4.00	8.00	82.00	24.50	497.00	4.00
131	6.00	7.00	8.00	87.00	24.53	202.00	4.00
132	4.00	4.00	8.00	82.00	24.64	293.00	4.00
133	6.00	6.00	8.00	87.00	24.00	152.00	4.00
134	7.00	6.00	7.00	87.00	24.64	172.00	4.00
135	4.00	4.00	8.00	79.00	27.83	228.00	4.00
136	7.00	7.00	7.00	91.00	41.00	128.00	4.00
137	4.00	4.00	6.00	75.00	24.30	246.00	3.00
138	5.00	5.00	5.00	75.00	26.02	160.00	3.00
139	7.00	8.00	7.00	93.00	25.50	134.00	4.00
140	7.00	7.00	8.00	93.00	25.00	193.00	4.00
141	7.00	7.00	7.00	91.00	24.00	135.00	4.00
142	7.00	8.00	7.00	90.00	32.09	139.00	4.00
143	3.00	4.00	6.00	76.00	24.00	260.00	4.00
144	7.00	7.00	7.00	88.00	24.12	133.00	4.00
145	6.00	7.00	8.00	92.00	31.10	190.00	4.00
146	4.00	4.00	8.00	80.00	25.00	240.00	4.00
147	7.00	6.00	7.00	89.00	24.05	127.00	4.00
148	6.00	7.00	7.00	89.00	26.00	129.00	4.00

	tc	filter_$	art
112	3.00	0	1.00
113	3.00	0	1.00
114	3.00	0	2.00
115	3.00	0	1.00
116	3.00	0	2.00
117	3.00	0	1.00
118	4.00	0	1.00
119	3.00	0	1.00
120	3.00	0	1.00
121	3.00	0	1.00
122	4.00	0	1.00
123	3.00	0	1.00
124	3.00	0	1.00
125	3.00	0	2.00
126	4.00	0	1.00
127	3.00	0	1.00
128	3.00	0	1.00
129	4.00	0	2.00
130	4.00	0	2.00
131	4.00	0	2.00
132	4.00	0	1.00
133	3.00	0	1.00
134	3.00	0	2.00
135	4.00	0	2.00
136	3.00	0	2.00
137	4.00	0	1.00
138	3.00	0	1.00
139	3.00	0	2.00
140	4.00	0	2.00
141	3.00	0	2.00
142	3.00	0	1.00
143	4.00	0	2.00
144	3.00	0	2.00
145	4.00	0	2.00
146	4.00	0	2.00
147	3.00	0	1.00
148	3.00	0	1.00

	group	age	sex	ht	wt	invknee	cause
149	2.00	21.00	1.00	173.00	98.00	.00	.00
150	2.00	20.00	1.00	178.00	87.00	.00	2.00
151	2.00	23.00	1.00	168.00	88.00	.00	1.00
152	2.00	42.00	1.00	190.00	113.00	.00	1.00
153	2.00	24.00	1.00	170.00	87.00	1.00	1.00
154	2.00	27.00	1.00	171.00	82.00	1.00	2.00
155	2.00	28.00	1.00	176.00	92.00	1.00	2.00
156	2.00	32.00	1.00	160.00	78.00	1.00	3.00
157	2.00	33.00	1.00	182.00	103.00	.00	2.00
158	2.00	22.00	1.00	185.00	109.00	.00	2.00
159	2.00	44.00	1.00	184.00	117.00	1.00	2.00
160	2.00	35.00	1.00	168.00	83.00	.00	2.00
161	2.00	20.00	1.00	174.00	81.00	.00	3.00
162	2.00	40.00	1.00	186.00	98.00	.00	1.00
163	2.00	41.00	1.00	183.00	103.00	.00	1.00
164	2.00	43.00	1.00	180.00	101.00	.00	2.00
165	2.00	33.00	1.00	176.00	98.00	.00	2.00
166	2.00	35.00	1.00	175.00	87.00	.00	3.00
167	2.00	32.00	1.00	170.00	85.00	.00	3.00
168	2.00	20.00	1.00	175.00	87.00	.00	2.00
169	2.00	24.00	1.00	172.00	88.00	.00	.00
170	2.00	31.00	1.00	170.00	81.00	.00	2.00
171	2.00	21.00	1.00	180.00	102.00	.00	1.00
172	2.00	23.00	1.00	188.00	113.00	.00	2.00
173	2.00	45.00	1.00	167.00	82.00	.00	2.00
174	2.00	44.00	1.00	166.00	76.00	.00	2.00
175	2.00	43.00	1.00	172.00	91.00	.00	.00
176	2.00	33.00	1.00	170.00	98.00	.00	1.00
177	2.00	35.00	1.00	180.00	104.00	1.00	2.00
178	2.00	39.00	1.00	167.00	87.00	.00	3.00
179	2.00	37.00	1.00	191.00	118.00	.00	2.00
180	2.00	27.00	1.00	186.00	103.00	1.00	2.00
181	2.00	29.00	1.00	175.00	99.00	.00	2.00
182	2.00	26.00	1.00	170.00	91.00	.00	2.00
183	2.00	25.00	1.00	172.00	78.00	.00	.00
184	2.00	43.00	1.00	171.00	88.00	.00	2.00
185	2.00	45.00	1.00	177.00	85.00	1.00	2.00

	date1	date2	function	activity	symptom1	symptom2
149	29-APR-95	22-NOV-95	3.00	4.00	4.00	3.00
150	30-APR-95	27-AUG-95	4.00	3.00	4.00	4.00
151	02-MAY-95	28-AUG-95	4.00	4.00	4.00	4.00
152	03-MAY-95	25-DEC-95	4.00	4.00	3.00	4.00
153	05-MAY-95	30-OCT-95	4.00	3.00	4.00	4.00
154	08-MAY-95	30-AUG-95	3.00	4.00	4.00	4.00
155	11-MAY-95	01-OCT-95	4.00	3.00	4.00	3.00
156	13-MAY-95	04-DEC-95	4.00	4.00	3.00	4.00
157	17-MAY-95	02-JAN-96	4.00	3.00	4.00	4.00
158	22-MAY-95	05-APR-96	4.00	4.00	3.00	4.00
159	25-MAY-95	16-NOV-95	3.00	3.00	2.00	2.00
160	28-MAY-95	12-MAY-96	4.00	4.00	3.00	4.00
161	30-MAY-95	18-NOV-95	3.00	4.00	3.00	3.00
162	05-JUN-95	02-MAR-96	4.00	4.00	4.00	4.00
163	06-JUN-95	27-NOV-95	4.00	4.00	4.00	4.00
164	07-JUN-95	27-FEB-96	3.00	4.00	4.00	3.00
165	08-JUN-95	28-NOV-95	4.00	4.00	4.00	3.00
166	14-JUN-95	18-OCT-95	4.00	3.00	4.00	3.00
167	17-JUN-95	01-DEC-95	4.00	4.00	4.00	3.00
168	28-JUN-95	04-OCT-95	3.00	4.00	3.00	4.00
169	29-JUN-95	01-FEB-96	3.00	4.00	4.00	4.00
170	30-JUN-95	04-APR-96	4.00	3.00	4.00	3.00
171	30-JUN-95	04-MAR-96	4.00	4.00	3.00	4.00
172	03-JUL-95	06-JUL-96	4.00	4.00	4.00	4.00
173	04-JUL-95	08-APR-96	4.00	3.00	3.00	3.00
174	08-JUL-95	01-MAR-96	3.00	4.00	4.00	4.00
175	09-JUL-95	02-APR-96	2.00	2.00	3.00	3.00
176	10-JUL-95	07-APR-96	4.00	4.00	4.00	4.00
177	11-JUL-95	01-MAY-96	3.00	4.00	3.00	3.00
178	12-JUL-95	02-JAN-96	4.00	4.00	3.00	4.00
179	13-JUL-95	17-MAR-96	3.00	4.00	3.00	3.00
180	18-JUL-95	28-FEB-96	4.00	4.00	3.00	4.00
181	22-JUL-95	05-MAY-96	4.00	4.00	4.00	4.00
182	26-JUL-95	27-APR-96	4.00	3.00	4.00	4.00
183	28-JUL-95	17-MAY-96	4.00	4.00	4.00	4.00
184	29-JUL-95	18-FEB-96	4.00	4.00	4.00	3.00
185	02-AUG-95	23-MAY-96	3.00	4.00	3.00	3.00

	symptom3	symptom4	rom1	rom2	ligev1	ligev3	ligev7
149	3.00	4.00	3.00	4.00	3.00	4.00	3.00
150	3.00	4.00	4.00	4.00	3.00	4.00	4.00
151	3.00	4.00	3.00	3.00	4.00	4.00	3.00
152	3.00	4.00	3.00	4.00	3.00	4.00	1.00
153	3.00	4.00	4.00	4.00	3.00	3.00	3.00
154	3.00	4.00	3.00	3.00	4.00	4.00	4.00
155	4.00	3.00	4.00	4.00	4.00	4.00	4.00
156	3.00	4.00	3.00	4.00	3.00	3.00	4.00
157	4.00	3.00	3.00	3.00	3.00	4.00	3.00
158	4.00	3.00	4.00	3.00	4.00	4.00	3.00
159	3.00	3.00	1.00	1.00	2.00	3.00	1.00
160	4.00	3.00	3.00	3.00	4.00	3.00	3.00
161	4.00	3.00	3.00	4.00	3.00	4.00	4.00
162	4.00	3.00	2.00	4.00	4.00	4.00	4.00
163	4.00	3.00	2.00	4.00	4.00	4.00	4.00
164	4.00	3.00	4.00	4.00	4.00	4.00	3.00
165	4.00	3.00	3.00	4.00	3.00	4.00	4.00
166	4.00	3.00	3.00	3.00	4.00	3.00	3.00
167	4.00	4.00	4.00	3.00	4.00	4.00	4.00
168	3.00	4.00	3.00	4.00	4.00	3.00	4.00
169	4.00	4.00	4.00	4.00	4.00	3.00	3.00
170	4.00	3.00	3.00	4.00	4.00	4.00	4.00
171	4.00	4.00	4.00	4.00	3.00	4.00	4.00
172	4.00	4.00	3.00	4.00	4.00	4.00	3.00
173	4.00	3.00	3.00	3.00	2.00	3.00	4.00
174	3.00	3.00	3.00	4.00	2.00	3.00	3.00
175	2.00	2.00	1.00	3.00	2.00	3.00	1.00
176	4.00	3.00	4.00	4.00	4.00	3.00	4.00
177	4.00	3.00	3.00	3.00	3.00	4.00	3.00
178	3.00	3.00	3.00	4.00	3.00	4.00	3.00
179	4.00	3.00	4.00	3.00	3.00	3.00	4.00
180	4.00	4.00	3.00	4.00	4.00	4.00	4.00
181	4.00	3.00	4.00	4.00	4.00	3.00	4.00
182	3.00	4.00	4.00	4.00	4.00	3.00	4.00
183	3.00	4.00	4.00	4.00	4.00	4.00	4.00
184	4.00	4.00	2.00	4.00	3.00	3.00	4.00
185	4.00	4.00	2.00	4.00	4.00	4.00	4.00

	ligev8	kt2000	comp1	comp2	comp3	harv	x_ray1
149	3.00	4.00	4.00	4.00	3.00	4.00	6.00
150	3.00	4.00	3.00	3.00	4.00	4.00	7.00
151	3.00	4.00	3.00	3.00	4.00	3.00	8.00
152	4.00	3.00	4.00	4.00	4.00	1.00	3.00
153	4.00	4.00	3.00	3.00	4.00	3.00	6.00
154	3.00	4.00	4.00	4.00	3.00	4.00	8.00
155	4.00	3.00	3.00	3.00	4.00	4.00	7.00
156	4.00	4.00	4.00	4.00	4.00	3.00	7.00
157	3.00	3.00	3.00	4.00	2.00	2.00	5.00
158	4.00	4.00	2.00	2.00	3.00	4.00	4.00
159	3.00	2.00	3.00	3.00	3.00	1.00	2.00
160	4.00	3.00	2.00	2.00	2.00	2.00	4.00
161	4.00	4.00	3.00	3.00	3.00	3.00	5.00
162	4.00	4.00	2.00	2.00	2.00	1.00	3.00
163	4.00	4.00	2.00	2.00	3.00	1.00	3.00
164	4.00	4.00	2.00	2.00	3.00	1.00	3.00
165	4.00	3.00	4.00	4.00	4.00	4.00	6.00
166	4.00	4.00	2.00	2.00	3.00	2.00	5.00
167	3.00	4.00	4.00	4.00	4.00	4.00	6.00
168	3.00	3.00	4.00	4.00	4.00	4.00	8.00
169	4.00	3.00	4.00	4.00	4.00	4.00	8.00
170	4.00	3.00	3.00	3.00	3.00	4.00	4.00
171	4.00	4.00	2.00	2.00	4.00	4.00	4.00
172	4.00	3.00	3.00	3.00	3.00	4.00	4.00
173	3.00	3.00	2.00	2.00	3.00	2.00	3.00
174	3.00	3.00	2.00	2.00	2.00	2.00	3.00
175	3.00	2.00	3.00	3.00	3.00	1.00	2.00
176	3.00	4.00	3.00	3.00	2.00	4.00	4.00
177	3.00	3.00	3.00	3.00	3.00	4.00	4.00
178	4.00	3.00	2.00	2.00	3.00	2.00	5.00
179	3.00	3.00	2.00	2.00	2.00	2.00	5.00
180	3.00	4.00	3.00	4.00	3.00	4.00	7.00
181	4.00	4.00	4.00	3.00	3.00	4.00	4.00
182	4.00	3.00	4.00	4.00	3.00	4.00	6.00
183	4.00	4.00	3.00	3.00	3.00	4.00	4.00
184	4.00	2.00	3.00	3.00	3.00	3.00	3.00
185	4.00	2.00	3.00	3.00	3.00	3.00	3.00

	x_ray2	x_ray3	func	score	follow	t	cat1
149	7.00	8.00	7.00	88.00	25.46	207.00	4.00
150	6.00	6.00	7.00	88.00	26.40	119.00	4.00
151	8.00	7.00	8.00	91.00	31.11	118.00	4.00
152	3.00	3.00	7.00	73.00	24.56	236.00	3.00
153	8.00	7.00	8.00	89.00	24.80	178.00	4.00
154	7.00	6.00	8.00	91.00	28.61	114.00	4.00
155	8.00	6.00	8.00	91.00	26.50	143.00	4.00
156	6.00	8.00	8.00	91.00	24.50	205.00	4.00
157	5.00	5.00	5.00	75.00	32.19	230.00	3.00
158	4.00	4.00	8.00	79.00	24.00	319.00	4.00
159	2.00	2.00	2.00	47.00	25.00	175.00	2.00
160	4.00	4.00	7.00	72.00	25.34	350.00	3.00
161	8.00	8.00	8.00	87.00	24.00	172.00	4.00
162	3.00	3.00	7.00	72.00	24.00	271.00	3.00
163	3.00	3.00	6.00	72.00	26.36	174.00	3.00
164	3.00	3.00	4.00	69.00	30.28	265.00	3.00
165	6.00	6.00	7.00	88.00	34.51	173.00	4.00
166	5.00	5.00	6.00	75.00	26.00	126.00	3.00
167	6.00	6.00	8.00	91.00	27.46	167.00	4.00
168	7.00	6.00	7.00	89.00	26.20	98.00	4.00
169	7.00	6.00	8.00	93.00	28.00	217.00	4.00
170	4.00	4.00	7.00	79.00	29.36	279.00	4.00
171	4.00	4.00	8.00	82.00	24.00	248.00	4.00
172	4.00	4.00	8.00	82.00	24.60	369.00	4.00
173	3.00	3.00	4.00	63.00	24.00	279.00	3.00
174	3.00	3.00	7.00	66.00	26.13	237.00	3.00
175	2.00	2.00	3.00	48.00	25.15	268.00	2.00
176	4.00	4.00	8.00	81.00	26.00	272.00	4.00
177	4.00	4.00	6.00	73.00	28.92	295.00	3.00
178	5.00	5.00	6.00	75.00	24.59	174.00	3.00
179	6.00	5.00	6.00	73.00	28.43	248.00	3.00
180	6.00	6.00	7.00	89.00	28.44	225.00	4.00
181	4.00	4.00	8.00	84.00	24.20	288.00	4.00
182	6.00	6.00	7.00	88.00	25.02	276.00	4.00
183	4.00	4.00	8.00	84.00	24.56	294.00	4.00
184	3.00	3.00	7.00	73.00	27.66	204.00	3.00
185	3.00	3.00	6.00	72.00	26.77	295.00	3.00

	tc	filter_$	art
149	4.00	0	2.00
150	3.00	0	2.00
151	3.00	0	2.00
152	4.00	0	1.00
153	3.00	0	2.00
154	3.00	0	2.00
155	3.00	0	1.00
156	4.00	0	2.00
157	4.00	0	1.00
158	4.00	0	2.00
159	3.00	0	1.00
160	4.00	0	1.00
161	3.00	0	2.00
162	4.00	0	2.00
163	3.00	0	2.00
164	4.00	0	2.00
165	3.00	0	1.00
166	3.00	0	2.00
167	3.00	0	2.00
168	3.00	0	1.00
169	4.00	0	1.00
170	4.00	0	1.00
171	4.00	0	2.00
172	4.00	0	1.00
173	4.00	0	1.00
174	4.00	0	1.00
175	4.00	0	1.00
176	4.00	0	2.00
177	4.00	0	1.00
178	3.00	0	1.00
179	4.00	0	1.00
180	4.00	0	2.00
181	4.00	0	2.00
182	4.00	0	1.00
183	4.00	0	2.00
184	4.00	0	1.00
185	4.00	0	1.00

	group	age	sex	ht	wt	invknee	cause
186	2.00	45.00	1.00	176.00	88.00	.00	2.00
187	2.00	33.00	1.00	166.00	87.00	.00	2.00
188	2.00	34.00	1.00	165.00	77.00	1.00	1.00
189	2.00	38.00	1.00	163.00	82.00	.00	1.00
190	2.00	39.00	1.00	180.00	103.00	.00	2.00
191	2.00	22.00	1.00	179.00	100.00	.00	2.00
192	2.00	24.00	1.00	190.00	125.00	.00	3.00
193	2.00	27.00	1.00	178.00	91.00	.00	2.00
194	2.00	29.00	1.00	176.00	87.00	.00	2.00
195	2.00	30.00	1.00	170.00	91.00	.00	1.00
196	2.00	31.00	1.00	180.00	92.00	.00	2.00
197	2.00	21.00	1.00	173.00	78.00	.00	2.00
198	2.00	23.00	1.00	175.00	87.00	.00	1.00
199	2.00	33.00	1.00	200.00	122.00	.00	2.00
200	2.00	22.00	1.00	176.00	91.00	.00	2.00

	date1	date2	function	activity	symptom1	symptom2
186	05-AUG-95	27-APR-96	3.00	3.00	2.00	2.00
187	06-AUG-95	12-MAR-96	4.00	3.00	4.00	3.00
188	08-AUG-95	13-MAR-96	3.00	4.00	3.00	4.00
189	09-AUG-95	28-MAR-96	4.00	3.00	4.00	3.00
190	14-AUG-95	17-JAN-96	3.00	3.00	4.00	3.00
191	17-AUG-95	08-APR-96	4.00	4.00	3.00	4.00
192	18-AUG-95	03-MAY-96	4.00	4.00	4.00	4.00
193	22-AUG-95	17-JUN-96	4.00	4.00	3.00	4.00
194	27-AUG-95	28-FEB-96	3.00	3.00	4.00	3.00
195	27-AUG-95	19-MAY-96	4.00	4.00	4.00	4.00
196	29-AUG-95	17-MAR-96	4.00	4.00	3.00	4.00
197	30-AUG-95	18-FEB-96	4.00	4.00	4.00	4.00
198	30-AUG-95	26-FEB-96	3.00	4.00	4.00	3.00
199	07-SEP-95	17-MAY-96	4.00	3.00	4.00	4.00
200	09-SEP-95	12-MAR-96	4.00	4.00	4.00	3.00

	symptom3	symptom4	rom1	rom2	ligev1	ligev3	ligev7
186	2.00	3.00	1.00	3.00	2.00	3.00	1.00
187	3.00	3.00	4.00	4.00	4.00	3.00	4.00
188	3.00	3.00	4.00	4.00	3.00	3.00	3.00
189	4.00	3.00	3.00	3.00	4.00	3.00	3.00
190	3.00	3.00	3.00	3.00	3.00	3.00	4.00
191	4.00	3.00	3.00	4.00	3.00	3.00	4.00
192	3.00	4.00	3.00	4.00	3.00	3.00	3.00
193	4.00	4.00	3.00	4.00	4.00	4.00	4.00
194	4.00	4.00	4.00	4.00	4.00	4.00	4.00
195	4.00	3.00	3.00	3.00	3.00	3.00	3.00
196	4.00	4.00	3.00	3.00	4.00	4.00	4.00
197	3.00	3.00	3.00	4.00	4.00	3.00	3.00
198	4.00	4.00	3.00	3.00	3.00	4.00	3.00
199	4.00	4.00	4.00	3.00	4.00	3.00	4.00
200	4.00	4.00	3.00	3.00	4.00	4.00	4.00

	ligev8	kt2000	comp1	comp2	comp3	harv	x_ray1
186	3.00	2.00	3.00	3.00	3.00	1.00	2.00
187	4.00	4.00	4.00	4.00	3.00	4.00	7.00
188	3.00	3.00	2.00	2.00	2.00	2.00	6.00
189	3.00	3.00	2.00	2.00	2.00	2.00	6.00
190	3.00	3.00	2.00	2.00	3.00	3.00	6.00
191	4.00	3.00	4.00	4.00	4.00	4.00	8.00
192	3.00	4.00	2.00	2.00	3.00	4.00	4.00
193	4.00	4.00	2.00	2.00	3.00	4.00	4.00
194	3.00	3.00	2.00	2.00	2.00	4.00	6.00
195	4.00	4.00	3.00	3.00	3.00	4.00	4.00
196	3.00	3.00	4.00	4.00	3.00	4.00	8.00
197	4.00	4.00	4.00	4.00	4.00	3.00	8.00
198	3.00	4.00	4.00	4.00	3.00	4.00	8.00
199	4.00	4.00	4.00	4.00	4.00	4.00	8.00
200	4.00	3.00	3.00	3.00	4.00	4.00	8.00

	x_ray2	x_ray3	func	score	follow	t	cat1
186	2.00	2.00	2.00	48.00	24.95	266.00	2.00
187	7.00	8.00	7.00	91.00	27.80	219.00	4.00
188	6.00	6.00	6.00	75.00	25.60	218.00	3.00
189	6.00	5.00	6.00	74.00	26.12	232.00	3.00
190	5.00	5.00	7.00	74.00	24.50	156.00	3.00
191	8.00	8.00	8.00	94.00	25.79	235.00	4.00
192	4.00	4.00	8.00	77.00	24.60	259.00	4.00
193	4.00	4.00	8.00	81.00	26.92	300.00	4.00
194	6.00	6.00	8.00	83.00	26.00	185.00	4.00
195	4.00	4.00	8.00	79.00	24.20	266.00	4.00
196	8.00	8.00	8.00	94.00	26.77	201.00	4.00
197	8.00	8.00	8.00	94.00	25.20	172.00	4.00
198	7.00	8.00	8.00	91.00	26.14	180.00	4.00
199	8.00	8.00	8.00	97.00	30.00	253.00	4.00
200	8.00	7.00	8.00	93.00	40.20	185.00	4.00

	tc	filter_$	art
186	4.00	0	1.00
187	4.00	0	2.00
188	4.00	0	1.00
189	4.00	0	1.00
190	3.00	0	1.00
191	4.00	0	1.00
192	4.00	0	2.00
193	4.00	0	2.00
194	4.00	0	1.00
195	4.00	0	2.00
196	4.00	0	1.00
197	3.00	0	2.00
198	4.00	0	2.00
199	4.00	0	2.00
200	4.00	0	1.00