Outcome of single stage anterior and posterior surgery for tuberculous paraplegia

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CERTIFICATE

This is to certify that the thesis titled **"Outcome of single stage anterior and posterior surgery for tuberculous paraplegia "**is the bonafide work of **Dr. Abhay Gahukamble** towards the M.S. Branch II (Orthopaedic Surgery) Degree Examination of the Dr. M.G.R. University, Tamil Nadu to be conducted in February 2007.

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INTRODUCTION

Tuberculosis is a major infectious disease with an increasing morbidity and mortality forecast for the world at large. The estimated number of newly occurring cases has increased from 7.5 million in 1990 to 11.9 million in 2005, an increase of 58.6% over a 15 year period[1]. Quite unlike the popular misconception that tuberculosis is no longer a public health problem, the association of HIV AIDS and multidrug resistance has further compounded the existing situation. India has been classified along with the sub Saharan African countries into group IV countries with an annual risk of infection of 1- 2.5% [2]**.** Spinal tuberculosis is the most common form of articuloskeletal tuberculosis, in HIV-negative patients, between 3% and 5% of tuberculosis cases are skeletal, compared with 60% of cases in HIV-positive patients [3].

Anti tuberculous chemotherapy since its introduction in the early 1960s has become the mainstay of management with other interventions considered supplementary to improve the final outcome. While effective chemotherapy controls the infection, it alone is insufficient to rectify the problems arising from bone destruction. Unlike early tuberculous spondylitis where conservative management may suffice, in advanced cases with cold abscesses, kyphosis and paraplegia surgical intervention has a major role to play. In developing countries where the burden of tuberculosis is

the highest, surgery is considered only for absolute indications to allow an equitable distribution of scarce resources [4].

In the past, neural decompression for tuberculous paraplegia has been carried out in various ways with similar rates of neurological recovery though progression of kyphosis and its attendant problems were issues that arose. An anterior arthrodesis comprising a surgical extirpation of the tuberculous focus and its replacement with a bone graft in a structurally sound position is advocated as the treatment of choice [5, 6]. The theoretical advantages of this procedure were mitigated due to the need for prolonged immobilization and high incidence of graft related complications that occurred as shown in long term follow up studies[7].

The use of instrumentation anterior or posterior to protect the graft is advocated in some centers to retain the advantages of an anterior arthrodesis while decreasing the rate of graft related complications and allowing the patient to be rehabilitated earlier.

Since 1993 in the Department of Orthopaedic surgery, Christian Medical College and Hospital, Vellore, patients with tuberculous spondylitis needing surgery have undergone a combined anterior debridement and grafting and posterior instrumentation. This study evaluates the outcome of patients with tuberculosis of the dorsal, dorsolumbar and lumbar spine with neurological complications who underwent radical anterior

debridement and fusion and posterior instrumentation in the department of Orthopaedics and spine surgery Unit 1 Christian Medical College, Vellore.

AIMS

1. To assess the neurological recovery in patients who underwent anterior debridement, fusion and posterior instrumentation and early rehabilitation.
2. To assess the incidence of pressure sores, hypostatic pneumonia and urinary tract infections in these patients.
3. To assess the incidence of graft related complications
4. To study the extent of deformity correction and maintenance in these patients

REVIEW OF LITERATURE

EVOLUTION OF TREATMENT OF SPINAL TUBERCULOSIS

Tuberculosis has been the nemesis of mankind through the ages. Over the years various attempts have been made to combat it with very poor results till the introduction of chemotherapy. The association of paraplegia with spinal tuberculosis was recognized as early as 1779, when Percivall Pott published his famous monograph in which he pointed out that the cause lay in the destruction of the vertebral bodies. He even laid the foundation of surgical treatment of the condition when he wrote: ***"The remedy for this most dreadful disease consists merely in procuring a large discharge of matter."*** Since then many operative treatments have been described and developed, including laminectomy (Macewen 1888, Chipault 1896), costo-transversectomy (Menard 1900), spinal fusion (Albee 1911; Hibbs 1912), lateral rhachotomy (Capener 1933), antero-lateral decompression (Alexander 1946, Dott 1947), costo-transversectomy and curettage of the vertebral body (Wilkinson 1952) and anterior transthoracic decompression (Hodgson and Stock 1956; Hodgson, Stock Fang and Ong 1960). In spite of these efforts surgery fell into disrepute till the introduction of antituberculous chemotherapy due to high mortality and morbidity.

ADVENT OF ANTITUBERCULOUS CHEMOTHERAPY

Anti tuberculous chemotherapy has become a constant feature of any treatment regime since its introduction though

duration of drug intake differs between centers. Prior to the concept of the Middle path regime pioneered by Tuli et al [4] there were two radically differing schools of thought. A number of surgeons (Wilkinson 1950, 1969, Orell 1951, Fellander 1955, Kondo and Yamada 1957, Hodgson and Stock, Fang and Ong 1960, Bailey, Gabriel Hodgson and Shin 1972) practiced surgical extirpation of every vertebral lesion while others (Konstam and Konstam 1958, Kaplan 1959, Konstam and Blesovsky 1962, Stevenson and Manning 1962, Friedman 1966) treated patients with antitubercular drugs and rest alone. Both the approaches had their pros and cons. Tuli et al treated their patients mostly on conservative lines and laid out specific indications for surgical intervention.

The Medical Research Council Working Party on tuberculosis of the spine carried out a series of collaborative controlled clinical trials with interrelated experimental design to investigate several different methods of treating spinal tuberculosis. The studies were carried out in Korea, Rhodesia, Madras, Hong Kong and South Africa, the design of the trial and mode of treatment based on the available local resources. The long term goal in these trials was to attain a favorable status which was defined as full physical activity, clinical and radiographic quiescence, no central nervous system involvement, no sinuses and no clinical evidence of residual abscesses in patients treated solely on the allocated regimen.

A 5 year assessment of controlled trial of inpatient and

outpatient treatment and plaster of Paris jacket for tuberculous spondylitis in children on standard chemotherapy [8] observed that results achieved in both groups were favorable without any statistically significant difference in outcome. Other inferences drawn from this study were the lack of any beneficial effect on adjuvant streptomycin on the final outcome and no statistically significant difference in the favorable status achieved in the outpatient ambulatory group with the use of plaster of Paris jackets.

A 10 year assessment of controlled trial comparing debridement and spinal fusion and standard chemotherapy [9] reported that bony fusion occurred earlier and in a higher percentage of patients in Radical surgery series. There was no appreciable difference in the results at 10 years and those at 5 years. The Medical Research Council's Working Party on Tuberculosis of the Spine recommendation made after the 5 year report was not modified after the 10 year follow up: **"*When appropriate facilities and enough hospital beds are available, together with experienced spinal surgeons and good postoperative nursing the modified Hong Kong operation as performed by its originators, has definite advantages. Compared with the other methods of treatment investigated by the working party, it produced substantially earlier bony fusion, vertebral reconstitution and no increase in kyphosis. It makes more demands on the surgical and nursing staff and on hospital beds … Where adequate facilities are lacking, reliance should be placed on ambulant chemotherapy alone* "**

Over the 10 year period there was greater increase in the angle of kyphosis in the debridement series as compared to the radical series at all sites. In thoracic and thoracolumbar lesions this amounted to a mean increase of 9.8° in the debridement series and a mean reduction of 1.4° in the radical series. In lumbar lesions a mean increase of 7.6° in the debridement series contrasted with a mean reduction of 0.5°.

A 15 year assessment of controlled trial of management of tuberculous spondylitis, the thirteenth report of Medical research council 10 concluded that while a majority of patients treated with open radical debridement, radical excision with bone grafting and conservative management with chemotherapy achieve favorable status the advantage of radical excision and bone grafting was less late deformity.

THE RATIONALE OF ANTERIOR SPINAL ARTHRODESIS

Anterior spinal arthrodesis has proven to be superior to chemotherapy alone in the prevention of progressive deformity [6, 8, 9, 11-13, 15, 20]. Kyphosis is a common complication seen in patients treated with chemotherapy alone [8-11, 16].

Kyphosis occurs in the thoracic spine as a result of the disease process but can progress in spite of inactivation of the disease by chemotherapy. The kyphosis is the mechanical result of the biological destruction of the vertebral body. Puig Guri stated that destruction of a thoracic vertebral body resulted in a posterior

displacement of the center of motion, a subluxation at the level of the articular facets and increase in weight borne by the anterior part of the body. The destruction thus results in a three dimensional instability. In the lumbar spine, the large bodies and vertical articular facets are more apt to telescope that to angulate. Thus in these two regions the mechanics of the region predispose to deformity unless the forces are counteracted by external or internal splinting. The cervical spine is prevented from telescoping by the interposition of the transverse processes, and in this part of the spine there was the least deformity.

Kyphosis is more common in the thoracic spine and this region is subjected to the greatest degree of angulation. Although chemotherapy may inactivate the disease, the vertebral collapse will continue until the vertebral bodies in the region of the kyphosis meet anteriorly or until the highly caseated material in the region of the vertebral bodies and the highly vascular granulation tissue mature into bone [7]. The final gibbus deformity depends on the amount of initial pretreatment vertebral loss and can be calculated based on the formula devised by Rajasekaran et al [16]. Following debridement, placement of a graft in the interbody region subjects it to the same forces that result in the kyphosis. This can lead on to graft related complications which are well highlighted in the series by Hodgson et al[6] and Rajasekaran et al [7].

Gross kyphosis developing in the thoracic region can cause

progressive loss of pulmonary function that may lead to respiratory and secondary cardiac failure. While this occurs only in cases of gross kyphosis, milder degrees may be cosmetically unacceptable.

To prevent progression of the kyphosis the use of external support or prolonged recumbency without the use of a bone graft in a structurally sound position is ineffective. The graft serves the function of providing structural support and introducing an osteogenic focus. Protecting the graft with instrumentation or bracing is required in order to counteract the forces that tend to deform the spine and dislodge the graft.

LONG TERM RESULTS OF ANTERIOR SPINAL FUSION

In international literature a number of series have been published where the treatment protocol include anterior debridement and bone grafting with chemotherapy.

Hodgson and Stock et al [6, 13] showed remarkable results which could not be replicated by other investigators. The mean increase in the angle of kyphosis was 4° in the debridement group and 0° in the anterior arthrodesis group. Only 15% of the patients who had anterior arthrodesis had an increase of more than 11° in the angle of kyphosis, compared with 30% of the patients with debridement. Their patients had less severe disease with a mean pretreatment vertebral loss of 0.7 which could be the reason for the excellent result.

Rajasekaran et al [7] at eight years follow up with regard to progression of kyphosis had 59% excellent or good result. However all these patients had minimum destruction of the vertebral bodies, limited excision of bone resulting in small post debridement defect which needed only a short graft.19% had a fair result and 22% had a poor result. An increase in deformity was common in patients who had extensive involvement of the vertebral bodies that resulted in large post debridement defects necessitating a graft spanning more than two disc spaces. A stable graft that provided structural support was observed in only 41% of patients and failure of the graft due to slippage, fracture and absorption or subsidence was seen in 59%. The graft was found to fail most often in patients in whom it spanned more than two disc spaces. This was also shown by Oga et al [31]

Chen et al [5] reported on 50 adult patients with a mean follow up of 5 years. 14 of the patients had a posterior fusion and instrumentation with Harrington rod or Luque SSI. The average final correction of the kyphotic angle was 10° (1-44°) in 35 patients and 10 patients had deterioration of the kyphotic angle, mean 4.8°(2-9°). 4 patients (8%) had pseudoarthrosis at final follow-up but revision was not warranted, as all were asymptomatic.

Lifeso et al [22] treated 107 adults with spinal tuberculosis with an average age of 41.8 years. 53 of these patients required surgical intervention of which anterior decompression and fusion

was the procedure of choice. The average degree of kyphosis as measured by the Cobb technique was 21°. After anterior decompression it worsened by an average of 0.6°(range, 15° improvement to 10° deterioration) .

Upadhyay et al [23] detected no significant difference in the mean angle of deformity and kyphosis between children and adults postoperatively at follow up. The longitudinal pattern of deformity change being similar ruled out the possibility of posterior spinal growth contributing to the deformity after anterior spinal arthrodesis. Prior to this Fountain et al [21] studied 31 patients of 241 consecutive cases of anterior spine fusion for tuberculosis of the spine in children to assess the incidence of late progressive kyphosis following successful anterior spine fusion and based on 3 patients suggested that if late progression did occur without mechanical graft failure or non union, growth retardation of the anterior vertebral ring epiphysis above or below the fusion mass may be considered the cause. Needless to say this view was not shared by Upadhyay et al.

Bailey et al [24] studied 100 consecutive children with tuberculous spondylitis treated by anterior arthrodesis. The average increase in kyphosis was 22.2° seen in 72% of the patients. Graft fracture and absorption were the major complications.

NEUROLOGICAL RECOVERY IN TUBERCULOUS PARAPLEGIA

Paraplegia together with residual spinal deformity is one of the most unwanted complications of spinal tuberculosis. The incidence of paraplegia is 20% [25] once the spine is involved. The recovery rate from paraplegia is influenced by many factors: the patient's general state, age, and spinal cord condition; the level and the number of involved vertebrae; the severity of spinal deformity; the duration and severity of paraplegia; the time to initiation of treatment; the type of treatment; and drug sensitivity [25,40] . Most patients with neurological deficits recover within 6 months but those with direct involvement of the meninges recover slowly [25]. In the early active stage of the disease, Pott's paraplegia caused by abscess can be managed as effectively by chemotherapy alone as by decompressive surgery, but chemotherapy alone is inappropriate management of paraplegia in the patient with advanced tuberculosis and deformity [3,18,41] . However, recovery rates after anterior decompression surgery are widely variable; 75% recovered in a series by Hodgson and Stock (1967) [14], 84% in a study by Kohli et al (1967) [26], 78% by Goel et al (1967) [27],53% in one by Guirguis et al (1967) [28], 60% by Martin et al (1971) [29], 69% by Tuli et al (1975) [4] , 94% by Lifeso et al (1985) [22] and 89.6% by Moon et a l[25]. Lifeso et al [22] and Jain et al [30] reported recovery rate of 78.6% and 86% with costotransversectomy and anterolateral decompression respectively.

RATIONALE OF POSTERIOR STABILIZATION

Correction and prevention of progression of the kyphosis have been ancillary aims of surgery after decompression and extirpation of the disease focus. The graft used in reconstructing the anterior column has to withstand enormous forces in the range of hundreds of pounds per square inch [7].Rajasekaran et al [7] have shown that the graft failed most often in patients in whom it spanned more than two disc spaces. Other graft related complications are graft slippage, subsidence and fracture. Protecting the graft by posterior fusion has been suggested as early as 1911 by Albee and Hibbs and was done by Kemp et al [15] in all cases where the destruction involved more than two vertebrae. It was not until the pioneering work by Oga et al [31] that instrumentation was used for posterior stabilization in tuberculosis.

ANTERIOR SPINAL ARTHRODESIS AND POSTERIOR STABLIZATION:

Combined anterior spinal arthrodesis and stabilization with posterior or anterior instrumentation is now a well recognized accepted procedure in tuberculous spondylitis and several studies have demonstrated satisfactory results. Güven et al [32] reported a series of 10 cases with posterior instrumentation, in which there was a 3.4° loss in the correction of local kyphosis. Benli et al [33] reported excellent results in 59 patients with a minimum 5 years of follow - up with correction rates in local kyphosis angle of (78.5 ±

20.5 %) and correction loss at the last control visit of (1.5° ± 1.9°). Sundararaj et al [34] reported mean loss of correction of 4.38, 2.8 and 3.52 in the dorsal, dorsolumbar and lumbar regions respectively with a mean surgical correction of kyphosis of 13.7%. Graft related problems were only 6.5% with no slippage. Yilmaz et al [35] using anterior instrumentation in 22 patients showed maintenance of correction in 21 and a maximum loss of 3° in sixteen patients. Moon et al [37] reported loss of correction not exceeding 3° in 39 adults and 5 children who underwent posterior instrumental stabilization and anterior interbody fusion. The rates of neurological recovery are comparable to series using only anterior spinal arthrodesis. The disadvantages of adjuvant posterior instrumentation is prolonged operation time, prolonged anaesthesia, increased blood loss and increased post operative morbidity.

INDIAN STUDIES WITH COMBINED ANTERIOR SPINAL ARTHRODESIS AND POSTERIOR INSTRUMENTATION.

Laheri et al [36] studied twenty-eight patients with post-tuberculous kyphosis deformity averaging 64.3 ° (range 17 to 105) treated by a single stage posterolateral decompression, correction of kyphosis, anterior interbody fusion and posterior instrumentation. The mean kyphosis correction obtained was 62.5% with the mean post-operative kyphosis angle reducing to 24.1 ° (range 5-60). At a

mean follow-up of 5.8 years (4-7 years) the mean kyphosis angle loss was 3.2 ° (range 0-5 °). Of the 23 patients with neurological deficit, recovery was seen in 91.3% while deterioration was seen in 4.3%. The remaining five patients were neurologically intact pre-operatively. Bony fusion was seen in all cases at 9 months. One patient with suboptimal pulmonary function died post-operatively (mortality 3.5%).

Sundararaj et al [34] presented a prospective study of 77 patients who underwent combined anterior (radical debridement and anterior fusion) and posterior (instrumentation and fusion) surgery. The mean preoperative vertebral loss was highest (0.96) in the dorsal spine. The maximum correction the kyphosis in the dorsolumbar spine was 17.8°. Loss of correction was maximal in the lumbosacral spine at 13.7°. All patients had firm anterior fusion at a mean five months. The incidence of infection was 3.9% and graft-related problems 6.5%.

Ramani et al [38] studied 61 patients with spinal tuberculosis affecting C3-D2 region over a 5 year period to evaluate the efficacy of anterior instrumentation in reconstruction of the spine, providing pain relief, neurological recovery and prevention of deformity. The neck pain score changed from a preoperative average of 7 to 2 at follow up of 4 months. 85% of the patients had complete pain relief while 16 patients who had grade III to IV muscle strength regained complete power. Flexion and extension views did not show any

evidence of instability or nonunion. They concluded that anterior reconstruction using titanium plates and locking screws for stabilization of the subaxial and cervicodorsal region tuberculosis is a useful adjunct in preventing kyphotic deformity. A satisfactory segmental stability and fusion is achieved by this technique.

Our study aims at evaluating the outcome of patients who have undergone a combined anterior and posterior surgery as mentioned before and identifying the advantages and disadvantages of this line of management.

PATIENTS AND METHODS

STUDY DESIGN:

A prospective follow up of a cohort of patients who underwent combined anterior (anterior debridement and bone grafting) and posterior (posterior instrumentation and fusion) surgery was done.

DEFINITIONS

Frankel grading [35]

Type A indicates a complete spinal cord injury;

Type B, a spinal cord injury with only sensation present;

Type C, an injury with motor function present but not useful;

Type D, an injury with useful motor function; and

Type E, an injury with intact neurological function.

Angle A [7:] Angle made by drawing a line through the superior surface of the first normal cephalad vertebra to the lesion and a line through the inferior surface of the first normal vertebra caudad to the lesion. Perpendiculars were then drawn from these lines and the angle A measured.

Initial correction: Difference between preoperative and immediate post operative deformity angle

Final correction: Difference between the immediate post operative and follow up deformity angle

Graft subsidence: loss of height of the strut graft placed in the interbody region.

Graft slippage: displacement of the strut graft from the interbody space into the surrounding region

Graft fracture: Cortical discontinuity in the strut graft.

Local Kyphus angle [33]: the angle between the upper and lower end plates of the collapsed levels or involved levels.

Assessment of loss of vertebral height [16]: Each vertebra is divided into ten equal parts based on the vertebral height as measured on the lateral radiograph. The initial loss of vertebral body was assessed by measuring the average loss of height of each affected vertebra. Expected height of the affected vertebra is calculated by taking the average of heights of one vertebra above and below the affected levels.

SETTING: This study was conducted in the Department of Orthopaedics and Accident surgery Unit 1, Christian Medical College and Hospital, Vellore.

PATIENTS:

INCLUSION CRITERIA

1. Definitive diagnosis of tuberculosis of the spine based on histopathological or microbiological evidence.

2. Presence of objective motor , sensory and or autonomic deficits (Frankel A,B and C)
3. Patients who have undergone anterior debridement, fusion and posterior instrumentation in one or two stages

DATA COLLECTION

All patients with tuberculosis of the dorsal, dorsolumbar and lumbar spine with neurological deficits from 1999 – 2004 were assessed preoperatively based on retrospective records and recorded in a data sheet (sample provided in the appendix). Those with Frankel A, B, and C were included in this study. The patients were followed up after surgery and outcome was assessed objectively based on clinical examination, radiographs and subjectively to assess functional outcome.

INITIAL ASSESSMENT

CLINICAL ASSESSMENT

- Symptoms
- Neurology

RADIOLOGICAL ASSESSMENT

- Preoperative deformity,
- Preoperative vertebral loss

INVESTIGATIONS- Hb, Liver function test, ESR

TREATMENT GIVEN:

- Type of surgery done first
- Anaesthesia
- Duration
- Complications
- Post operative period

FOLLOW UP

CLINICAL –

- Symptomatology
- Examination of neurology

RADIOLOGY-

- Deformity
- Implant issues
- Fusion

FUNCTIONAL OUTCOME

- Functional independence
- Capacity to return to previous occupation

STATISTICAL ANALYSIS

Analysis was performed using Chi-square test or Fisher's exact test for categorical variables, Student's t-test for nominal and Mann-Whitney test for non nominal continuous variables. Statistical significance of univariate comparisons was defined as $p < 0.05$. A multivariate model was not used as the numbers needed were not attainable. This was calculated using software packages SPSS version on an IBM compatible PC.

RESULTS

This study was done over a 5 year period from 1999- 2004.Of the 76 patients with tuberculosis of the spine 37 patients with Frankel A,B and C grade neurological deficits were included in the study. One patient had a follow up of only 2 months and thus was excluded from the post operative evaluation.

BASELINE, PREOPERATIVE AND IMMEDIATE POST OPERATIVE DATA

AGE: The mean age of this study group was 32.49 years (range of 4-61 years). 16.2 % of the patients were 15 years old or younger and 16.2% were older than 55 years. **Table 1**

SEX RATIO: The male is to female ratio was 17:20 with a marginal predominance of females.

LEVEL OF THE LESION: Table 2: The commonest level involved was the thoracic level with 81.1% of the patients falling into this category.

NUMBER OF VERTEBRAE INVOLVED AND PREOPERATIVE LOSS OF VERTEBRAL HEIGHT: Table 3

A mean of 2.43 vertebrae (2-4 vertebrae) were involved at the level. The total number of vertebrae involved was on an average 2.97 with a range from 2-10. Mean number of disc spaces involved was 1.6 (1- 3).

The mean preoperative loss of vertebral height was **0.923** (0.2-2.4)

CLINICAL PRESENTATION:

The average duration of back pain was 136.24 days (range 7-365) days. The average duration of motor weakness was 43.17 days (range 0-150 days). The average duration of sensory deficits is 7.06 days (range 0-90 days). The average duration of bladder and bowel involvement was 11.41 days (range 0-90 days). 8.8 % (3 patients) had flexor spasms. 21 patients (56.8 %) had co morbid conditions- including diabetes mellitus, hypertension, pulmonary, disseminated tuberculosis, tuberculous abdomen, tuberculous meningitis, pleural effusion, coronary artery disease, COPD, rheumatoid arthritis, hydronephrosis, hepatotoxicity, hyperthyroidism, aortic regurgitation and pregnancy.

24 patients (68.6 %) had constitutional symptoms during presentation. 2 patients had past history of tuberculosis. All patients had a gibbus and one had a scoliosis on presentation. 6 patients had clinically evident cold abscesses.

Table 1 Age distribution

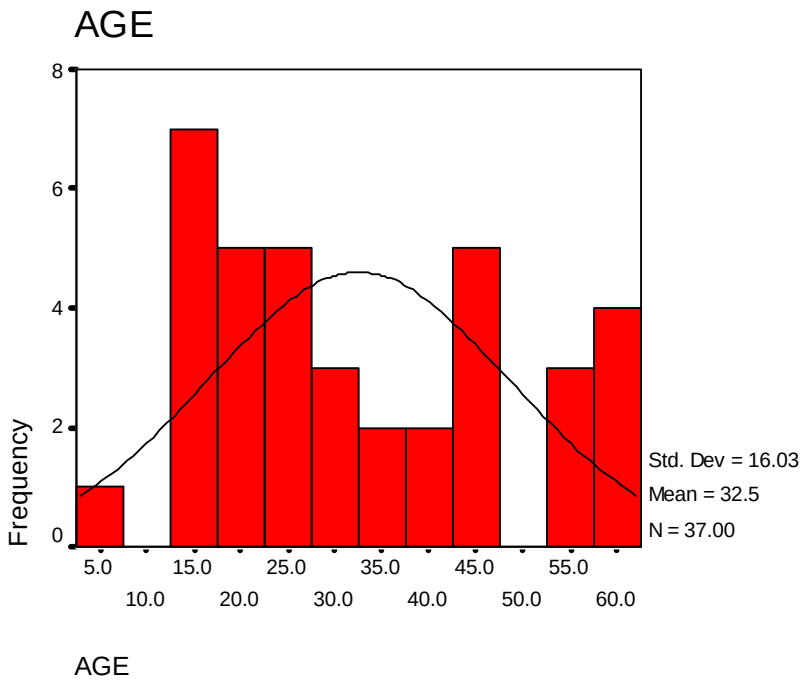


Table 2: Site of the disease

	Frequency	Percent
thoracic	30	81.1
thoracolumbar	3	8.1
lumbar	4	10.8
Total	37	100.0

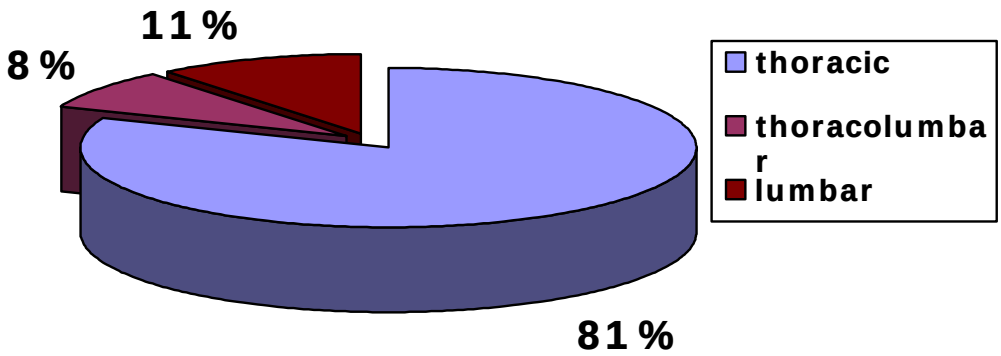


Table 3: Number of vertebrae at the operated site.

Number of vertebrae	Frequency	Percent
2	24	64.9
3	10	27.0
4	3	8.1
Total	37	100.0

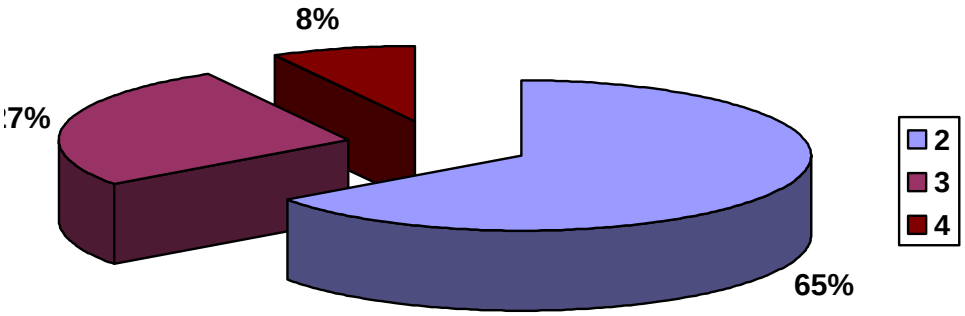
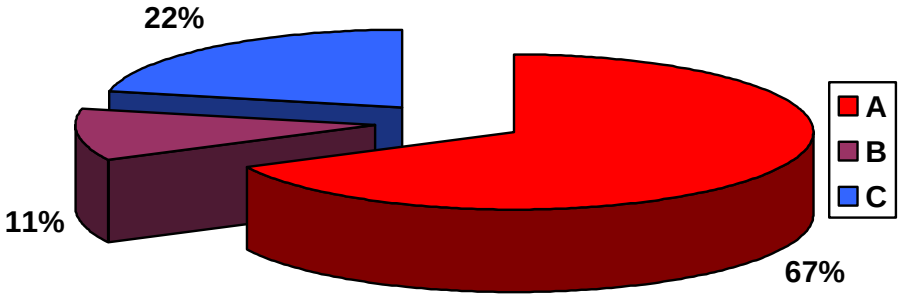


Table 4 Pre operative Frankel Grade

Frankel grade	Frequency	Percent
A	25	67.6
B	4	10.8
C	8	21.6
Total	37	100.0



PREOPERATIVE FRANKEL GRADE: Table 4

25 patients (67.6%) had a preoperative Frankel grade A and 4(10.8%) and 8 (21.6%) patients had a preoperative Frankel grade of B and C respectively.

BEDSORES:

5 (13.5 %) patients had pressure sores at presentation.3 patients had sacral sores, one had a trochanteric sore and one had both. Their ages ranged from 15 to 59 years. The duration of neurological deficits ranged from 20 to 60 days. During the post operative period in the hospital there was improvement in the sores and no additional sores were seen in the cohort.

URINARY TRACT INFECTION:

11 (29.7%) of patients had urinary tract infections at presentation.

No patients had hypostatic pneumonia on presentation.

Overall 35.1 % (13) patients had complications of immobilization preoperatively.

INVESTIGATIONS:

PCV - average was 36.2

ESR - average was 63.3

Albumin -average was 3.54 gm%

Total protein- average was 7.38 gm%

AFB smear was positive in 10 patients (27%)

AFB culture was positive in 13 patients (35.1%). 2 patients had multidrug resistant tuberculosis.

PREOPERATIVE DEFORMITY ANGLES: Table 5

Average preoperative angle A was **27.86°** (0.50 - 62.60°)

The average angle A in the thoracic region was 30.1° (6.8-62.60°) in the thoracolumbar region was 26.87° (12.8-53.40°) and in the lumbar region was 9.40° (0.5-26.30).

The average preoperative Local Kyphus angle in our series was 27.14°

Table 5: preoperative angle A

N	32
Missing	5
Mean	27.86
Minimum	0.50
Maximum	62.60

MAGNETIC RESONANCE IMAGING:

MRI films were not available for 7 patients, of the remaining 30 patients, preverterbral abscess were seen in 51.4%, paraveretebral abscesses were seen in 64.9%, epidural abscesses were seen in 78.4% and psoas abscesses were seen in 13.5%.

Cord parenchymal changes were present as cord edema in 10

patients and myelomalacia in 1 patient. The patient with myelomalacic changes was a 16 year old girl with four levels of involvement. She presented with a history of 10 days of paraplegia. The MRI showed cord compression at D8, 9 and she underwent intervention at that level. She went on to recover to Frankel E. Of the 10 patients with cord edema one expired, three did not follow up and the remaining six patients went on to recover to Frankel E.

SURGICAL PARAMETERS:

All patients had single stage anterior and posterior surgery. 1 patient had anterior surgery followed by posterior and then anterior surgery. Operative records for two patients were not available. In 45.9% (17) patients the anterior surgery was done before the posterior instrumentation. In 48.6% (18) patients the posterior surgery was done first. In 25 patients the anterior approach was through a thoracotomy **Table 6**

Table 6: Approach of anterior surgery

	Frequency	Percent	Valid Percent
Extended posterolateral	6	16.2	16.2
Retroperitoneal	4	10.8	10.8
Retropleural	1	2.7	2.7
Thoracotomy	25	67.6	67.6
Total	37	100.0	100.0

The average duration of surgery was 355 min. The duration of the anterior and posterior surgery separately was 166 and 165 min

respectively. The average stay in the surgical intensive care unit was 2.42 days **Table 7** (range 0- 16 days). The average blood replaced was approximately 2 units. The average hospital stay was 20.43 days **Table 8(pg 31)**.

Table 7: Duration of stay in Surgical Intensive Care Unit in days

N	33
Missing	4
Mean	2.42
Minimum	0
Maximum	16

25 patients of the 37 were transferred to the surgical intensive care unit. Three patients developed pneumonitis postoperatively and required SICU care for 16, 7 and 6 days.

The first was a 59 year old lady with D4-6 involvement who underwent a tracheostomy on the 7th post operative day for prolonged ventilation but after transfer to the ward required to be shifted back for 5 more days because of a blockage in the tracheostomy tube.

The second patient was a 14 year old girl with D2-4 involvement and the third was a 19 year old girl with D3-4 involvement. The first two patients had anterior surgery through a thoracotomy and the third was operated through an extended posterolateral approach. Excluding these three patients the average duration of stay in the surgical ICU was 2.3 days

Table8: Duration of hospital stay

N	30
Missing	7
Mean	14.33
Minimum	7
Maximum	18

POST OPERATIVE COMPLICATIONS:

1 patient died in the immediate post operative period following an intraoperative myocardial infarction in spite of an immediate percutaneous transluminal coronary angioplasty. He was a 58 year old diabetic and hypertensive with coronary artery disease with Frankel B paraplegia of 1 month duration.

4 patients had post operative wound infections, two of whom grew methicillin resistant staphylococcus aureus (MRSA) but none required any surgical intervention for the same and subsided with appropriate antibiotics.

4 patients developed pulmonary complications evident as consolidation and pneumonitis but all recovered with antibiotics and chest physiotherapy. 6 patients had miscellaneous complications which included intraoperative pleural tear, intraoperative CSF leak, post op scoliosis, supraventricular tachycardia and tracheostomy blockage requiring reintubation.

Table 9: Origin of graft

Type	Frequency	Percent	Valid Percent
Tricortical iliac crest bone graft	25	67.6	69.4
Fibula graft	2	5.4	5.6
Cage with iliac graft	7	18.9	19.4
Local or rib graft	2	5.4	5.6
Total	36	97.3	100.0
Missing	1	2.7	
	37	100.0	

GRAFT: Table 9

Tricortical iliac crest bone graft was used in 25 patients (67.6%), fibula graft was used in 2 (5.4%), a cage with iliac graft was used in 7 (18.9%) and local or rib graft was used in 2 (5.4%).The average length of the graft was 37.24 mm **Table 10**. In 84.4% of the patients the graft was less than 42 mm in length.

Table 10: Length of graft in mm

N	32
Missing	5
Mean	37.24
Minimum	20
Maximum	70

POSTERIOR INSTRUMENTATION:

The Hartshill rectangle was used in 28 patients (75.7 %) and pedicle screw fixation in 9 patients (24.3 %).

POST OPERATIVE DEFORMITY ANGLES:

The average postoperative angle A was **16.36°** (range -11 to 47.90°). The average in the thoracic region was 20.26° (-2.4 to

47.9°), in the thoracolumbar region was 10.43° (3.10 to 20.60°) and in the lumbar region was -2.6° (-11 to 6.2°).

The average local Kyphus angle was 16.39° (range -9.90 to 46.90°)

Table 11: immediate post operative correction in angle A

Mean	11.90
Minimum	-3.70
Maximum	36.90

IMMEDIATE POST OPERATIVE CORRECTION: Table 11

The average immediate post operative correction in angle A was 11.90° (range -3.70 to 36.90°). The average correction in the thoracic region was 10.92° (2 to 36.90°), in the thoracolumbar region was 16.43° (5.20 to 32.80°) and in the lumbar region was 14.93° (-3.70 to 36.10°).

The average immediate post operative correction in the local Kyphus angle was 10.88° (range -7.20 to 37.90°).

NEUROLOGY AT DISCHARGE:

Except two patients all the rest were status quo at discharge with regards their neurological deficits. 1 patient improved from Grade A to B and 1 deteriorated from Grade C to A. In this patient no cord compression by the implants was demonstrable by imaging but he was subsequently lost to follow up.

MOBILIZATION:

All patients were started on a regimen of physiotherapy which included position change two hourly, chest physiotherapy, deep breathing exercises and passive mobilization of the joints. Post operatively all patients were propped up in bed or sat up the day after the surgery in case the patient was not transferred to the surgical intensive care unit. After the wound drains and chest tube were removed the patient was then sat out of bed and mobilized in a wheelchair. All patients were mobilized within two weeks prior to discharge from the hospital in wheelchairs/ walkers as per their capability. This ability to mobilize patients early and aggressively is the key advantage of posterior instrumentation and fusion.

FOLLOW UP DATA

DURATION OF FOLLOW UP:

14 patients were followed up personally.4 patients were followed up by X-rays and telephonic interviews, their last out patient visit had shown full neurological recovery. Data for 9 patients were collected from last follow up visit in the out patient department after surgery. 9 patients were lost to follow up. 1 patient died. Two patients with follow up of 2 and 6 months were excluded from the concerned follow up analysis.

SYMPTOMS AND FUNCTIONAL RECOVERY

Data for neurological recovery was available for 29 patients. 26 out of these 29 patients were independent in activities of daily living and were able to return to previous occupation at the end of 6 months.

1 patient had significant back pain which subsided after implant removal for implant failure (Refer case 1). No other patient had significant pain or paraesthesia. 3 patients complained of prominence of the implants without associated pain or discomfort.

CASE 1: KD a 40 year old housewife with D11-L1 tuberculosis spine presented with 3 months history of Frankel A paraplegia. Her preoperative vertebral loss was 1.4 with a preoperative deformity of 53.40° (Fig 1). She underwent surgery on 16.7.2001 and iliac crest

graft of 40 mm was used to reconstruct the anterior column. (Fig 2). Her post operative deformity angle was 20.60°. She presented 2 years later with low back pain and a prominent implant. Her radiograph at that point showed a graft fracture and implant failure with a loss of correction of 25.20° (Fig 3). She underwent implant exit and subsequently was asymptomatic. (Fig 4)

Fig1

Fig 2

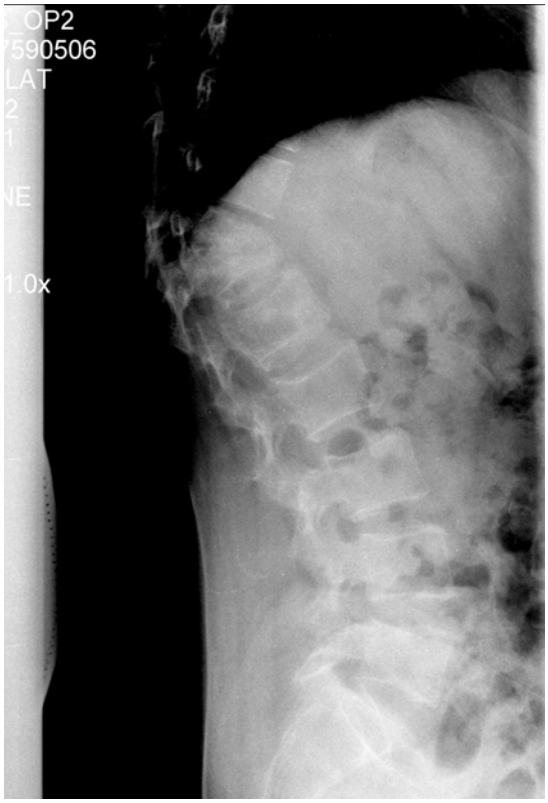


Fig3

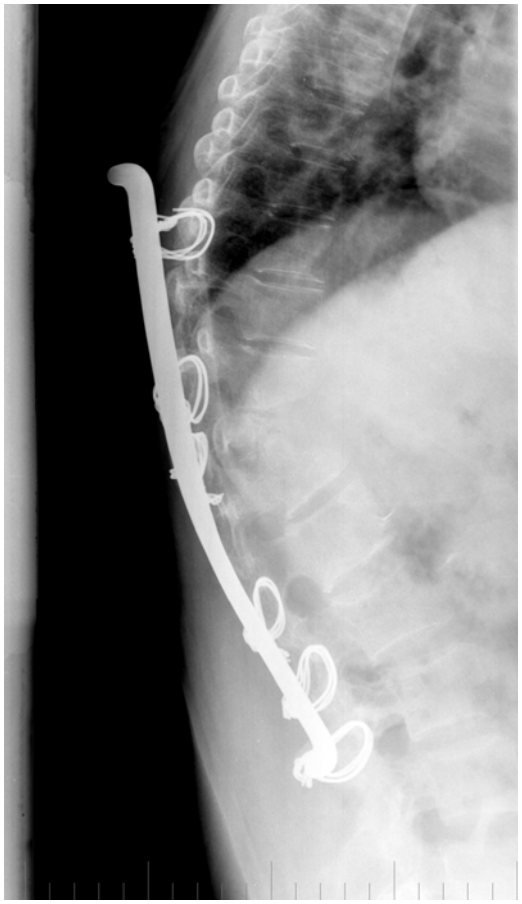


Fig 4

DURATION OF FOLLOW UP:

Average duration of follow up was 33.07 months. Total follow up was 72.2 %.

Table 12: Average Angle A at follow up

N	26
Missing	11
Mean	23.1808
Minimum	-1.00
Maximum	72.50

RADIOGRAPHIC ASSESSMENT AT FOLLOW UP: Table 12

Local kyphus angle at follow up was an average of 22.77° (range -4 ° to 69°)

Angle A at follow up was an average of 23.18° (range -1 to 72.50°)

The mean angle A in the thoracic region is 27.10° (8 to 72.50°)

The mean angle A in the thoracolumbar region is 25.50° (5.20 to 45.80°)

The mean angle A in the lumbar region is 2.43° (-1.00 to 4.10°)

LOSS OF CORRECTION AT FOLLOW UP: Table 13 (pg 39)

Loss of correction of angle A at follow up was an average of 6.98° (range 0.20 to 35.90°)

The mean loss of correction in Angle A in the thoracic region is 6.42° (range 0.20 to 35.90°)

The mean loss of correction in Angle A in the thoracolumbar region is 13.65° (range 2.10 to 25.20°)

The mean loss of correction in Angle A in the lumbar region is 6.28°

(range 0.40 to 12.60°)

Loss of correction of the local kyphus angle was an average of 6.48° (range 0.10 to 34.30°)

Table 13: Loss of correction at follow up

N	25
Missing	12
Mean	6.98
Minimum	0.20
Maximum	35.90

Table 14: Neurological recovery at follow up

	Frequency	Percent	Valid Percent
Missing	7	18.9	18.9
A	3	8.1	8.1
D	3	8.1	8.1
E	23	62.2	62.2
N	1	2.7	2.7
Total	37	100.0	100.0

A, B, C, D, E – Frankel Grade

N not assessed as patient expired.

NEUROLOGICAL RECOVERY: Table 14

Follow up data for neurological recovery was not available for 7 patients (18.9%).1 patient expired in the immediate post operative period and thus was excluded. Of the remaining 29 patients 23 recovered fully to Frankel E (79.3%), 3 patients who were Frankel A to begin with recovered to Frankel D (10.3%). Only three patients did not show any recovery (10.3%).Of the 29 patients 89.6% showed good neurological recovery.

25 patients were Frankel A preoperatively; Of these 13 (52%) recovered to Frankel E, 3 (12%) recovered to Frankel D , 3(12%) remained Frankel A at 6,10 and 18 months follow up respectively after which they were lost to follow up and 6 (24%) were lost to follow up.

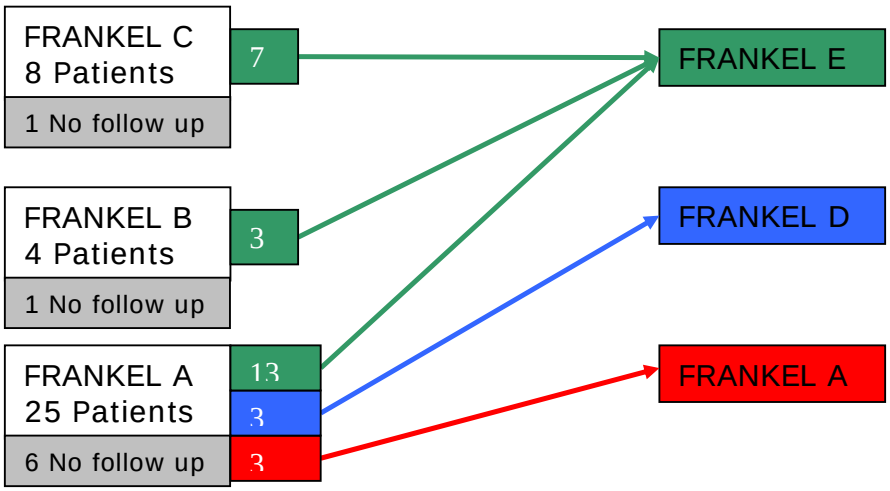


Table 15: Major implant complications at follow up

	Frequency	Percent	Valid Percent
Yes	3	8.1	11.5
No	23	62.1	88.5
Total	26	70.3	100.0
Missing	11	29.7	
Total	37	100.0	

IMPLANT COMPLICATIONS AT FOLLOW UP: Table 15

9 patients had implant complications. Of these 3 patients had major complications which include Hartshill rectangle pull-off in two

and Hartshill rectangle breakage in one patient. One patient underwent implant removal 2 years after the surgery and one has been advised elective implant removal. The third patient was advised no further intervention as she is asymptomatic (case 2 pg 55).

The minor implant complications seen were Drummond wire breakage and slippage in one patient each. In 4 patients who had two levels of pedicle screw fixation above and below the level of involvement, one or two pedicle screws broke without loss of integrity of the construct. None of these patients warranted revision or further intervention. **The percentage of major implant complications is 11.5 %.**

Table 16: Graft complications:

	Frequency	Percent	Valid Percent
none	22	59.5	88.0
fracture	1	2.7	4.0
slippage	1	2.7	4.0
others	1	2.7	4.0
Total	25	67.6	100.0
Missing	12	32.4	
	37	100.0	

GRAFT COMPLICATIONS: Table 16

The graft complications were evaluated at last follow up. One patient had a graft slippage (refer case 2, pg 56), one patient had graft fracture and one had change in position on the graft without slippage. This patient did no require any intervention at 18 months

follow up .The patient with graft fracture also had a symptomatic implant failure and underwent implant exit (Refer case 1, pg 35.). She subsequently fused but had lost 25.20° of correction. **The overall graft complication rate was 5.4%.**

STATISTICAL ANALYSIS

The outcome variables considered in the univariate analysis were:

1. LOSS OF CORRECTION: the statistically significant variables are:

LOSS OF CORRECTION > 10°

1. Preoperative loss of vertebral height > 1 (p = 0.021),
2. Post operative angle A > 20°(p = 0.041)
3. Post op correction >10° (p= 0.027)
4. Post operative local Kyphus angle correction >10° (p= 0.035)
5. Presence of implant complications (p= 0.027)
6. Presence of graft complications (p= 0.000)

LOSS OF CORRECTION > 15°

1. Local kyphosis angle > 35° (p= 0.05)
2. Preoperative angle A > 40° (p= 0.037)

2. POST OPERATIVE COMPLICATIONS: the statistically significant variables are:

1. Presence of an immunocompromised state (p = 0.003)
2. Preoperative local kyphus angle > 330° (p= 0.037)
3. Preoperative angle A > 17° (p = 0.021)
4. Loss of correction of angle A > 15° (p = 0.032)

3. IMPLANT COMPLICATIONS: the statistically significant variables are:

1. Loss of correction > 10° (p= 0.027)
2. Length of graft > 40mm (p = 0.007)
3. Presence of graft complications (p = 00.037)

4. GRAFT COMPLICATIONS: the statistically significant variable are:

1. Preoperative local kyphus angle > 45° (p = 0.008)
2. Preoperative angle A > 45° (p= 0.005)
3. Correction in angle A > 15° (p = 0.058)
4. Correction of local kyphus angle > 25° (p= 0.005)
5. Loss of correction of angle A > 10° (p= 0.000)
6. Loss of local kyphus angle > 6° (p = 0.002)

DISCUSSION

AGE AND SEX RATIO:

The average age in this cohort is 32.49 years with a range from 4-61 years. 16.2 % of the patients were 15 years old or younger and 16.2% were older than 55 years. As is seen in the frequency distribution there is a bimodal pattern of prevalence. Though the earlier studies showed high percentage of patients in the age group of below 15 years-33% [7] and 71% [9] respectively, the recent studies have low percentage of pediatric population 10% [31] , 0% [32] and 11% [37] . It has been postulated than earlier diagnosis and more effective chemotherapy and universal BCG vaccination are responsible for this dramatic decrease.

The average age of our patients is comparable to that of other series of Chen et al [5], Yilmaz et al [35] and Jain et al [30] of 48 years, 43 years and 35 years respectively.

There is a marginal predominance of females in our series.

NUMBER OF VERTEBRAE INVOLVED:

The average number of vertebrae involved in our series in 2.43 with an average vertebral loss of 0.923 ranging from 0.2 to 2.4. The mean number of disc space involved is 1.6 (1-3).The pre operative loss of vertebral height of 0.7, 1.1 by Hodgson et al [13] and Rajasekaran et al [7] respectively and by the MRC [9] of 0.76 in the radical group, 0.77 in the debridement group and 1.32 in the

conservatively managed group is comparable with ours. Though our study includes only paraplegics and would be expected to have a higher preoperative vertebral loss as compared to studies involving the entire spectrum of tuberculosis of the spine , it is consistent with the fact that to date no statistically significant correlation has been established between extent of involvement and presence of paraplegia. 5 patients had multifocal vertebral involvement with two patients having four levels of involvement.

LEVEL OF LESION:

The commonest level involved was the thoracic region with 81.1 % of the patients having a significant lesion in the thoracic level. In contrast to other studies by Hodgson et al [13], Tuli et al [4] and Rajasekaran et al [7] who reported highest incidence in the dorsolumbar region, only 8.1 % of our patients belonged to this category. The fact that our study included only the paraplegics could explain this discrepancy.

CLINICAL PRESENTATION:

At presentation the average duration of pain was 136 days approximately four and a half months and the average duration of motor deficits was 43 days. 56.8% of patients had other significant co morbidities and 68.6 % had constitutional symptoms. 8.8% presented with flexor spasms. Only six patients (16 %) had clinically evident cold abscesses and none had sinuses or fistulae as compared to 38% as reported by Tuli et al [14]. This is probably due

to the fact that 48.6% of patients had received some form of antituberculous therapy prior to coming to our center.

INVESTIGATIONS:

The baseline average pre operative PCV, Serum albumin and Serum total protein was 36.2, 3.57 gm% and 7.38 gm% respectively indicating good general condition prior to surgery.

MAGNETIC RESONANCE IMAGING:

Of the 30 patients whose films were reviewed one third had high signal intensities in the cord indicating cord edema and one patient showed signs of myelomalacia however this patient went on to have a full neurological recovery(ref. Pg 29)

SURGICAL PARAMETERS:

All the patients underwent single stage surgery with one patient requiring anterior surgery for strut graft insertion following anterior debridement and posterior instrumentation as three dimensional instability present in this patient following the initial debridement made graft slippage a possibility during the process of positioning the patient prone prior to instrumentation.

The average time for the entire surgery including time for positioning between the two procedures was 355 minutes.

67.6% of patients underwent a thoracotomy, 16.2% underwent the anterior debridement and strut grafting through an

extended posterolateral approach while the remaining had retropleural or retroperitoneal approaches.

POST OPERATIVE COMPLICATIONS

1 patient died in the immediate post operative period following an intraoperative myocardial infarction in spite of an immediate percutaneous transluminal coronary angioplasty. He was a 58 year old diabetic and hypertensive with coronary artery disease with Frankel B paraplegia of 1 month duration.

4 patients had post operative wound infections, two of whom grew MRSA but none required any surgical intervention for the same and subsided with appropriate antibiotics.

4 patients developed pulmonary complications evident as consolidation and pneumonitis but all recovered with antibiotics and chest physiotherapy. Two of the patients underwent a thoracotomy and in one an extended posterolateral approach was used. The surgical records for the fourth patient are not available. Hodgson et al [6] reported a 4% pulmonary complication rate with 2 deaths. Presence of a haemo or pneumothorax was not reported as a complication if no further intervention was needed. The other reported complications were ileus (1%) and wound infection (4%).

Thoracotomy in paraplegics is fraught with risks because of the compromised pulmonary reserve in these patients secondary to intercostal paralysis to which is added the burden of prolonged

surgery and need for single lung ventilation in some patients. None of our patients had haemo or pneumothorax probably due to the routine use of chest drainage and we had no deaths due to bronchopneumonia in our series in contrast to reports by Hodgson et al [13].

6 patients had miscellaneous complications .One patient had an intraoperative pleural tear which was repaired and in another an intraoperative CSF leak was encountered through the pedicle which was sealed. One patient was found to have a scoliosis post operatively. One patient developed atrial fibrillation and supraventricular tachycardia which was managed with appropriate drugs and monitoring in the cardiac critical care unit .One patient who underwent a tracheostomy on the 7th day of her intensive care stay because of a pneumonia subsequently developed a blockage in the tracheostomy tube requiring reintubation and transfer to the surgical intensive care unit for a period of 5 days.

The average use of blood or blood products of approximately 2 units, the average post operative intensive care stay of 2.42 days and an average duration of hospitalization of 14.33 days with the reasonable complication rate is evidence of the fact that in spite of the added morbidity of the adjuvant posterior surgery, in a setup where adequate facilities are available it is warranted.

PREOPERATIVE KYPHOSIS AND MAINTAINENCE OF CORRECTION:

The Kyphus angle measured as the angle A is the mathematical supplement of the Angle “K” described by Konstam and Blesovsky for measuring degree of kyphosis.

The Local Kyphus angle also was measured. The average preoperative Kyphus angle A in our series is 27.86° which is comparable with that of Rajasekaran et al [7] 21.2° , MRC trial 26° [9] , Jain et al 24.8° [30] and Chen et al 25° [5] .

The average post operative angle A in our series is 16.36° with a range from -11 (11° lordosis) to 47.90°.

The difference in the pre operative and immediate post operative angle of deformity is the correction attained. The mean correction in the thoracic region is 10.92° (2 to 36.90°), in the thoracolumbar region is 16.43° (5.20 to 32.80°)and in the lumbar region is 14.93° (-3.70 to 36.10°). The average post operative correction attained in our series is 11.90° with a range from -3.70 to 36.90°.The average Kyphus angle correction in the thoracic region is 10.92° (2 to 36.90°), in the thoracolumbar region is 16.43° (5.20 to 32.80°) and in the lumbar region is 14.93° (-3.70 to 36.10°).The average correction of 11.90° is lower than 21° reported by Moon et al [37] in their study of combined anterior fusion and posterior stabilization but since the aim of the correction is to restore the anatomy to near normal it is dependant on the preoperative deformity present. Our

lower average preoperative deformity of 27.86° as compared to 37° reported by Moon et al [37] may explain the difference.

The Angle A at follow up was average of 23.18° (range -1 to 72.50°). The mean angle A in the thoracic region is 27.10° (8 to 72.50°), in the thoracolumbar region is 25.50° (5.20 to 45.80°) and in the lumbar region is 2.425° (-1.00 to 4.10°) .

Average Loss of correction of 6.98° (0.20 to 35.90°) .The average loss of correction in the thoracic, thoracolumbar and lumbar regions were 6.42° (0.20 to 35.90°), 13.65° (2.10 to 25.20°) and 6.28° (0.40 to 12.60°) respectively.

The loss of correction is dependant on the rigidity of fixation, integrity of the construct till fusion takes place and integrity of the graft. Implant failure and graft fracture, subsidence or slippage result in loss of correction.

The average loss of correction of only 3°, 3.2° and 3.4°was reported by Moon et al [37], Laheri et al [36] and Guven et al [32] respectively.

In the thoracic spine group- one patient with a preop angle of 62.6° corrected to 36.6° post-operatively subsequently progressed to 72.50° with a loss of correction of 35.90°. This patient had graft slippage in the post operative period which required a re thoracotomy and fusion in situ with fibula graft (refer case 2 pg 55). Though she also had multidrug resistant tuberculosis and presented

3 years after the surgery with a tuberculous lesion in the left radius, she recovery from Frankel A to D.

In the Thoracolumbar spine group one patient with preoperative deformity of 53.40° corrected to 20.60°post operatively subsequently progressed to 45.80° with loss of correction of 25.20° She also had a symptomatic implant failure necessitating implant exit and graft fracture which subsequently fused(refer case1 pg 35).

Excluding these two patients the average loss of correction in our series is 4.92° which is comparable with those of Moon et al [37] and Laheri et al [36] and is much lower than the average loss reported in series not using posterior stabilization Bailey et al [11] and Rajasekaran et al [7].

IMPLANT

In the thoracic region the implant used was the Hartshill rectangle with sublaminar wiring in 27 patients and pedicle screw fixation in 3 patients .In the lumbar region the implant used were pedicle screw fixation and in the thoracolumbar region one patient had Hartshill rectangle application and two had pedicle screw fixation. Total of 28 patients had Hartshill rectangle and in 9 patients pedicle screw fixation was used. At follow up 2 of the 28 patients had complications of which one underwent an implant exit, one has been advised an elective implant exit and three other

patients had minor implant issues not warranting any intervention. One patient have a single wire breakage and one a single wire slippage, both insignificant. In the remaining one patient the Hartshill rectangle is pulling off inferiorly but as the patient is asymptomatic no implant exit is planned.

Of the 9 patients with pedicle screw fixation 4 patients have pedicle screw breakage but none are symptomatic. In the patients with pedicle screw fixation with two levels above and below the level of the lesion, the pedicle screws at the extremes showed breakage (4 out of 7 patients). As the intervertebral disc in between the two levels of fixation is preserved, the implant failure could be attributed to micro movements causing fatigue with time. In three patients the implants were intact for 8, 12 and 18 months respectively while in the fourth the implant breakage was seen at follow up at 57 months, the previous x-ray done at 3 months being normal. This high rate of implant failure in this particular subgroup would suggest the need for an elective implant exit after the graft has united.

The average loss of correction in the Hartshill rectangle group is 7.2° and in the pedicle screw fixation group is 6.26 °. Even though pedicle screw fixation in principle is superior to the Hartshill rectangle with sub laminar wiring because of the fact that it immobilizes all the three columns of the spine, is more rigid and allows short segment fusion; the results with both these systems

was similar in our series probably due to softer bone in the vertebral bodies resulting in a submaximal fixation and higher number of implant failures in the pedicle screw fixation group. No implant related complications were reported by Moon et al [37] and Yilmaz et al [35].

GRAFT COMPLICATIONS:

In our series the most commonly used graft is autologous tricortical iliac crest bone graft followed by the use of titanium cages with iliac graft. Ribs and local graft and dual fibula were used in two patients each. The average graft was 37.24 mm and 84.4% of the patients had graft lengths less than 42 mm.

Graft related complications were seen in three patients. One patient had graft slippage. One had a graft fracture with implant failure and required implant exit. One patient had a change in the position of the graft without slippage from the intervertebral space. Studies with anterior arthrodesis alone have a high percentage of graft related problems despite 3 months of bed rest(Rajasekaran et al [7]) .Graft slippage 24%, graft fracture 20% ,absorption 20% and subsidence 4%. No subsidence was seen in our series which we relate to adequate debridement to healthy bleeding bone.

NEUROLOGICAL RECOVERY:

89.6% of the patients for whom the data was available showed good neurological recovery. This is comparable to Tuli et al [4] results of 78.5% recovery with the middle path regime and 98.3% recovery reported by Moon et al [37]. These findings corroborate the fact that **posterior instrumentation has no deleterious effect on neurological recovery**.

ADVANTAGES OF MOBILIZATION:

All patients were mobilized prior to discharge at approximately a week to 2 weeks post operatively. One patient who did not show any neurological recovery developed urinary tract infection post operatively. Apart from this one patient none of the others developed pressure sores, hypostatic pneumonia post operatively. The added advantage being that **none of these complications occurred even during the interim period of neurological recovery**. Though recall bias at follow up is a factor which cannot be excluded, any complications requiring hospitalization and specialized care would mitigate this confounding factor. Those with sores preoperatively showed improvement. While in Hodgson's series [6] the incidence of bedsores and cystitis is 6%, in spite of an average of 3 months and 12 days of bed rest the graft complications rate is 12 %.**Early mobilization allows better self care decreasing the incidence of pressure sores, urinary**

tract infections and hypostatic pneumonia. It also has a positive psychological effect on these patients. Caring for a paraplegic requires investment of finance and manpower, a luxury that can scarce be afforded in a third world country. The consequences of early mobilization are far reaching affecting utilization of hospital resources, patient care and social acceptance. The more practical point of view is that by making the patient semi independent with regard to activities of daily living it relieves the care givers of a major burden. This is a definite advantage over regimes where a minimum of 3 months of bed rest is required post operatively [4, 7, 15].

ILLUSTRATIVE CASE STUDIES:

CASE 2: Ms HY a 22 year old student with D9-11 tuberculosis of the spine presented with 6 month history of mid back pain and 1 month history of Frankel A paraplegia. She had a past history of pulmonary tuberculosis 1 year prior for which she had received adequate antituberculous therapy. Her preoperative angle A was 62.60° (Fig 5.) She underwent surgery on 30.8.2003 and her post operative angle A was 36.60°. She had a graft slippage (Fig 6) in the immediate post operative period and underwent a re-thoracotomy and fusion in situ with dual fibula grafts. At 37 months follow up there was progression of the deformity to 72.50° (Fig 7) and she

had recovered to Frankel D. Functionally she was independent and had rejoined her college to complete her education. At this point she presented with a lytic lesion in the distal radius which was curetted and the culture grew multidrug resistant mycobacterium tuberculosis. Her latest x ray (Fig 8) shows Hartshill rectangle pull-off inferiorly but in view of her asymptomatic pseudoarthrosis she has not been advised any further surgery. She is being treated with second line antituberculous therapy.

Fig 5

Fig 6

Fig 7

Fig 8

CASE 3: RH a 14 year old student from Bangladesh with D6-7, Frankel A tuberculous paraplegia and a preoperative vertebral loss of 1.1 presented with 2 month history of pain and 1 month history of neurological deficits. He had a preoperative angle A of 41.10° (Fig 9) and underwent surgery on 3.3.2004. His deformity was corrected to 26° (Fig 10) and dual fibula grafts were used. He underwent repeat anterior surgery after the anterior debridement and posterior instrumentation as explained in the discussion. At 18 months follow up the deformity angle A was 28.70° (Fig 11) with a loss of correction of 2.70°. The graft was incorporated without any

subsidence or fracture. The Hartshill rectangle showed a single wire breakage which was asymptomatic. He had recovered to Frankel E.

Fig 9

Fig 10

Fig 11

CASE 4: BA a 27 year old laborer presented with D6-9 tuberculosis spine. He had 2 months history of Frankel A paraplegia and the preoperative vertebral loss was 0.9. His preoperative deformity angle was 18.50° (Fig 12). He underwent surgery on 17.2.2001 with a post operative angle of 8.80° (Fig 13). At 54 month follow up his deformity angle was 14.40 with a loss of correction of 5.60° (Fig 14) and there were no implant or graft related complications. He had returned to his prior occupation at 9 months though he had recovered neurologically to Frankel A at 6 months.

Fig 12

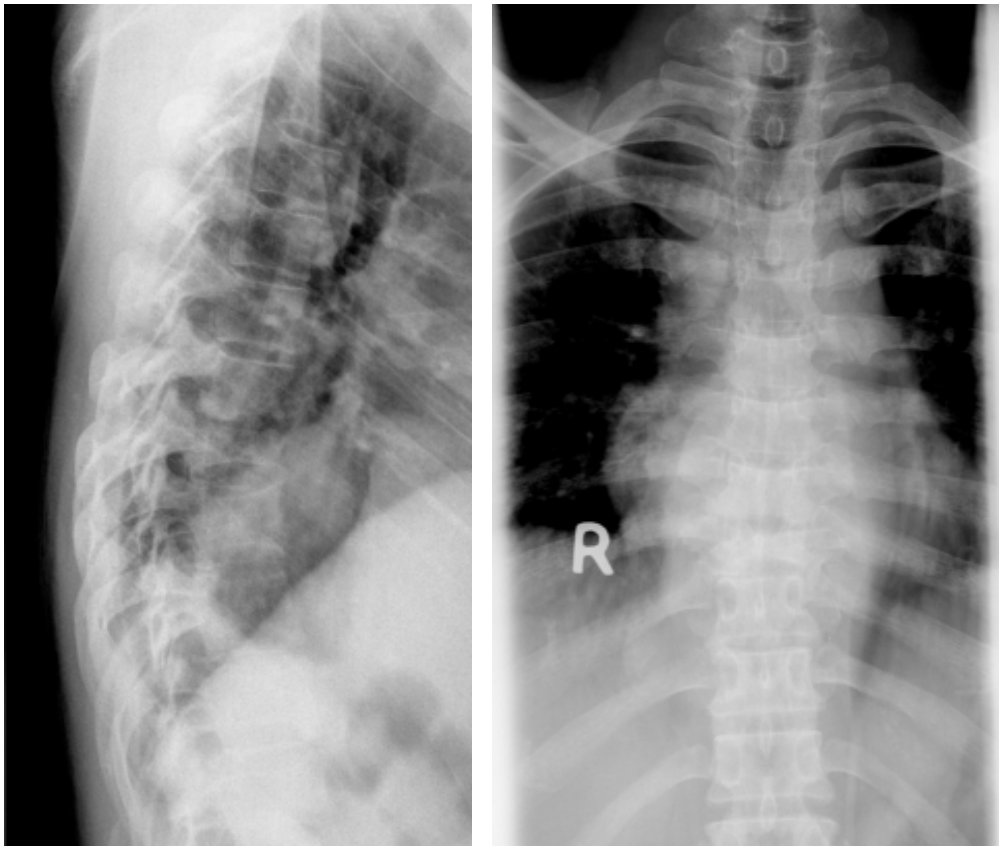


Fig 13

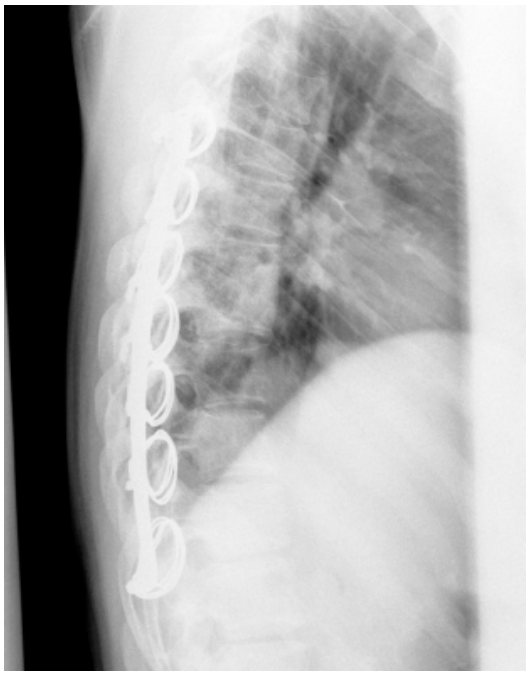
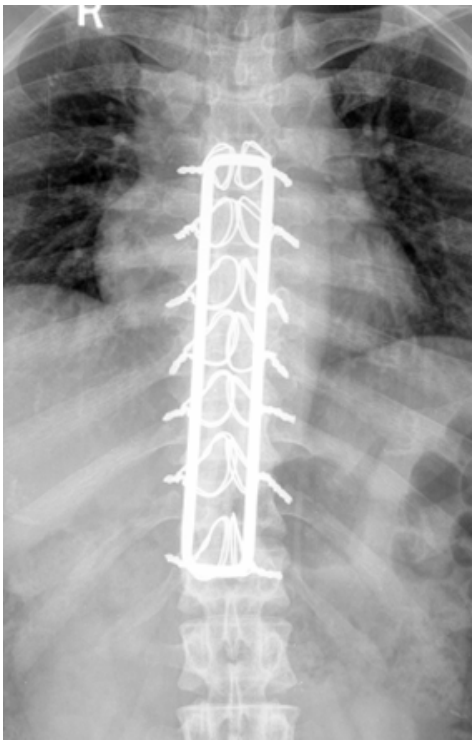


Fig 14



CONCLUSION

In the cohort that was studied 89.6% showed good neurological recovery, the average loss of correction was 6.98° (0.20 to 35.90°) and the complication rate was reasonable.

We conclude that

1. Single stage anterior debridement, decompression and fusion with strut grafting and posterior stabilization and fusion permits early ambulation, shortens hospital stay and allows early rehabilitation.
2. It decreases morbidity during the period of hospitalization and the interim period when the neurological status is recovering.
3. It does not interfere with neurological recovery.
4. It minimizes graft complications in terms of graft slippage, absorption and fractures and had minimal implant complications.
5. It allows deformity correction and maintains this correction at long term follow up.

This regime can thus be recommended for treatment of patients with tuberculous paraplegia in centers where adequate facilities are present.

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PROFORMA

NAME
AGE AT SURGERY
SEX
OCCUPATION

LEVEL

SYMPTOMS:
- BACK ACHE
- DEFORMITY
- NEUROLOGICAL DEFICIT-
  1. MOTOR
  2. SENSORY
  3. BOWEL AND BLADDER
- COMPLICATIONS
  - BED SORES
  - URINARY TRACT INFECTIONS
  - CHEST INFECTIONS
- CO MORBIDITIES:
  - DM
  - HT
  - OTHERS- SPECIFY

- CONSTITUTIONAL SYMPTOMS:

- PAST HISTORY OF TB

HISTORY OF INTAKE OF ATT: YES – ADEQUATE/ INADEQUATE
NUMBER OF DRUGS
DURATION
NO –

EXAMINATION:
- SYSTEMIC- RELEVANT
- LOCAL
  - GAIT
  - DEFORMTIY
  - TENDERNESS
  - COLD ABSCESS
- NEUROLOGY

MOTOR
- BULK
- TONE
- POWER

BEEVORS			
		RIGHT	LEFT
HIPS	FLEXION		
	EXTENSION		
	ABDUCTION		
	ADDUCTION		
KNEES	EXTENSION		
	FLEXION		
ANKLE	EHL		
	EDL		
	TIB ANT		
	TIB POST		
	PERONEII		
	GASTOSOLEUS		
	FHL		
	FDL		

REFLEXES
- KNEE CLONUS
- KNEE JERK
- ANKLE CLONUS
- ANKLE JERK
- PLANTARS

SENSORY
- TOUCH- LEVEL
- PAIN/TEMPERATURE- LEVEL
- VIBRATION

PER RECTAL EXAMINATION
BLADDER AND BOWEL

ASIA SCORE
TULI STAGE
FRANKEL STAGE

INVESTIGATIONS:
PCV/HB
ESR
LFT
SPUTUM AFB
AFB SMEAR
AFB CULTURE AND SENSITIVITY

CHEST XRAY: EVIDENCE OF PULMONARY TB
INFECTION
XRAY:
LEVEL INV.
NO. OF LEVELS INV.
KYPHUS ANGLE (konstams' angle)
LOSS OF VERTEBRAL HT.(Rajasekaran-Shanmugasundaram method)
ABSCESSES
MRI:
LEVEL INV
ABSCESSES
CORD CHANGES

SURGERY DONE:

ANTERIOR RADICAL DEBRIDEMENT AND BONE GRAFTING
APPROACH
DURATION OF SURGERY
BLOOD LOSS
SIZE OF GRAFT
NATURE OF GRAFT- FIBULA/ ILIAC CREST/ RIB
POSTERIOR INSTRUMENTATION
DURATION
FIXATION- LEVELS
TYPE

POST OP CARE
SICU- INDICATION
DURATION

POST OP
PCV
DRAINAGE- WOUND DRAIN
CHEST DRAIN
BLOOD PRODUCTS USED- INTRA OP/ POST OP

NEUROLOGY- CHANGE- YES / NO
FRANKEL GRADE

POST OP XRAY: ANGLE OF KYPHUS
CORRECTION OF DEFORMTIY
SIZE OF GRAFT
IMPLANT FIXATION –ADEQUATE / INADEQUATE

COMPLICATIONS: GRAFT RELATED
SURGERY RELATED-
PNEUMONIA
UTI
THROMBOPHLEBITIS
ILIAC DONOR
COMPLICATIONS
WOUND INFECTION

DURATION OF HOSPITAL STAY
NEUROLOGY AT DISCHARGE- FRANKEL GRADE

PROFORMA AT FOLLOW UP

DURATION OF FOLLOW UP

RETURN TO OCCUPATION

SYMPTOMS:
BACK ACHE
DEFORMITY
NEUROLOGICAL DEFICIT-
1. MOTOR
2. SENSORY
3. BOWEL AND BLADDER

COMPLETION OF ATT YES / NO DURATION_____
REGIMEN: 2HREZ- 16HR
ANY OTHER- SPECIFY_____

EXAMINATION:
BODY WEIGHT
SYSTEMIC- RELEVANT

LOCAL
- GAIT
  - WALKING DISTANCE
- DEFORMTIY
- TENDERNESS

NEUROLOGY
- MOTOR
  - BULK
  - TONE
  - POWER

BEEVORS			
		RIGHT	LEFT
HIPS	FLEXION		
	EXTENSION		
	ABDUCTION		
	ADDUCTION		
KNEES	EXTENSION		
	FLEXION		
ANKLE	EHL		
	EDL		
	TIB ANT		
	TIB POST		
	PERONEII		
	GASTOSOLEUS		
	FHL		
	FDL		

REFLEXES
- KNEE CLONUS
- KNEE JERK
- ANKLE CLONUS
- ANKLE JERK
- PLANTARS

SENSORY
- TOUCH- LEVEL
- PAIN/TEMPERATURE- LEVEL
- VIBRATION

PER RECTAL EXAMINATION

FRANKEL GRADE
TULI GRADE
ASIA SCORE

INVESTIGATIONS:
ESR (AT THE END OF ATT)

X RAY

KYPHUS ANGLE (KONSTAM'S ANGLE)

LOSS OF CORRECTION

GRAFT: FUSION – BRIDWELL CRITERIA- GRADE 1 / 2 / 3 / 4
SUBSIDENCE
SLIPPING
FRACTURE

IMPLANT: HARTSHILL WIRE BREAKAGE
RECTANGLE BREAKAGE
PEDICLE SCREWS: SCREW BREAKAGE
SCREW CUT OUT

CHEST X RAY
MRI --

SNO	INITIALS	HOSP NO	AGE	SEX	LEVEL	NOV	DSp	LVHt	REGION	PAIN	MOT	SENS	BLAD	FS	DM	IC	HT
1	K	295185C	27	f	D7,8	2	1	0.9	thoracic	180	1	0	0	no	.	no	no
2	S	049856C	29	f	L2-3	2	2	0.2	lumbar	45	18	0	18	no	no	no	no
3	RK	438811C	19	f	D3-4	2	2	1.2	thoracic	45	15	0	0	yes	no	no	no
4	V	550812C	16	f	D8,9,L1,L4,S1	2	2	1	thoracic	45	10	0	0	no	no	no	no
5	MC	131630C	14	f	D2-4	3	2	1	thoracic	60	60	0	0	no	no	no	no
6	P	989076B	27	f	D8-10	3	2	1.2	thoracic	180	42	0	0	no	no	yes	no
7	V	474212C	55	m	D5-7	3	2	0.5	thoracic	15	10	0	15	no	yes	yes	no
8	RH	126493C	13	f	D4-5	2	1	0.3	thoracic	90	15	15	15	no	no	no	no
9	KD	040997C	40	f	D11,12L1	3	2	1.4	thoracolumba	365	150	90	90	no	no	no	no
10	SMR	152720C	59	f	D4-6	3	1	1	thoracic	45	3	0	0	no	no	no	no
11	HY	351012C	22	f	D9-11	3	2	1.7	thoracic	240	30	30	30	no	no	no	no
12	AB	673154B	44	m	L3-4	2	.	.	lumbar	120	20	0	0	no	no	no	no
13	N	531930C	4	f	D4-7	4	3	2.4	thoracic	7	60	0	7	no	no	no	no
14	A	136105C	26	f	D8-9	2	1	0.2	thoracic	240	150	0	0	no	no	no	no
15	AD	867917B	21	f	D4-5	2	.	.	thoracic	90	15	0	0	no	no	no	no
16	PD	561197C	53	m	D10-11	2	1	0.6	thoracic	240	60	0	0	no	no	no	no
17	RH	434815C	14	m	D6-7	2	2	1.1	thoracic	60	30	30	0	yes	no	no	no
18	Z	617056A	13	m	D1-3	3	2	1	thoracic	.	.	.	.	.	.	no	.
19	MC	101199C	55	f	D12L1	2	1	1	thoracolumba	60	60	0	0	no	no	no	no
20	BS	806212B	59	m	D6-7	2	.	.	thoracic	30	20	20	20	yes	yes	yes	yes
21	RH	109175C	21	f	D6-8	3	2	1.1	thoracic	120	7	0	0	no	no	no	no
22	BA	994152B	27	m	D6-9	4	3	0.9	thoracic	180	60	0	0	no	no	no	no
23	SJ	299133C	18	m	D5-6	2	2	1	thoracic	365	60	0	30	no	no	no	no
24	S	887247B	46	f	D3-6,D7,D10,	4	.	.	thoracic	30	30	0	0	no	no	no	no
25	AP	130136C	58	m	D5-7,L3-5	3	2	1.1	thoracic	90	30	0	0	no	yes	yes	yes
26	VD	964264B	44	f	D9-10	2	1	1	thoracic	.	.	.	.	.	.	.	
27	JK	911180B	47	m	D5,6,7	3	2	1	thoracic	.	.	.	.	.	no	no	no
28	SKV	524071C	25	m	D7,8	2	1	0.5	thoracic	150	60	0	20	no	no	no	no
29	PNS	161039C	61	m	D11-12	2	1	0.2	thoracolumba	60	60	0	60	no	yes	yes	yes
30	V	142666C	16	m	D6-7	2	1	1.1	thoracic	180	60	10	10	no	no	no	no
31	T	302555C	43	f	D7-8, L1-5	2	1	0.2	thoracic	30	0	0	0	no	no	no	yes
32	J	274987C	31	m	D7,8	2	1	1	thoracic	120	45	45	45	no	no	no	no
33	K	705923B	35	m	L2	2	.	.	thoracic	120	60	0	0	no	no	no	no
34	SB	751937B	38	m	D3-4	2	.	.	thoracic	180	14	0	14	no	no	no	no
35	GM	890874B	35	m	D7-8	2	1	0.8	thoracic	365	120	0	0	no	no	no	no
36	UR	552874C	32	f	L1-2	2	1	1.1	lumbar	365	90	0	0	no	no	no	no
37	H	771370B	15	f	D1,L1-2	2	.	.	lumbar	120	30	0	14	no	no	no	no

ABBREVIATIONS

SEX: f- female, m- male

NOV: number of vertebrae

LVHt: preop loss of vertebral height

FS: flexor spasms

DM: diabetes mellitus

IC: immunocompromised

HT: hypertension

SNO	COMORBIDITI	CS	PHTB	ATT	GIBB	SCOI	TEND	COLD AB	FR	BED SORE	UTI	PNEU	PCV	ESR	tot p	alb	SGO
1	pregnant	yes	no	appropriate	yes	no	yes		A	none	yes	no	28.8	25	6.2	2.8	33
2	Tb abdomen	yes	no	inappropriate	yes	no	yes		A	none	yes	no	30.3	11	8	3	23
3	disseminated	yes	no	appropriate	yes	no	yes		A	none	no	no	32.1	40	8.2	4.2	23
4	disseminated	yes	no	none	yes	no	yes		A	none	no	no	34.5	95	7.9	3.7	19
5	nil	yes	no	none	yes	no	yes		B	none	no	no	30.9	77	8.2	4	28
6	Rheum Arthrit	yes	no	appropriate	yes	no	yes		A	trochanteric	yes	no	37	130	6.4	2.3	29
7	nil	no	no	none	yes	no	yes		A	none	no	no	36.3	.	6.8	3.3	22
8	TBM,Left hydr	no	no	none	yes	no	yes		A	none	yes	no	35.1	85	7.7	3.7	41
9	nil	yes	no	appropriate	yes	no	yes		A	none	no	no	27.6	60	8	4.2	22
10	pleural effusio	yes	no	appropriate	yes	no	yes		A	none	yes	no	39	112	6.4	3	36
11	nil	yes	yes	none	yes	no	yes	paraspinal	A	none	no	.	35.9	12	4.4	1.8	60
12	nil	no	no	inappropriate	yes	no	yes		C	none	.	no	41.4	.	6.5	2.9	60
13	nil	yes	no	none	yes	no	yes		A	none	no	no	33	40	7.6	4.8	34
14	nil	no	no	appropriate	yes	no	yes		C	none	no	no	43	.	7.5	4	36
15	Pulmonary TB	yes	no	inappropriate	yes	no	yes		A	none	.	no	33.3	.	7.3	4.1	20
16	COPD smoke	no	no	appropriate	yes	no	yes		C	none	no	no	41.4	43	6.7	3.3	31
17	nil	yes	no	appropriate	yes	no	yes	none	A	none	no	no	37.6	74	7.4	3.9	31
18	Drug induced	.	.	.	.	.	.		A	.	yes	.	27	70	8	3.5	41
19	Hyperthyroid,	yes	no	none	yes	no	yes		C	sacral	yes	no	31.5	68	7.9	3.3	68
20	nil	yes	no	none	yes	yes	yes		A	sacral	no	no	33	120	6.5	2.6	34
21	nil	no	no	none	yes	no	yes	paraspinal	C	none	no	no	39	.	6.6	3.6	45
22	nil	yes	no	appropriate	yes	no	yes		A	none	no	no	40.8	80	9.3	4.6	35
23	nil	yes	no	appropriate	yes	no	yes		A	none	no	no	44.7	10	7.9	5.2	72
24	nil	yes	no	appropriate	yes	no	yes		A	none	yes	no	33	90	7.9	3.8	65
25	Coronary arte	yes	no	none	yes	no	yes		B	none	no	no	42.3	83	7.5	3.4	55
26		.	.	.	.	.	.		B	none	yes	.	34	15	7.6	3.4	13
27		yes	no	none	yes	no	yes		C	none	no	no	37	75	8	4.2	38
28	nil	no	yes	appropriate	yes	no	yes		A	none	yes	no	41	15	8	3.8	49
29	aortic regurgit	yes	no	none	yes	no	yes		A	none	yes	no	31	115	7.3	3.1	94
30	HbsAg postive	no	no	none	yes	no	yes		A	both	no	no	36.3	110	7.4	2.8	153
31	drug induced	yes	no	none	yes	no	yes		C	none	no	no	35.7	110	7.3	3.1	317
32	HbsAg positiv	yes	no	none	yes	no	yes	paraspinal	A	none	no	no	42.6	75	.	.	.
33	TBM	yes	no	none	yes	no	yes		C	none		no	38.1	40	.	.	.
34	bipolar disord	no	no	none	yes	no	yes	lumbar	A	none	.	no	37	6	.	.	.
35	nil	no	no	none	yes	no	yes	paraspinal	B	none	.	no	40	.	.	.	.
36	nil	yes	no	appropriate	no	no	yes		A	none	no	no	35.2	72	7.8	3.9	.
37	nil	no	no	inappropriate	yes	no	yes	paravertebral	A	sacral	no	.	42.9	5	.	.	.

ABBREVIATIONS

CS: constitutional symptoms

PHTB:past history of tuberculosis

ATT: antituberculous therapy

GIBB: gibbus

SCO: scoliosis

TEND: tenderness

FR: frankel Grade

UTI: urinary tract infection

tot p: total protein

alb: albumin

SNO	SGPT	ALP	creat	AFB s	AFB c	To vert	LKA preop	A preop	LKA pop	A pop	LKA corr	A corr	A fu	LKA fu
1	11	151	0.7	none	no	2	14.3	22.7	.	.	.	.	17.4	19.5
2	12	65	0.6	none	yes	2	7	1.4	-2	-11	9	12.4	-1	-4
3	13	102	0.9	none	no	2	31	26	20.2	22	10.8	4	23.8	21.2
4	14	119	0.6	none	no	5	27.4	33.2	6.8	16.7	20.6	16.5	21	12.8
5	14	231	0.5	none	no	3	45	55.4	44.9	47.9	0.1	7.5	52	55.3
6	15	70	0.7	none	no	3	23.2	21.3	16.3	19	6.9	2.3	.	.
7	15	120	1.1	none	no	3	22.2	23.1	16	18.7	6.2	4.4	.	.
8	18	147	0.6	none	no	2	15	23	22	21	-7	2	24.9	23.5
9	18	79	0.8	none	no	3	49.4	53.4	19.4	20.6	30	32.8	45.8	44.6
10	19	92	1.2	moderate	yes	3	19.2	31.5	18.5	26.9	0.7	4.6	.	.
11	19	130	0.6	few	no	3	62.8	62.6	34.7	36.6	28.1	26	72.5	69
12	20	92	0.9	moderate	.	2	.	.	9.5	6.2	.	.	4.1	9.4
13	21	175	0.6	none	yes	4	71.3	48.2	33.4	11.3	37.9	36.9	18.9	37.8
14	26	144	0.8	few	no	2	3.4	10.2	1.5	7.4	1.9	2.8	9	6.3
15	27	111	.	none	no	3	.	.	.	.	.	.	.	.
16	30	180	0.7	none	no	2	11.9	6.8	7.5	2.2	4.4	4.6	.	.
17	35	169	0.6	few	yes	2	25	41.1	25.2	26	-0.2	15.1	28.7	26.6
18	42	157	0.7	.	.	3	33.8	37.6	16.3	18.2	17.5	19.4	21.5	15.4
19	43	128	1	none	yes	2	21.4	14.4	14.5	3.1	6.9	11.3	5.2	16.7
20	47	101	1	.	.	3	.	28.9	.	10.9	.	18	13.4	.
21	48	72	0.7	none	yes	3	57	54	46.9	46.5	10.1	7.5	46.7	45.6
22	52	122	0.5	few	yes	4	20	18.5	6	8.8	14	9.7	14.4	6.4
23	57	99	0.8	moderate	yes	2	44.4	43	41.6	35	2.8	8	43.6	41.5
24	61	48	.	none	no	10	.	.	.	16.9	.	.	.	.
25	66	229	0.9	none	no	6	13.8	11.6	.	.	.	.	.	.
26	74	104	1	none	no	2	14	12.3	3.1	-2.4	10.9	14.7	8	8.5
27	94	212	0.9	none	yes	3	14.3	22.7	11.3	18.4	3	4.3	20.9	16.2
28	114	76	0.9	none	yes	2	10.2	18.7	8.8	15.8	1.4	2.9	18.6	10.3
29	122	93	1.1	none	yes	2	10.1	12.8	6.3	7.6	3.8	5.2	.	.
30	153	173	0.6	few	yes	2	46.2	39.5	14.8	22.9	31.4	16.6	37.2	33.7
31	281	123	0.8	few	yes	7	10.9	14.3	8.2	10.6	2.7	3.7	13.7	9.9
32	.	.	0.8	none	no	2	8.3	27.7	15.5	.	-7.2	.	.	.
33	.	.	0.8	few	no	2	.	.	.	.	.	.	.	.
34	.	.	.	none	.	2	.	.	.	.	.	.	.	.
35	.	.	.	.	.	2	54	48.7	33.7	29	20.3	19.7	35.8	37
36	.	.	0.6	none	no	2	27.7	26.3	-9.9	-9.8	37.6	36.1	2.8	5
37	.	.	0.6	.	.	3	.	0.5	0.8	4.2	.	-3.7	3.8	1.1

ABBREVIATIONS

AFB s: afb smear

AFB c: afb culture

LKA preop: preop local kyphus angle

A preop: preop angle A

LKA postop: post local kyphus angle

A postop:post op angle A

LKA corr: correction in local kyphus angle

A corr: correction in angle A

A fu: follow up in angle A

LKA fu: follow up local kyphus angle

LKA loss: loss of local kyphus angle

A loss: loss of angle A

SNO	A loss	LKA loss	Dur fu	pre	para	epi	psoas	MRI	Date Sx	FIRST SUR	APPROACH	GRAFT	Length
1	.	.	18	no	yes	yes	no		5.5.2003	anterior	thoracotomy	tricortical iliac	34
2	10	6	47	no	yes	yes	no	cord normal	29.9.01	posterior	retroperitonea	tricortical iliac	34
3	1.8	1	20	yes	yes	yes	no	cord edema	16.4.04	posterior	not done	local/rib	.
4	4.3	6	18	yes	yes	yes	no	myelomalacia	8.12.04	posterior	thoracotomy	tricortical iliac	32
5	4.1	10.4	31	yes	yes	yes	no	cord edema	27.1.03	posterior	thoracotomy	tricortical iliac	32
6	.	.	.	yes	yes	yes	no	cord edema	14.2.01	anterior	thoracotomy	tricortical iliac	35
7	.	.	6						5.6.04	anterior	thoracotomy	tricortical iliac	30
8	3.9	1.5	18	yes	yes	yes	no	cord edema	6.3.2002	posterior	thoracotomy	tricortical iliac	32
9	25.2	15.2	46	no	yes	yes	yes		16.7.01	anterior	retropleural	tricortical iliac	40
10	.	.	.	yes	no	yes	no		29.5.02	anterior	thoracotomy	tricortical iliac	42
11	35.9	34.3	57						30.8.03	posterior	thoracotomy	fibular graft	70
12	-2.1	0.1	64						19.3.99	anterior	retroperitonea	cage with bon	40
13	7.6	4.4	19	yes	yes	yes	no		8.10.04	posterior	not done	local/rib	21
14	1.6	4.8	19	yes	no	yes	no		3.4.02	posterior	thoracotomy	tricortical iliac	32
15	.	.	70	yes	yes	yes	no		5.4.00	posterior	not done	tricortical iliac	.
16	.	.	.	yes	yes	yes	no		24.12.04	anterior	thoracotomy	tricortical iliac	33
17	2.7	1.4	18	yes	yes	yes	no		3.3.04	.	thoracotomy	fibular graft	60
18	3.3	0.9	18	yes	no	yes	no	cord normal	29.4.00	.		.	.
19	2.1	2.2	24	yes	yes	yes	yes	splenomegaly	19.12.01	posterior	thoracotomy	cage with bon	70
20	2.5	.	.					no mri	22.10.99	posterior	thoracotomy	cage with bon	35
21	0.2	2	18	no	yes	yes	no		11.1.02	anterior	thoracotomy	tricortical iliac	33
22	5.6	0.4	54	no	yes	yes	no	cord edema	17.2.01	anterior	thoracotomy	tricortical iliac	29
23	8.6	0.1	18	yes	yes	yes	no	cord edema	7.5.2003	anterior	thoracotomy	tricortical iliac	48
24	.	.	.						17.5.00	anterior	thoracotomy	tricortical iliac	.
25	.	.	.	no	yes	yes	yes	cord edema	15.3.02	posterior	thoracotomy	cage with bon	30
26	10.4	5.4	63						29.11.00	anterior	thoracotomy	tricortical iliac	32
27	2.5	4.9	56	no	no	yes	no		5.1.01	posterior	thoracotomy	tricortical iliac	62
28	2.8	1.5	20	yes	yes	yes	no	cord normal	22.9.04	anterior	thoracotomy	tricortical iliac	42
29	.	.	.	yes	yes	yes	no	cord edema	5.6.2002	posterior	thoracotomy	tricortical iliac	32
30	14.3	18.9	45	yes	yes	yes	no	cord edema	10.4.02	anterior	thoracotomy	tricortical iliac	32
31	3.1	1.7	28	yes	yes	yes	no	cord edema	16.5.03	anterior	thoracotomy	tricortical iliac	36
32	.	.	.	no	yes	yes	no		4.4.2003	posterior	thoracotomy	tricortical iliac	32
33	.	.	.	no	no	yes	yes		3.2.99	anterior	retroperitonea	cage with bon	35
34	.	.	.							posterior	not done	cage with bon	20
35	6.8	17.4	2	no	yes	no	no	no mri	21.6.00	posterior	not done	tricortical iliac	.
36	12.6	14.9	18	yes	yes	yes	no	cord normal	15.12.04	anterior	retroperitonea	tricortical iliac	22
37	-0.4	0.3	78	no	no	yes	yes	no mri		posterior	not done	cage with bon	35

ABBREVIATIONS
Dur fu: duration of follow up
pre: prevertebral abscess on MRI
para: paravertebral abscess on MRI
epi: epidural abscess on MRI
LEV GRAFT: levels of grafting

SNO	LEV GRAFT	FIXn	DUR ANT	IMPLANT	LEV POST	DUR PO	TOT DUR	PLBG	POST PC	SICU	HD	BR	POP FR
1		3,3	180	Hartshill	D4-11	120	300	yes	28	3	.	3	A
2	L2-3	2,2	180	PSF	T12,L1-L3,4	120	300	yes	37	0	9	1	A
3		3,3	0	Hartshill	D1-7	300	300	yes	27	6	18	3	A
4	D7-9	3,3	180	Hartshill	D4-10	180	360	yes	29	3	14	2	B
5	D2-4	2,4	240	Hartshill	C7-D7	240	480	yes	32	7	16	5	B
6		3,3	150	Hartshill	D5-12	190	340	yes	31	2	17	1	A
7	D5-7	3,2,3	240	Hartshill	D2-10	180	420	yes	26	0	18	3	A
8		3,3	240	Hartshill	D1-8	180	420	yes	31	2	.	2	A
9		2,1,3	180	Hartshill	D8-L3	150	330	yes	32	2	14	2	A
10		3,3	195	Hartshill	D1-8	135	330	yes	32	16	17	4	A
11		3,3	.	Hartshill		.	.	yes	24	.	.	3	A
12		1,1	195	PSF	L2-4	120	315	yes	36	0	14	1	C
13		4,4	0	Hartshill	D2-11	360	360	yes	38	4	14	2	A
14		3,3	180	Hartshill	D5-11	180	360	yes	30	2	14	1	C
15			0	Hartshill	D2-9	225	225	yes	30	2	17	1	A
16		1,1	240	PSF	D9-12	150	390	yes	32	2	12	1	A
17		3,4	.	Hartshill		.	.	yes	33	2	14	2	A
18			.	Hartshill		.	.	.	.	.	.	.	A
19	D11-L2	2,2	180	PSF	D10,11-L2,3	120	300	no	23	2	16	2	C
20	D5-D8	4,4	150	Hartshill	D2-D10	210	360	yes	22	2	18	3	A
21	D6-7	3,4	150	Hartshill	D4-11	180	330	yes	35	0	15	4	C
22		2,2,3	180	Hartshill	D5-11	180	360	yes	37	2	14	2	A
23	D5-7	3,2,3	180	Hartshill	D2-10	180	360	yes	25	2	14	1	A
24		4,4,3	.	Hartshill	D1-11	300	300	no	25	3	17	2	A
25		3,3,4	240	Hartshill	D1-10	180	420	yes	28	1	14	3	B
26	D9-11	2,2	.	PSF	D7,8-11,12	.	.	no	23	.	.	2	B
27	D5-8	3,1,4.5	180	Hartshill	D3-12	210	390	yes	28	.	.	0	C
28	D5-7	3,4	240	Hartshill	D2-9	210	450	yes	28	2	12	1	A
29		2,2	360	PSF	D9,10 L2-3	240	600	no	32	2	14	4	A
30		3,3	180	Hartshill	D3-8	150	330	yes	30	3	12	3	A
31		2,2,4	180	Hartshill	D4-11	180	360	yes	29	3	14	1	C
32	D7-9	3,3	180	Hartshill	D5-11	210	390	yes	29	3	15	2	A
33	L1-L3		195	PSF	L1-3	120	315	yes	31	2	14	0	C
34			.	Hartshill	D1-8	285	285	yes	.	0	7	1	A
35	D7-9	4,3	0	Hartshill	D5-12	300	300	yes	27	0	14	0	B
36	L1-2	2,1	150	PSF	D11-L3	150	300	yes	29	0	12	0	A
37		2,2	0	PSF		360	360	yes	29	0	.	.	A

ABBREVIATIONS

FIXn: number of levels of fixation above, at and below

DUR ANT: duration of anterior surgery

LEV POST: levels of posterior fixation

DUR PO:duration of posterior surgery

PLBG: posterolateral bone grafting

HD: Duration of hospital stay

BR: blood replaced

SICU: duration of surgical ICU stay

POP F: post operative Frankel grade

SNO.	COMPL	DFR	ADDL INFO	RFR	IMP C	GRAFT C
1	none	A	LSCS done 3 days before surgery	E	none	none
2	none	A	skin rash after Att thus dose titrated	E	above 2 pedic	none
3	pneumonia	A	D4-5 costotransveresctomy, ARDS- MICU,mild retrolisthesis	E	none	none
4	none	B	bm biopsy- tb	E	none	none
5	pneumonia	B	one wire in the inv level also, left lower lobe consolidatio	E	none	none
6	pneumonia	A	patellar clonus,		no follow up	.
7	wound infectio	A	MRSA treated with teicoplanin	A	none at 6 mor	.
8	none	A	D4,5,6 posterior elements involved	E	none	none
9	other	A	implant failure and exit after 2 years, pleural tear intraop	D	hatshill pull of	fracture
10	other	A	reintubated in sicu once,preop sudden dyspnoe- PE ruled out,tr		no follow up	.
11	other	A	scoliosis post op cobb 14.4,MDR TB	D	hartshill pullin	slippage
12	none	C	incisional hernia, osteoarthritis knee, no pre op xrays	E	none	none
13	none	A	Costotransversectomy,all wires single xpt lower most,	A	none	none
14	none	C		E	none	none
15	none	A	clonus	E		.
16	other	A	post op SVT,pedicle screws 1 level above and below and 1 scre		no follow up	.
17	none	A	sensory and motor recovery	E	1 wire broken	none
18	pneumonia	A	vesical calculi, drug induced hepatitis & UTI post op	A	none at 10 mo	none
19	none	C	FFP given for deranged LFT, HCV,allograft used,RAI 131 befor	E	left uppermos	none
20	wound infectio	A	MRSA	E	none	none
21	none	C	anterior -posterior-anterior	E	none	none
22	none	A	clonus	E	none	none
23	none	A	clonus, D10 haemangioma		none	none
24	none	A	costotransversectomy D4-5,D7,D10		no follow up	.
25	other	E	expired -MI emergency ptca	N		.
26	none	D	no mri available	E	inferior most p	none
27	none	C	old D9 compression #	E	1 wire slipped	none
28	none	A	pulm tb 1 yr ago	E	hartshill and 1	none
29	other	A	csf leak L2 pedicle, power3 but BB inv, MDRTB,inf seb cyst		no follow up	.
30	wound infectio	A	HbsAg positive	E	none	none
31	none	C	small destructive lesion L1-5 not compressing the cauda	E	none	none
32	none	A	power 2 but BB inv, no post op lateral	D	no follow up	.
33	none	C	no xrays available	E	no xrays avail	.
34	none	A	L5 costotransversectomy,anterolateral decompression			.
35	wound infectio	B	costotransversectomy D8	E		.
36	none	A	scoliosis preop cobb 8.8,graft changed postn, 1 cross link	E	superior 2 pe	shift
37	none	A		E	none	none

ABBREVIATIONS

DFR: Frankel grade at discharge

RFR: Frankel grade at review

IMP C: implant complications

GRAFT C graft complications