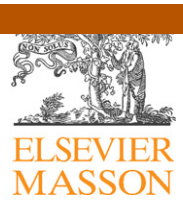
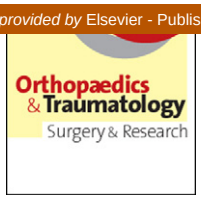
Orthopaedics & Traumatology: Surgery & Research (2013) 99, 196—201



Available online at
SciVerse ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en



ORIGINAL ARTICLE

Material costs of anterior cruciate ligament reconstruction with hamstring tendons by two different techniques

J. Cournapeau [a,*], S. Klouche [a], P. Hardy [a,b]

[a] *Hôpitaux Universitaires Paris Ile-de-France Ouest, AP—HP, 92100 Boulogne-Billancourt, France*
[b] *Université de Versailles Saint-Quentin, UFR des Sciences de la Santé, 78035 Versailles, France*

Accepted: 5 October 2012

KEYWORDS
ACL reconstruction;
Hamstring;
All-inside;
Cost analysis

Summary
Introduction: In France, approximately 36,000 anterior cruciate ligament (ACL) reconstruction surgical procedures are performed every year. Technical progress, in particular arthroscopy, has made surgery more precise, but more expensive. In a context of healthcare cost containment, the increase in the cost of technology must be compared to the improved outcome for the patients. The main aim of this study was to determine all material costs related to ACL reconstruction using hamstring tendons. This study also compared the material costs between the two arthroscopic techniques: standard or ''all-inside''.
Materials and methods: A retrospective study of material costs was performed in 2011. With the standard technique, the tibial tunnel was drilled from outside to inside, while with the all-inside technique two tunnels were drilled from inside to outside. All of the material used from the first swab to the final bandage was reported. It was classified into three categories: reusable arthroscopy material, disposable arthroscopic material, and disposable surgical supplies. The costs were those of our supplier in 2011 (Arthrex™) and based on Public Hospitals of Paris (AP—HP) public contract tariffs.
Results: Standard ligament reconstruction was less expensive than the all-inside technique: 791.59 € versus 931.06 € excluding taxes (hors taxes [HT]), respectively. The largest percentage of expenses was allocated to disposable material use (81 and 84%).
Discussion: Possible avenues of savings are limited: all the material used was necessary. To control costs, correct use and good maintenance of instruments are the most important elements.
Level of evidence: Level IV. Economic and decision analyses, retrospective study.

Introduction

Ligament reconstruction of the anterior cruciate ligament (ACL) is one of the most frequent arthroscopic procedures. According to the Technical Agency for Information

* Corresponding author. Fax: +33 1 49 09 54 88.
E-mail address: cournapeau.jerome@gmail.com (J. Cournapeau).

1877-0568/$ - see front matter
http://dx.doi.org/10.1016/j.otsr.2012.10.013

on Hospitalizations (ATIH) 36,675 ligament reconstructions were performed in France in 2010 [1] corresponding to a Homogenous Group of Patients (HGP) (Groupe homogène de malades [GHM]) for act 08C34 ''arthroscopic surgical procedures of the cruciate ligaments''. The aim of this surgical treatment is threefold: to stabilize the knee, to protect the meniscus and to prevent osteoarthritic degeneration of the joint [2—4]. Since 1970 greater understanding of the anatomy of the ACL and the natural history of ligament tears have resulted in advances in surgery by gradually shifting from extraarticular isolated lateral tenodesis [5], to anatomical ligament reconstructions with autografts (patellar tendon, hamstrings) initially by open surgery and then by arthroscopy [6]. These techniques have gradually improved, in particular by the use of more effective graft fixation systems to obtain stable fixation and improved positioning of the implant. Arthoscopic ACL reconstruction is now a reliable, reproducible technique with good results of between 75 and 90%. Techniques have also become increasingly less invasive. Today, so-called ''all-inside'' techniques have been developed in which semi-tunnels are drilled, and all of the cortices are left intact.

This technical progress is associated with technological changes. Arthroscopic material has changed: high definition cameras, sterilizable arthroscopes, arthropumps, efficient arthroscopic instruments and medical devices that can be implanted and are absorbable. The cost of this intervention has increased considerably. This increase must be compared to the offset of a reduction in hospital stay, faster return to daily activities and especially improved functional results for the patient. An evaluation of our clinical and medico-economic practices is essential. In this era of tarification by act (T2A) and fixed tariffs for a Homogonous Diagnosis-related group (DRG) (Groupe homogène de séjour [GHS]), the price of the materials used must be determined. The average cost of a DRG/GHS in public hospitals corresponding to the HGP/GHM for the act 08C34 is 3726 € [1]. A detailed analysis of real costs would help identify the areas where costs could be saved.

The main goal of this study was to identify the cost of all material necessary for an ACL reconstruction with the hamstring tendons. The secondary goal was to compare the cost of material depending upon the surgical procedure chosen: standard or ''all-inside''. This is an analysis of costs, and not a ''cost-effective'' analysis performed in a University Hospital Center. The hypothesis was that disposable materials would represent the greatest proportion of costs for this procedure.

Materials and methods

A retrospective study of material costs was performed in 2011. This included patients undergoing single bundle arthroscopic ACL reconstruction with the hamstring tendons using two techniques.

Surgical technique

For the standard technique a separate femoral tunnel was drilled from inside to outside, using a femoral guide. The tibial tunnel was drilled from outside to inside. The graft was prepared with four Polysorb™ 0 (Covidien, Massachussetts, USA) traction sutures. A beath pin and a guide pin were necessary to pass the grafts into the tunnels. Tibial and femoral fixations were obtained by absorbable interference screws, screwed onto a guide (Interference Screw Bioresorbable, Arthrex™, Lezennes, France).

The all-inside technique also used a hamstring graft. Specific arthroscopic instruments were used. The two tibial and femoral tunnels were performed from inside to outside. The femoral tunnel was drilled with traditional material, while the tibial tunnel was drilled with a FlipCutter® (Arthrex™, Lezennes, France) which is an ''all in one'' disposable system. This includes a pin with a distal system for retrograde drilling once the pin is in the joint. Drilling of tunnels requires a specific RetroDrill® beath pin. To pass the graft into the tunnels, we used a suture passer loop. Femoral fixation was obtained by a TightRope™ implant and tibial fixation by cortical button fixation attached to the graft with a FiberWire® 2. The TightRope™ provides a double system for graft tension.

Method of analysis of material costs

This study analyzed material costs only. The costs of the operating room, the surgeon, the anesthesiologist, hospitalization costs and secondary costs (medication, sick leave, bandages, rehabilitation, follow-up consultation) were not taken into account. Management of any associated lesions was not included either: meniscal repair, meniscectomies, chondral repair, osteotomies.

All of the material used from the first swab by the paramedical team to the final bandage was reported. The material was divided into three groups: reusable arthroscopic material, disposable arthroscopic material and surgical supplies.

Reusable arthroscopic material

This material was divided into two groups: long lifespan, non-sterilizable material and short-lifespan material that could usually be sterilized (Tables 1 and 2). After material is purchased it is used several times for different types of arthroscopy: knee ligament reconstruction, shoulder arthroscopy... To evaluate the relative cost of this material for ligament reconstruction, we studied the lifespan of the product in relation to operating room purchases and the data from our supplier (Arthrex™, Lezennes, France). Based on the evaluation of the number of arthroscopies per year and the mean duration of a procedure, we determined the costs per procedure.

Ancillary instruments (clamps, tibial and femoral guides, cannulated drills, tibial dilators, screw driver, calibration material...) were separate. A list of material for traditional arthroscopy and an annex for material for the all-inside technique were available in our unit. This material was provided by our supplier.

Disposable arthroscopic material

Some of the material is the same for both techniques, others are more specific (Table 3). Costs of this material are subject to the tariffs in public contracts in particular that of the Agence générale des équipements et produits de

Table 1 Arthroscopic material with a long lifespan (arthroscopy column).

Element	Reference	Price in euros HT	Price/arthroscopy HT	Lifespan
Wide tray	AR-5995-20STI	5450	2.795	1950 arthroscopies
Shaver Console APSII	AR-8300	5775	2.96	
Multifunction footpedal Shaver APS II	AR-8310	1050	0.54	
HD camera console	IR8101-1512	12,890	6.61	
Keyboard	IR8100-KBF	150	0.075	
Xenon cold light source	IR8200	5370	2.75	
Digital color printer	AR-5969D	6000	3.075	
Arthropump	AR-6475	5000	2.565	
HD 26 inch screen	IR8300	6900	3.54	
Total (€)		48,585	24.915	

HT: excluding taxes (hors taxes).

Table 2 Arthroscopic material with a short lifespan.

Element	Reference	Price in euros HT	Price/arthroscopy HT	Lifespan
Triple CCD Camera head	IR8001	12,890	33.05	1 year
Cold light cable	IR8221	350	0.90	1 year
Arthroscope	IR0030	1995	19.95	100 arthroscopies
Arthroscope sleeve	IR0100	390	1	1 year
Mandrin	IR0200	70	0.18	1 year
Hand piece for shaver	AR-8330F	5000	5	100 arthroscopies
Bulb	20133027	860	1.72	500 hours
Ancillary instruments for standard technique		Deposit	Deposit	
Ancillary annex ''all-inside''		Deposit	Deposit	
Total (€)		21,555	61.8	

HT: excluding taxes (hors taxes).

Table 3 Disposable arthroscopic material.

Elements	Reference	Price in euros HT/unit	Quantity standard technique	Quantity all-in-one
Tubing	AR-6415	37.6	1	1
Shaver knife	AR-8380BC	85.54	1	1
Vacuum cable	ta7271I	0.8	1	1
Camera cover		1.59	1	1
Terylene	22017	0.82	1	1
Guide pin	AR-1250L	13.16	1	0
TightRope™ LCA[a]	AR-1588RT	117.91	0	1
Suture Button[a]	AR-8922	110.84	0	1
FiberWire® 2 needle[a]	AR-7200	61.31	0	1
FiberTape™[a]	AR-7237	121.2	0	1
Elexible cable relay	AR-1255-18	86.48	0	1
FlipCutter™	AR-1204F	112.8	0	1
Retro beath pin	AR-1595	57.34	0	1
Interference screw[a]	AR-1390B	208.633	2	0
Polysorb™ 0 suture	CL-917	1.53	4	0
Standard beath pin	AR-1297L	46.06	1	0
Screw guide	AR-1249	35.72	1	0
Total (€)			644.676	784.23

HT: excluding taxes (hors taxes).
[a] Not included in the GHS.

Table 4 Surgical supplies.

Element	Reference	Price in euros HT/unit	Quantity
Betadine 125 cm^3		1.26	2
Swab	401061 CZ	1.41	2
Surgical brush	371607	0.28	4
Brush 1st brush	4451GL	0.24	1
500 cm^3 saline	B230551	0.44	2
Jersey	421515PH	0.93	1
Gowns	660108	2.689	4
Gloves		0.33	12
Surgical drape	29173CEA	8.75	1
Mayo cover	8339CEC	0.74	1
Scalpel blades 11 et 23		0.252	2
Electric scalpel	VSUC1	1.68	1
BE plate	305300001	0.44	1
Saline pouch	101166	6	2
Polysorb™ 2/0	SL 622	1.555	1
Polysorb™ 0	CL-917	1.53	1
Vicryl® rapid 2/0	VR2253	3.311	1
Redon drain	5523648	1.34	1
Redon bottle	94625	0.22	1
Compresses (x10)	01172T1	0.369	3
Mepore®	670800	0.037	4
Velpeau Bandage	135705	0.814	3
Steri-Strip™	R1546	0.29	1
1 printed photo		0.8	1
Total		60.12	

HT: excluding taxes (hors taxes).

santé (AGEPS) (General Agency for Healthcare Equipment and Products) making it possible to obtain the various prices.

General surgical supplies
This included all material necessary to prepare the patient by the paramedical then surgical teams, material necessary to maintain a sterile environment for four healthcare practitioners during the procedure (the senior surgeon, the fellow, the resident and the operating room nurse) as well as traditional instruments such as the scalpel, saline solution to irrigate the joint, and equipment necessary to close and bandage the wound (Table 4). The public contract tariffs (AGEPS) determined the price of this material.

Number of arthroscopies

Between January 1, 2009 and December 31, 2010, 780 arthroscopies were performed in our unit, or 390 per year. The indication for most of these procedures was repair of rotator cuff tears and Bankart type stabilization of the shoulder. Sixty-five ACL ligament reconstructions were performed per year. The mean duration of a procedure was one hour.

Lifespan of the material

An arthroscopy column was replaced every 5 years or after 1950 arthroscopies. The arthroscope and the manual part of the Shaver were replaced after 100 arthroscopies. The insertion cannula, the obturator and the camera head lasted for one year. The bulb for the light source was changed approximately every 500 hours.

Results

The overall cost of material for standard ligament reconstruction was 791.59 € excluding taxes (hors taxes [HT]) while the all-inside technique cost 931.06 € HT. The VAT for the material was 19.6% for most material and 5.5% for implanted medical devices.

The all-inside technique was 18% more expensive than the standard technique. The excess cost was due to disposable material. The use of the FlipCutter® and the RetroDrill® beath pin as well as the suture pass cost 197.4 € more than the standard pin guide and beath pin. However TightRope™ and cortical button fixation cost 41.70 € less than the two interference screws (Tables 1—4).

Disposable material represented the highest proportion of the total cost: 81% for the standard technique, 84% for the all-inside technique. The costs of ''short lifespan arthroscopic material'' and ''general surgical supplies'' were equivalent for both techniques (7.7% for the standard technique, 6.5% for ''all-inside''). ''Long lifespan arthroscopic material'' represented the lowest proportion of costs (3 and 2.6%) (Figs. 1 and 2).

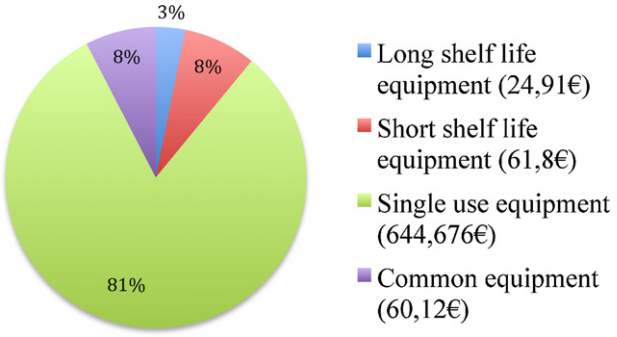


Figure 1 Cost of standard ligament reconstruction for a standard hamstrings technique.

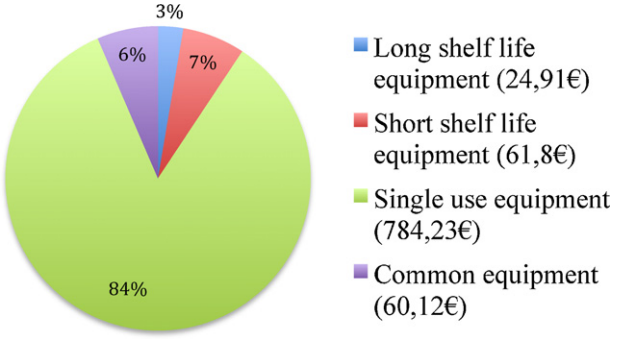


Figure 2 Cost of all inside STG ligament reconstruction.

Table 5 Costs for the different items of expenditure for the Diagnosis Related Group (GHS) corresponding to the Homogenous Group of Patients (GHM) 08C34 on the National Scale of Costs, reference 2010 [1].

Items of Expenditure	Amount (euros)
Clinical activities Medicine, Surgery, Obstetry (MCO)	884.2
Medicotechnical activities	1183.7
General logistics	532.6
Medical logistics (pharmacy. sterilization. biomedical engineering)	222.2
Direct costs	903.2
GHS	3726

Only the cost of the implants (screw, button TightRope™), were not included in the DRG but were reimbursed in addition (Tables 3 and 5): 411.30 € for the all-inside technique and 417.20 € for the standard technique to which the cost of the arthroscope column must be added.

Discussion

To our knowledge this is the first French study to analyze the cost of material for arthroscopic ACL ligament reconstruction.

Studies on the cost of arthroscopic surgery are rare [7]. Most of the studies of ACL reconstruction have focused upon the overall cost to the healthcare system, and they involve the North American market. In the United States, approximately 100,000 ligament reconstructions are performed each year [8]. Their estimated overall cost: (material, use of the operating room, rehabilitation, fees) is an estimated 1 billion dollars per year [9] or 10,000 $ per reconstruction. It is impossible to compare this cost with ligament reconstructions in France. There are numerous differences in management of this procedure between the two countries: first, this surgery is often performed on an outpatient basis in the US and on the other hand allografts (20% more expensive) are used quite often in the US while in France this is very rare [10,11].

To our knowledge only one European study has evaluated the overall cost of ligament reconstruction (operating room, anesthesia, surgical supplies, personnel staff or team, additional tests, rehabilitation, medication). [12]. This study only evaluated the standard hamstring technique, and the cost of material only took into account disposable material. The authors estimated the overall cost to be 2300 €. The cost of disposable material was 607 € (644 € in our study). Our study provided a more detailed inventory of materials.

In our study the cost of material was slightly higher for the ''all-inside'' technique because it uses more disposable material, while the cost of implanted material (reimbursed in addition to the GHS) were equivalent. This additional cost must be evaluated in relation to the value of this technique. For certain authors the ''all-inside'' technique is less invasive, results in less bone loss, allows better osteointegration of the graft and results in less postoperative pain [13,14]. Other studies are needed to confirm these benefits [15].

The interest of a cost analysis study is also to identify areas where cost savings are possible. Disposable material is subject to very strict rules of traceability and preparation, which explains its high cost. However, certain savings can be considered:

- general use of tubing systems in which only the connection with the arthroscope sleeve is changed after each procedure, provides savings after the second arthroscopic procedure (savings of 26.32 €, 52.64 € and 78.96 € for two, three or four arthroscopies per day);
- the use of an arthropump is not necessary for ligament reconstruction;
- another source of savings would be to increase the amount of material that can be sterilized, the Shaver knife, for example, but the price of storing and sterilizing must be evaluated;
- although the cost of the arthroscopy column is significant, this is offset if the arthroscope is used regularly;
- the arthroscopic material with a short lifespan is the most fragile: it is essential to be careful and avoid sudden movements that could cause damage (shaver against the arthroscope; poor position of the arthroscope when changing position during the Cabot manoeuvre for example). Moreover, this material is produced for the American market where sterilization norms are less strict (possibility of ''flash'' sterilization) which makes it more fragile during sterilization by French standards (sterilization at 134° for at least 18 minutes);

- it is also necessary to avoid any avoidable losses such as inadvertently contaminating a sterilized interference screw.

This study is limited because it was performed in one university hospital for a certain period. The possibility of negotiating with suppliers, which depends for example, on the size of the facility means that estimated costs cannot be compared to those of other public or private health facilities, although the proportion of costs in each area probably varies very little from one hospital unit to another. Furthermore, one element could not be taken into account: the motor. This material has a short lifespan. The role of wear associated with ligament reconstructions is difficult to evaluate in a traumatology department. Moreover, we did not take into account the direct cost of sterilizable material, or the secondary costs of sterilization and storage, making it impossible to evaluate the real cost of this disposable material. Final the global cost did not take into account unforeseen additional costs (example, a new screw if one was inadvertently contaminated).

Conclusion

This study has shown that the largest portion of the cost of ACL ligament reconstruction is associated with disposable arthroscopic material and implants. The ''all-inside'' technique was 18% more expensive than the standard technique. The GHS does not cover all the costs of material, in particular implants, which are reimbursed in addition.

Disclosure of interest

P.H. is a consultant for Arthrex™. J.C. and S.K. have no conflict of interest.

Acknowledgements

Jérôme Arnoux: Product manager, Arthrex™.

References

[1] www.atih.sante.fr/
[2] Keene GC, Bickerstaff D, Rae PJ, Paterson RS. The natural history of meniscal tears in anterior cruciate ligament insufficiency. Am J Sports Med 1993;21:672—9.
[3] Neyret P, Donell ST, Dejour H. Results of partial meniscectomy related to the state of the anterior cruciate ligament. Review at 20 to 35 years. J Bone Joint Surg Br 1993;75: 36—40.
[4] Noyes FR, Mooar PA, Matthews DS, Butler DL. The symptomatic anterior cruciate-deficient knee. Part I: the long-term functional disability in athletically active individuals. J Bone Joint Surg Am 1983;65:154—62.
[5] Lemaire M, Miremad C. Les instabilités chroniques antérieures et internes du genou. Traitement. Rev Chir Orthop 1983;69:591—601.
[6] Frank A. LCA : les options. In: « Arthroscopie ». 2e édition Paris: Elsevier; 2006, p. 176.
[7] Maravic M, Landais P. Arthroscopie pour gonarthrose en France en 2001. Rev Chir Orthop 2005;91:768—72.
[8] Surgery ABoO. Research committee report: Diplomatic newsletter. Chapel Hill, NC. 2004.
[9] Preventing injuries in sports, recreation, and exercise. Centers for Disease Control and Prevention. 2006.
[10] Cooper MT, Kaeding C. Comparison of the hospital cost of autograft versus allograft soft-tissue anterior cruciate ligament reconstructions. Arthroscopy 2010;26:1478—82.
[11] Cole DW, Ginn TA, Chen GJ, Smith BP, Curl WW, Martin DF, et al. Cost comparison of anterior cruciate ligament reconstruction: autograft versus allograft. Arthroscopy 2005;21: 786—90.
[12] Frenzel G, Wuschech H, Felmet G, Ingenhoven E, Schmidt M, Ziesche JJ. Kostenanalyse für den implantatfreien vorderen Kreutzbandersatz. Unfallchirurg 2010;113:615—20.
[13] Cerulli G, Zamarra G, Vercillo F, Pelosi F. ACL reconstruction with ''the original all-inside technique''. Knee Surg Sports Traumatol Arthrosc 2011;19:829—31.
[14] Benea H, Klouche S, Bauer T, Hardy P. Pain evaluation after ACL ligamentoplasty: ''all-inside'' versus classical technique. A prospective randomized comparative study. ESSKA 2012:21—955.
[15] Lubowitz JH. All-inside ACL: retroconstruction controversies. Sports Med Arthrosc 2010;18:20—6.