FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

XXII CURSO
DE REABILITAÇÃO
E TRAUMATOLOGIA
DO DESPORTO

Rotura do Ligamento Cruzado Anterior

- *Novas perspectivas para a cirurgia* -

Fernando Fonseca, MD PhD

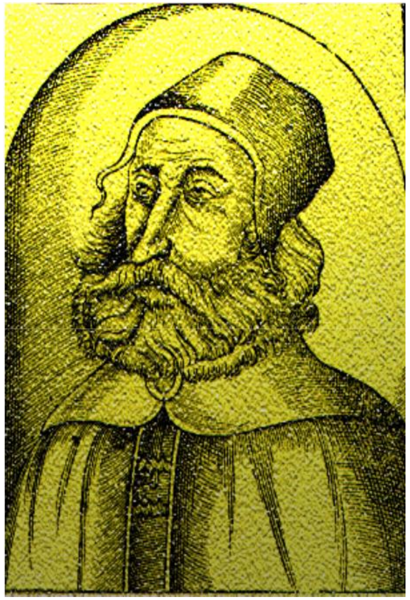
Faculdade Medicina Universidade Coimbra

Centro Hospitalar e Universitário de Coimbra

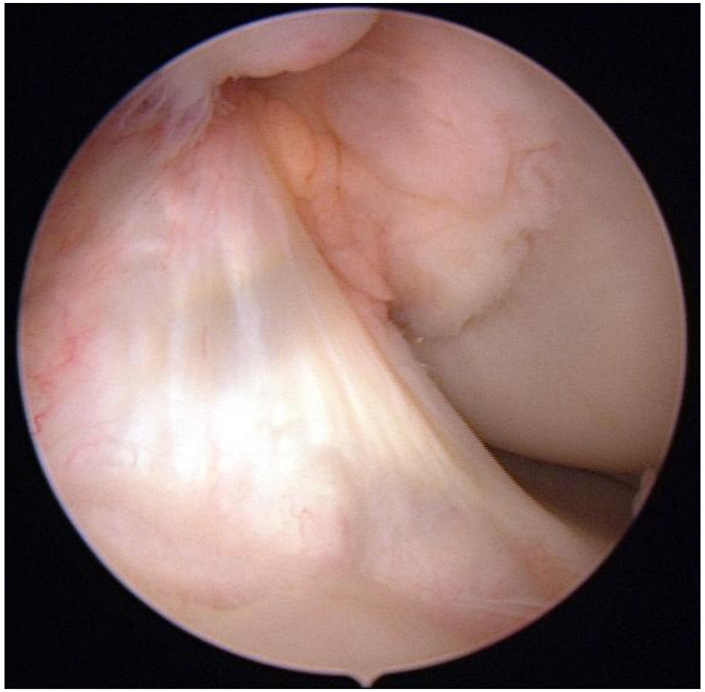
Faculdade de Ciências da Saúde / Universidade da Beira Interior

HUC
HOSPITAIS
DA UNIVERSIDADE
DE COIMBRA

O ligamento cruzado anterior do joelho é conhecido desde Galeno (130-201)



- Há mais de 100 anos Amédée Bonnet (1809-1858), descreveu a clínica de uma rotura do L.C.A., incluindo o estalido, a hemartrose e a mobilidade anormal da articulação.
- Stark (1850) descreve um caso de rotura do L.C.A. tratando-a com ortótese.
- Mayo Robson (1895) efectua um plastia do L.C.A.
- Battle (1900) efectua a primeira sutura ligamentar



2005

O problema

- Nos E.U. a incidência anual de roturas do LCA é de 1 em 3,500 habitantes, estimando-se em 75,000 por ano.
- A indústria refere anualmente mais de 100,000 reconstruções do LCA.
- Entre 5 a 15% dos casos operados registam-se resultados insatisfatórios
  - 8% são devidos a instabilidade e falência da plastia.

Garrick JG, Requa RK: Anterior cruciate ligament injuries in men and women: how common are they? In Prevention of noncontact ACL injuries by griffin LY, ed. AAOS, 2001

2005

«A» reconstrução do LCA

- 3 túneis femorais
  - (trans-tibial, medial, trans-condiliana)
- 2 transportes do enxerto (colher/colocar)
- 2 feixes do enxerto
- 3 fixações em cada extremidade
  - (distal, interferposição, transfixiva)
- 4 transplantes (TR, ST, STRI,TQ)

...logo 3 x 2 x 2 x 3 x 3 x 4 = 432 possibilidades

2012

- Novas perspectivas ?

Reconstruir o LCA

Farshad et al. BMC Health Services Research 2011, 11:317
http://www.biomedcentral.com/1472-6963/11/317

RESEARCH ARTICLE Open Access

Reconstruction versus conservative treatment after rupture of the anterior cruciate ligament: cost effectiveness analysis

Mazda Farshad[1*], Christian Gerber[1], Dominik C Meyer[1], Alexander Schwab[2], Patricia R Blank[3] and Thomas Szucs[3]

Table 1 Distribution of level of activities of a constructed population based on available studies after either operative or conservative treatment of torn ACL

	Patients with activity data (n)	Age (years)	Follow Up (months)	Activity level (Gottlob et al) Class I (%)	Class II (%)	Class III (%)	Class IV (%)	Class V (%)
operative								
Finke et al (2001)	46	34	132	2	12	12	20	0
Diekstall et al (1999)	60	27.9	51	5	6	6	11	32
Kessler et al (2008)	60	30.7	140	5	6	6	11	32
Seitz et al (1994)	63	25	102	0	0	7	56	0
mean/Sum	229	28	89	12	24	31	98	64
%				**5.2**	**10.5**	**13.5**	**42.8**	**27.9**
conservative								
Finke et al (2001)	25	32	140	11	6.5	6.5	1	0
Diekstall et al (1999)	49	23.8	53	7	7.5	7.5	20	7
Kessler et al (2008)	60	30.7	140	5	6	6	11	32
Seitz et al (1994)	21	28	102	0	3	12	6	0
mean/Sum	155	27	90	23	23	32	38	39
%				**14.8**	**14.8**	**20.6**	**24.5**	**25.2**

RESEARCH ARTICLE Open Access

Reconstruction versus conservative treatment after rupture of the anterior cruciate ligament: cost effectiveness analysis

Farshad et al. BMC Health Services Research 2011, 11:317
http://www.biomedcentral.com/1472-6963/11/317

Table 2 Total direct costs of operative and conservative treatment of a torn ACL

	Resource	amount	costs (USD)	costs per unit (USD)
Surgical treatment	Outpatient visit (15 min)	5(2-6)	718	144
	Xray (Knee, 3 views)	1(2-3)	128	128
	MRI	1	419	419
	In-hospital stay and OR	4.8 days	7391	7391
	Medication ambulant			
	low molecular heparin	16 days 1/day	150	9
	analgesic agents	16 days, 3/day	157	3
	Physiotherapy units	14 (9-27)	672	42
	Orthesis	1	291	291
	Total		**9926**	
Conservative treatment	Outpatient visit (15 min)	3(2-10)	431	144
	X-ray (Knee, 3 views)	1(1-2)	128	128
	MRI	1	419	419
	Medication			
	low molecular heparin	21 days, 1/day	197	9
	analgesic agents	21 days, 3/day	205	3
	Physiotherapy units	18 (9-27)	864	42
	Orthesis	1	291	291
	total		**2535**	

RESEARCH ARTICLE Open Access

Reconstruction versus conservative treatment after rupture of the anterior cruciate ligament: cost effectiveness analysis

Farshad et al. BMC Health Services Research 2011, 11:317
http://www.biomedcentral.com/1472-6963/11/317

Table 3 Incremental cost effectiveness analysis for reconstructive therapy of torn ACL

Strategy	Cost	Incremental Cost	Effect	Incremental Effect	Cost Effectiveness	Incremental Cost Effectiveness
Conservative	USD 15466		QALY 0,66		USD/QALY 23391	
Reconstruction	USD 16038	USD 572	QALY 0,78	QALY 0,12	USD/QALY 20612	**USD/QALY 4890**

Conclusion:

ACL reconstruction is cost effective. Our calculated incremental cost effectiveness of 4890 USD/QALY is in good agreement with the hitherto only available analysis performed by Gottlob et al (5857 USD/QALY). However, although the results of this study might contribute to informed decision making for health policymakers, the individual situation of the patient must be respected when suggesting one or the other strategy.

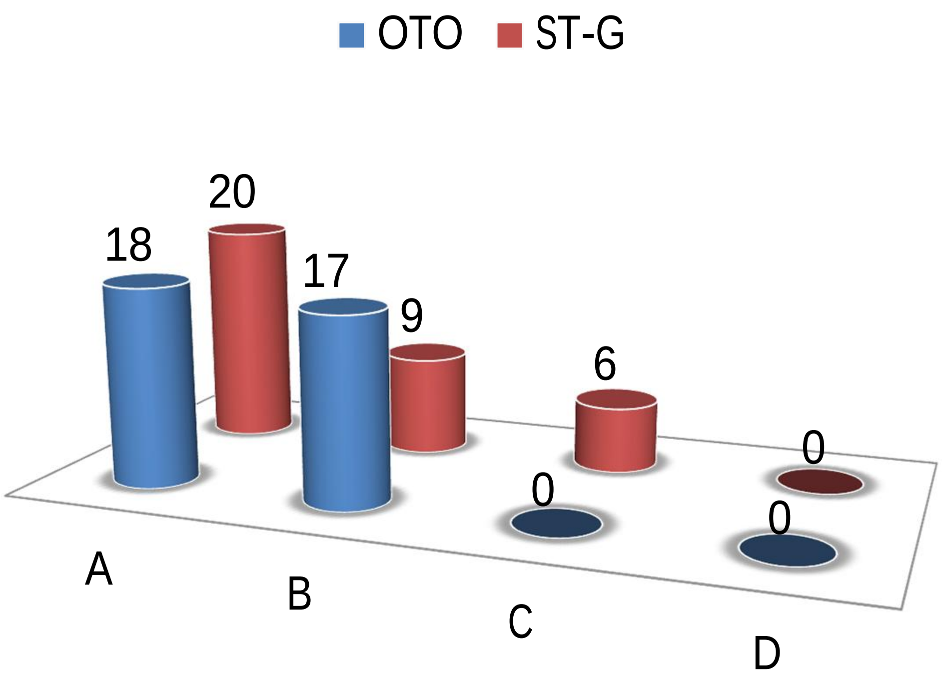
Que plastia ?

Tipo de plastia

- Semi-tendinoso – Gracilis
- Osso-tendão patelar-osso
- Osso tendão quadricipital

RESULTADOS: 2º ANO PÓS-OP.

IKDC



A	54,3%
B	37,1%
C	8,6%
D	0%

IKDC	OTO	STG	*p*	Teste
B	17 (48,6%)	9 (25,7%)	**0,006**	Fisher
C	0 (0%)	6 (17,1%)		

CONCLUSÕES

► Tanto a técnica OTO como a ST-G são óptimas escolhas para a ligamentoplastia do LCA.

► Ambas permitem, ao fim de 2 anos, uma boa estabilidade e excelentes resultados funcionais, sem diferenças estatisticamente significativas entre elas, com excepção da dor anterior no joelho, mais frequente na técnica OTO.

► Não existe uma solução única e universal para todos os doentes.

A recomendação de Goldblatt (2005), é pertinente...

“The choice of graft by the patient and surgeon must be individualized...”

MEDICA - a Journal of Clinical Medicine
ORIGINAL PAPERS

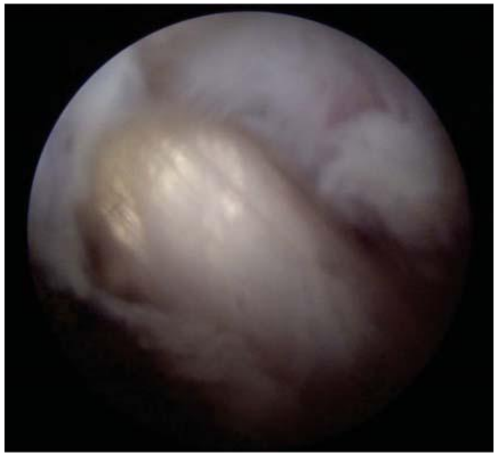
The Advantage of Arthroscopic Anterior Cruciate Ligament Reconstruction with Autograft from the Tendons of the Semitendinosus – Gracilis Muscles for the Recovery of the Stability of the Knee

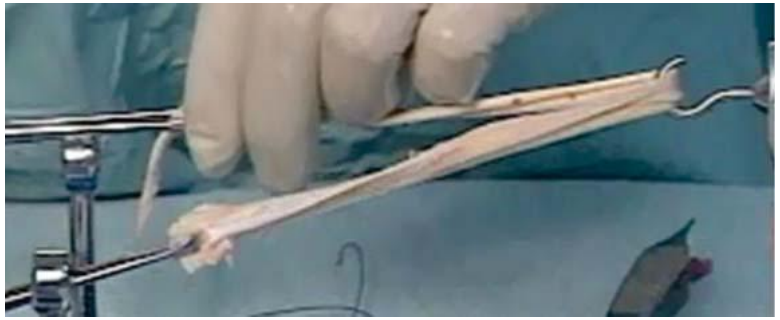
Catalin CIRSTOIU, MD, PhD; Gheorghe CIRCOTA, MD;
Corina PANAITESCU, MD; Radu NICULAITA, MD
Clinic of Orthopedics and Traumatology I, University Emergency Hospital of Bucharest

MAEDICA | A Journal of Clinical Medicine, Volume 6 No.2 2011

CONCLUSION

Arthroscopic ACL reconstruction with autograft from the semitendinosus and gracilis muscles provides early recovery with minimum postinterventional pain, increased mobility of the knee as early as the first two weeks postoperatively and significant decrease of the hospitalization duration and costs.





J Orthopaed Traumatol (2010) 11:211–219
DOI 10.1007/s10195-010-0124-9

REVIEW

Graft selection in arthroscopic anterior cruciate ligament reconstruction

Emilio Romanini · Franca D'Angelo · Salvatore De Masi · Ezio Adriani · Massimiliano Magaletti · Eleonora Lacorte · Paola Laricchiuta · Luciano Sagliocca · Cristina Morciano · Alfonso Mele

Table 1 Key questions, selected studies and recommendations on use of autograft in arthroscopic ACL reconstruction

Key questions	Studies	Recommendations
Is use of autograft effective in patients with anterior cruciate ligament injury (with or without meniscal lesions and/or grade I/II focal chondral lesions) and a shared indication to arthroscopic reconstruction?	407 identified, 26 selected, 19 rated, 19 included	*Clinical practice* Evidence is currently not sufficient to absolutely recommend use of one of the treated autograft techniques. Higher stability subsequent to use of patellar tendon is proven, while use of hamstring is suggested in patients needing, for various reasons, to stay on their knees for long periods of time, and who therefore need a substantial reduction of intensity and length of pain
Is use of autograft safe in patients with anterior cruciate ligament injury (with or without meniscal lesions and/or grade I/II focal chondral lesions) and a shared indication to arthroscopic reconstruction?	48 identified, 5 selected, 5 rated, 5 included	*Research* The methodological quality of the studies investigating the different autograft techniques is not very high. Randomized studies are therefore needed, with good statistical power, adequate blinding procedures in the choice of outcomes and a standardized definition of interventions and outcomes Qualitative studies are also needed, aimed at investigating patients' (and clinicians') preferences in relation to the relevance of the considered outcomes Further studies are finally recommended, aimed at testing the effectiveness of autograft with hamstring associated to extra-articular surgery to contain laxity

Graft selection in arthroscopic anterior cruciate ligament reconstruction

Emilio Romanini · Franca D'Angelo · Salvatore De Masi · Ezio Adriani · Massimiliano Magaletti · Eleonora Lacorte · Paola Laricchiuta · Luciano Saglioca · Cristina Morciano · Alfonso Mele

Table 2 Key questions, selected studies and recommendations on use of allograft in arthroscopic anterior cruciate ligament reconstruction

Key questions	Studies	Recommendations
Is use of allograft effective in patients with anterior cruciate ligament injury (with or without meniscal lesions and/or grade I/II focal chondral lesions) and a shared indication to arthroscopic reconstruction?	407 identified, 3 selected, 2 rated, 2 included	*Clinical practice* Use of autograft is recommended in anterior cruciate ligament reconstruction. Use of allograft shows, in fact, higher failure rate and slightly increased risk of infective complications
Is use of allograft safe in patients with anterior cruciate ligament injury (with or without meniscal lesions and/or grade I/II focal chondral lesions) and a shared indication to arthroscopic reconstruction?	48 identified, 3 selected, 2 rated, 2 included	*Research* Randomized studies are recommended, comparing the best techniques concerning the two types of graft (autograft and allograft) and providing information on the contextual (organizational, structural, cultural) determinants of effectiveness for each intervention

Table 3 Key questions, selected studies and recommendations on use of synthetic grafts in arthroscopic anterior cruciate ligament reconstruction

Key questions	Studies	Recommendations
Is use of synthetic grafts effective in patients with anterior cruciate ligament injury (with or without meniscal lesions and/or grade I/II focal chondral lesions) and a shared indication to arthroscopic reconstruction?	235 identified, 3 selected, 2 rated, 2 included	*Clinical practice* Lack of evidence does not allow recommendation of use of synthetic graft for anterior cruciate ligament reconstruction. The little available evidence suggests possible future development of use of such materials, but further studies are needed to assess their effectiveness
Is use of synthetic grafts safe in patients with anterior cruciate ligament injury (with or without meniscal lesions and/or grade I/II focal chondral lesions) and a shared indication to arthroscopic reconstruction?	48 identified, 0 selected, 0 rated, 0 included	*Research* Randomized studies are recommended, aimed at comparing use of synthetic grafts and the best available techniques of autograft and allograft for anterior cruciate ligament reconstruction Studies aimed at identifying synthetic materials and the most appropriate methodologies for their use are also recommended

Graft selection in arthroscopic anterior cruciate ligament reconstruction

Emilio Romanini · Franca D'Angelo · Salvatore De Masi · Ezio Adriani · Massimiliano Magaletti · Eleonora Lacorte · Paola Laricchiuta · Luciano Sagliocca · Cristina Morciano · Alfonso Mele

Conclusion:

Available evidence allows recommendation of *use of autograft over allograft in arthroscopic ACL reconstruction* and to recognize, for autograft, *better performance of PT over HS*. It is therefore appropriate to select one of these two main choices (PT and HS), assessing the indication on a case by case basis. It is also appropriate to consider *allograft and artificial ligaments only in very selected cases*, discouraging widespread use, given the potential risks and paucity of well performed, well-designed clinical studies. The indications for further research are also clear. *Consolidation of the experience in use of two- and four-strand HS and in using specific techniques to contain laxity is suggested*. Further investigations are also strongly suggested on use of synthetic grafts in studies comparing their effectiveness versus autograft.

Table 4 Comparison of allograft versus autograft

Outcome	Relevance[a]	Effectiveness rate	Quality of evidence[b]	Risk–benefit
Return to pre-injury activity	8.3-Critical	OR 1.2 (0.7–2.0) *favouring autograft*	+	Slight increase of infective complications in allograft
Graft rupture	8-Critical	OR 5.0 (1.4–18.3) *favouring autograft*	++	
IKDC score	7.7-Critical	OR 1.5 (0.2–10.4) *favouring autograft*	–	The sterilization procedures risk affecting the effectiveness of allograft
Lachman test	5.8-Important	OR 2.7 (0.7–10.8) *favouring autograft*	+	
Pivot shift test	5.8-Important	OR 1.2 (0.5–3.0) *favouring autograft*	+	
Hop test	5-Important	OR 5.7 (3.1–10.4) *favouring autograft*	+	

GRADE method

[a] 1–3 = unimportant; 4–6 = important; 7–9 = critical

[b] High = ++++; moderate = +++; low = ++; very low = +

FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

THE COCHRANE LIBRARY
Independent high-quality evidence for health care decision making

OTO vs ST-G

Objectives

This review compared the outcomes of ACL reconstruction using PT versus HT autografts in ACL deficient patients.

Search strategy

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (April 2008), the Cochrane Central Register of Controlled Trials (2008, Issue 2), MEDLINE (1966 to April 10 2008), EMBASE (1980 to April 10 2008), conference proceedings and reference lists. No language restrictions were applied.

Selection criteria

Randomized and quasi-randomized controlled trials comparing outcomes (minimum two year follow-up) following ACL reconstruction using either PT or HT autografts in skeletally mature adults, irrespective of the number of bundles, fixation method or incision technique.

Data collection and analysis

After independent study selection, the four authors independently assessed trial quality and risk of bias, and extracted data using pre-developed forms. Trial authors were contacted for additional data and information. Risk ratios with 95% confidence intervals were calculated for dichotomous outcomes, and mean differences and 95% confidence intervals for continuous outcomes.

Main results

Nineteen trials providing outcome data for 1597 young to middle-aged adults were included. Many trials were at high risk of bias reflecting inadequate methods of randomization, lack of blinding and incomplete assessment of outcome.

Pooled data for primary outcomes, reported in a minority of trials, showed no statistically significant differences between the two graft choices for functional assessment (single leg hop test), return to activity, Tegner and Lysholm scores, and subjective measures of outcome. There were also no differences found between the two interventions for re-rupture or International Knee Documentation Committee scores. There were inadequate long-term results, such as to assess the development of osteoarthritis.

All tests (instrumental, Lachman, pivot shift) for static stability consistently showed that PT reconstruction resulted in a more statically stable knee compared with HT reconstruction. Conversely, patients experienced more anterior knee problems, especially with kneeling, after PT reconstruction. PT reconstructions resulted in a statistically significant loss of extension range of motion and a trend towards loss of knee extension strength. HT reconstructions demonstrated a trend towards loss of flexion range of motion and a statistically significant loss of knee flexion strength. The clinical importance of the above range of motion losses is unclear.

Authors' conclusions:

<u>There is insufficient evidence to draw conclusions on differences between the two grafts for long-term functional outcome. While PT reconstructions are more likely to result in statically stable knees, they are also associated with more anterior knee problems.</u>

Patellar tendon versus hamstring tendon autograft for anterior cruciate ligament rupture in adults Nicholas GH Mohtadi[2], Denise S Chan[1,*], Katie N Dainty[3], Daniel B Whelan[4]
DOI: 10.1002/14651858.CD005960.pub2-Cohcrane

HUC HOSPITAIS DA UNIVERSIDADE DE COIMBRA

Evidence-Based Orthopaedics | March 16, 2011

A Comparison of the Results of Anterior Cruciate Ligament Reconstruction Using Bioabsorbable Versus Metal Interference Screws: A Meta-Analysis

Christopher E. Emond, MD, Erik B. Woelber, BA, Shanu K. Kurd, MD, MSCE, MHS, Michael G. Ciccotti, MD, Steven B. Cohen, MD

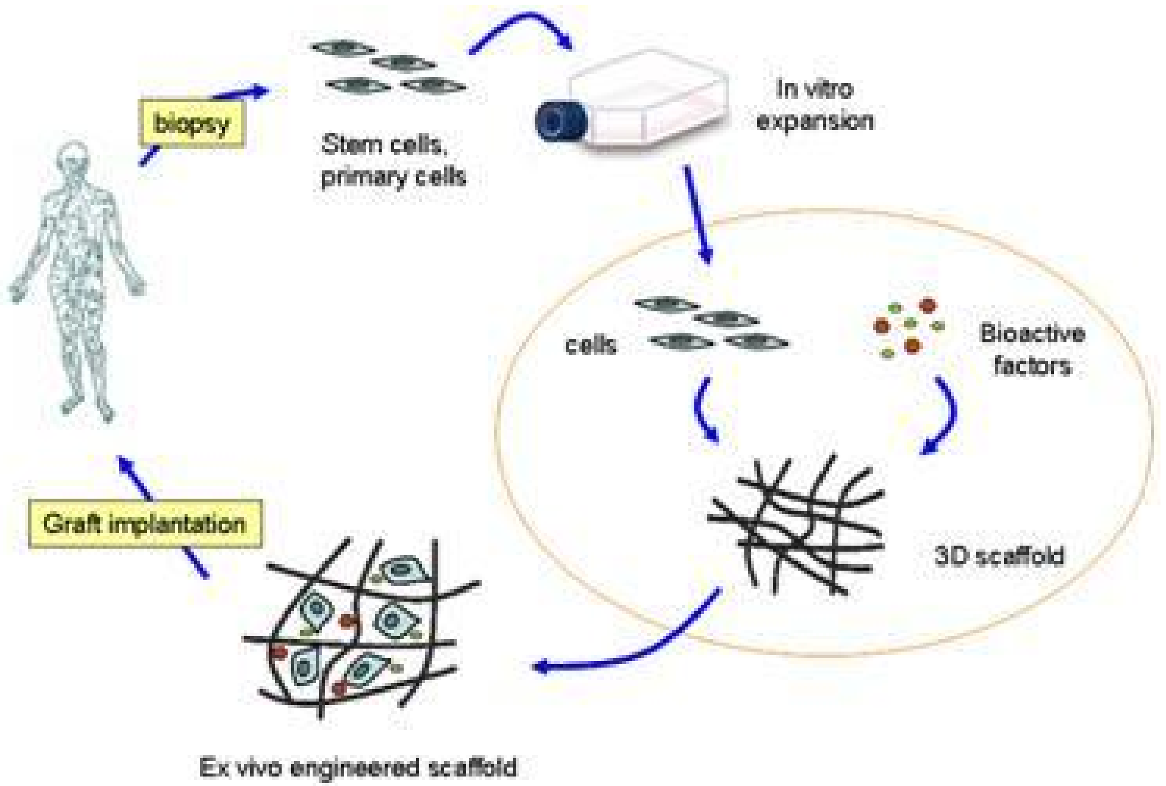
J. Bone Joint Surg. Am., Mar 2011; 93 (6); 572-580. doi: 10.2106/JBJS.J.00269

CONCLUSION:

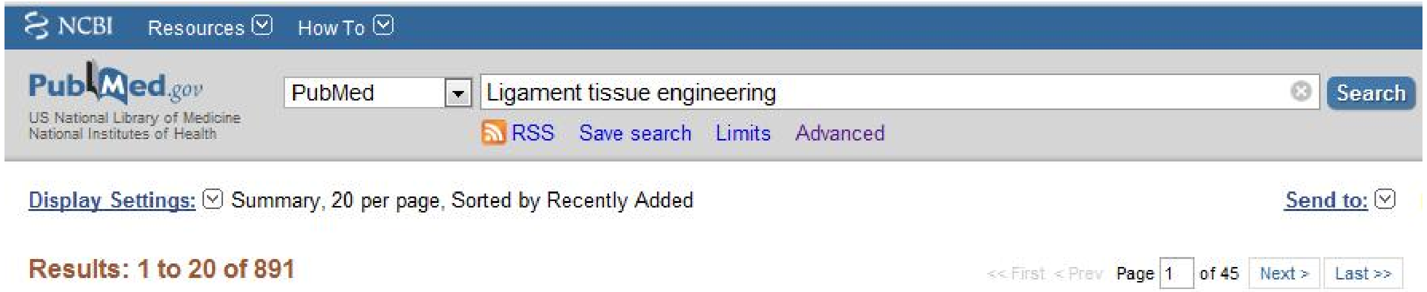
The clinical results associated with <u>bioabsorbable screws and metal screws are statistically similar.</u> Laxity evaluation demonstrated no significant differences between bioabsorbable screws and metal screws. The complication rates associated with bioabsorbable screws and metal screws were also similar.

The results of this meta-analysis support the hypothesis that <u>there are no significant differences in the outcomes associated with bioabsorbable screws as compared with metal screws for ACL reconstruction.</u>

Engenharia de tecidos



Engenharia de tecidos



Engenharia de tecidos

Available online at www.sciencedirect.com
SCIENCE DIRECT®

ELSEVIER

Biomaterials

Biomaterials 26 (2005) 7530–7536

www.elsevier.com/locate/biomaterials

Leading Opinion

Ligament tissue engineering: An evolutionary materials science approach ☆

Cato T. Laurencin*, Joseph W. Freeman

Department of Orthopaedic Surgery, University of Virginia, Charlottesville, VA 22903, USA

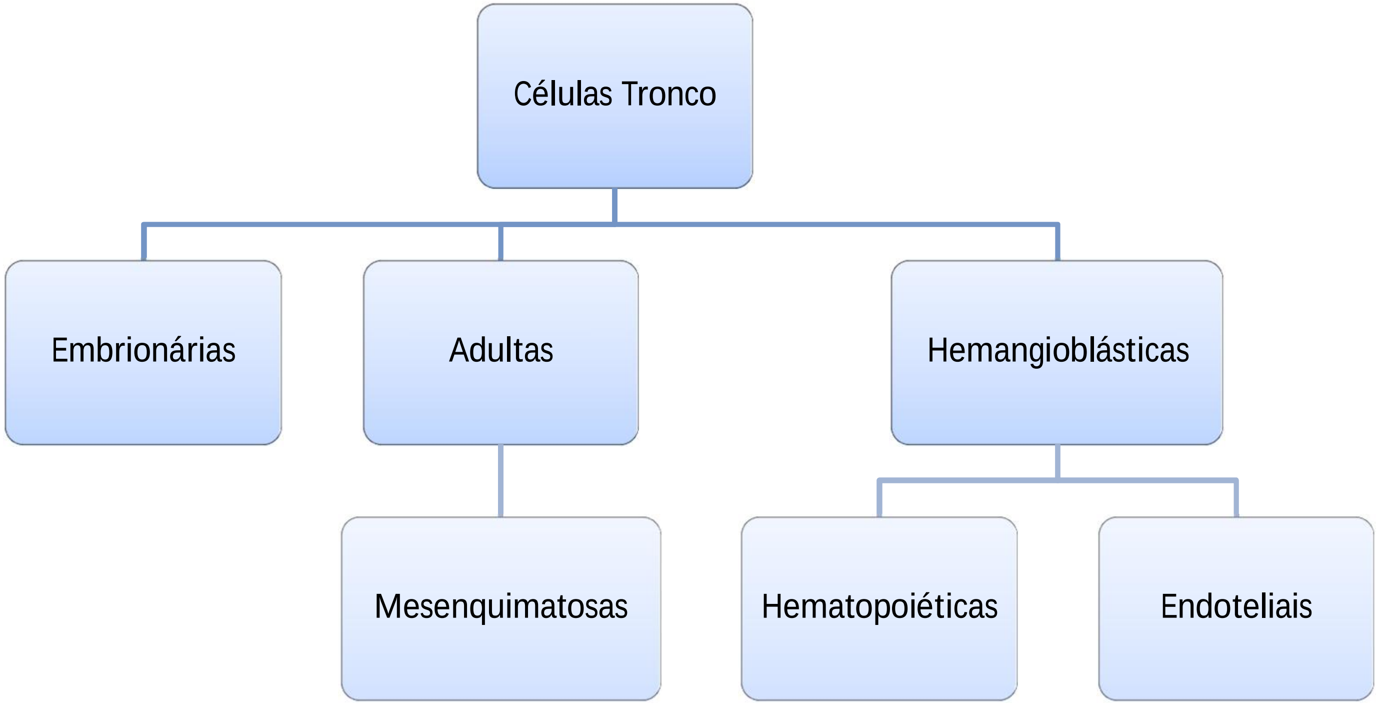
Received 5 April 2005; accepted 11 May 2005
Available online 19 July 2005

Abstract

The anterior cruciate ligament (ACL) is important for knee stabilization. Unfortunately, it is also the most commonly injured intra-articular ligament. Due to poor vascularization, the ACL has inferior healing capability and is usually replaced after significant damage has occurred. Currently available replacements have a host of limitations, this has prompted the search for tissue-engineered solutions for ACL repair. Presently investigated scaffolds range from twisted fiber architectures composed of silk fibers to complex three-dimensional braided structures composed of poly (L-lactic acid) fibers. The purpose of these tissue-engineered constructs is to apply approaches such as the use of porous scaffolds, use of cells, and the application of growth factors to promote ligament tissue regeneration while providing mechanical properties similar to natural ligament.

Keywords: Anterior cruciate ligament; Tissue engineering; Scaffold

Alguns aspectos



Alguns aspectos

- Celular
  - MSC (mesenchimal stem cell)
  - Fibroblastos
    - Factores de crescimento
- Matriz
  - Colagénio
  - Seda
  - Ácido poliláctico
  - .....
- Bioreactores

Aspectos recentes

- Leeds-Keio System90
- LARS - The Ligament Advanced Reinforcement System (Arc-sur-Tille, France)
  - Ligamento artificial constituído por fibras de tereftalato de polietileno (PET)
- Matriz (scaffold)

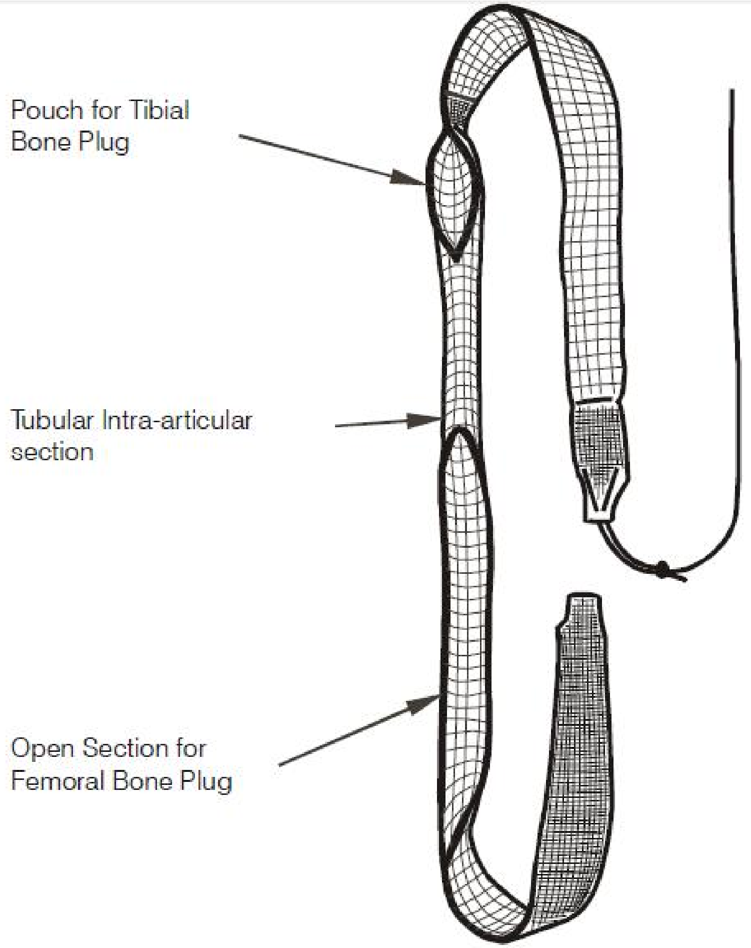


Figure 1

Matriz

Prosthesis	Advantages	Disadvantages
Carbon	Reduction and even distribution of stress between graft and soft tissue attachment Polylactic acid coat protects graft during implantation Encourages ingrowth of collagen into implant	Migration of carbon wear particles Unacceptable incidence of implant stretching and rupture led to poor long-term functional outcomes
Gore-Tex	Tensile strength 3X native human ACL	Progressive long-term loosening
Dacron	Polyester coating serves to protect implant from abrasion	Poor long-term stability
Leeds-Keio Artificial Ligament	Acts as a scaffold for soft tissue ingrowth Excellent max. tensile strength which exceeds that of native ACL	Acts as more of a load-bearing prosthesis, allowing for fibrous tissue ingrowth Large number of long-term graft ruptures
Kennedy Ligament Augmentation Device	Protects autogenous graft from excessive stresses	Weak implant-graft interface Propensity to cause intra-articular inflam. response and resulting synovitis and effusions
LARS Ligament	Mimics natural ACL structure and orientation Reduces shearing forces on the implant Porosity encourages tissue ingrowth	Residual post-operative laxity still present No long-term follow-up studies yet
Tissue-engineered Scaffolds	Duplicate mechanical & structural properties of native ACL Restoration of normal knee joint kinematics Implant can resemble normal ACL over time	Loses strength over time Allogenecity of collagen scaffolds can lead to rejection Consistent reprod. difficult due to batch-to-batch variability Collagen not as modifiable as biodegradable polymers

Table 1: Advantages and disadvantages of various prosthetic ACL grafts.

In Mascarenhas R, MacDonald; MJM 2008 11(1):29-37

FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

International Orthopaedics (SICOT) (2010) 34:465–471
DOI 10.1007/s00264-010-0963-2

REVIEW

Anterior cruciate ligament reconstruction with synthetic grafts. A review of literature

Claudio Legnani · Alberto Ventura · Clara Terzaghi · Enrico Borgo · Walter Albisetti

Abstract: Anterior cruciate ligament (ACL) rupture, one of the most common knee injuries in sports, results in anteroposterior laxity, which often leads to an unstable knee. Traditional ACL reconstruction is performed with autograft; disadvantages of this technique are donor site morbidity and a long rehabilitation period. In the 1980s, artificial ligaments became an attractive alternative to biological grafts. The initial enthusiasm surrounding their introduction stemmed from their lack of donor morbidity, their abundant supply and significant strength, immediate loading and reduced postoperative rehabilitation. Synthetic grafts made of different materials such as carbon fibers, polypropylene, Dacron and polyester have been utilised either as a prosthesis or as an augmentation for a biological ACL graft substitute. Nevertheless, every material presented serious drawbacks: cross-infections, immunological responses, breakage, debris dispersion leading to synovitis, chronic effusions, recurrent instability and knee osteoarthritis. Recently, a resurgence of interest in the use of synthetic prostheses has occurred and studies regarding new artificial grafts have been reported. Although many experimental studies have been made and much effort has been put forth, currently no ideal prosthesis mimicking natural human tissue has been found.

HUC
HOSPITAIS DA UNIVERSIDADE DE COIMBRA

International Orthopaedics (SICOT) (2010) 34:465–471
DOI 10.1007/s00264-010-0963-2

REVIEW

Anterior cruciate ligament reconstruction with synthetic grafts. A review of literature

Claudio Legnani · Alberto Ventura · Clara Terzaghi · Enrico Borgo · Walter Albisetti

Conclusion:

The study and analysis of failures in artificial ligament history has put the basis for future research and studies on finding a synthetic substitute with the best physical and chemical properties. Research in the field of artificial ligaments demonstrates that the ultimate characteristic required for these materials is biocompatibility (chemical stability, degree of polymerization, absence of soluble additives, scarce water adsorption, presence of pores for fibroblasts ingrowth); on the other hand, mechanical characteristics (traction resistance, stiffness, elongation, torsion and abrasion resistance) should be as similar as possible to those of the natural ligament. In order to succeed, tissue engineering should provide a functional and biologically valid ACL, able to promote a continuous tissue remodelling. Despite much effort and many experimental studies, every material has been found to have several drawbacks, and research to find the ideal substitute, mimicking the natural human tissue, is still ongoing.

Table 1 Mechanical properties of synthetic grafts compared to natural ligaments

Properties	Natural ligament	Carbon fibre	Gore-Tex	Dacron	Kennedy-LAD	Trevira	Leeds-Keio
Ultimate tensile strength (N)	1730	660	5300	3631	1500	1866	2000
Stiffness (N/mm)	182	230×10^9	322	420	280	68.3	270

The Use of Long-term Bioresorbable Scaffolds for Anterior Cruciate Ligament Repair

Gregory H. Altman, PhD
Rebecca L. Horan, PhD
Paul Weitzel, MD
John C. Richmond, MD

Abstract

The absence of adequate options to restore full knee joint function through anterior cruciate ligament reconstruction prompts the need to develop new ligament replacement strategies. Recent focus within the ligament engineering field has been on the establishment of appropriate anterior cruciate ligament graft design requirements and evaluation methods. A range of biomaterials and graft constructions has been explored in an attempt to identify the optimal ligament replacement. Thorough and standardized evaluation methods are required throughout all phases of development, from initial in vitro bench screening through a large animal in vivo model. The initial positive clinical, gross pathologic, histologic, and mechanical results from a 12-month in vivo goat study demonstrate the potential of bioengineered ligament devices.

J Am Acad Orthop Surg 2008;16:177-187

Table 1

Ligament Engineering Data Published to Date, With Emphasis on Proposed Materials and the Stage of Testing

Study	Graft Material	Function	Research Stage
Meaney et al[1]	Collagen-glycosaminoglycan gel with a growth factor (TGF-β1, PDGF-AB, EGF, FGF-2)	Healing: bridge torn ends	In vitro
Murray et al[2]	Collagen-platelet-rich-plasma gel with thrombin	Healing: bridge torn ends	In vitro
Lu et al[3]	PGA, PLAGA, or PLLA 3D braided scaffolds with adsorbed fibronectin	Total ligament replacement	In vitro
Altman et al,[4] Noth et al,[5] Henshaw et al[6]	Collagen gel seeded with MSCs or ACL fibroblasts	TE ligament	In vitro
Cooper et al[7]	3D braided PLGA (10:90) scaffold	TE ligament scaffold	In vitro
Sahoo et al[8]	PLGA (10:90) knitted scaffold with PLGA (65:35) electrospun nanofibers on surface	TE ligament scaffold	In vitro
Majima et al[9]	Alginate-based chitosan hybrid polymer fibers	TE ligament scaffold	In vitro
Funakoshi et al[10]	Chitosan-based hyaluronan hybrid polymer fibers	TE ligament scaffold	In vitro
Cristino et al[11]	Multilayer knitted scaffold of HYAFF-11, a hyaluronic acid derivative fiber	TE ligament scaffold	In vitro
Altman and colleagues,[4,12] Chen and colleagues,[13,17] Horan and colleagues,[14,15] Moreau et al[16]	*Bombyx mori* silk yarns: RGD modified, with or without mechanical or chemical stimuli	TE ligament, scaffold, total ligament replacement	In vitro
Gentleman et al[18]	Cross-linked bovine collagen fibers in a collagen gel	TE ligament, scaffold	In vitro
Bourke et al[19]	Poly (desamino tyrosyl-tyrosine ethyl ester [DTE] carbonate)	Total ligament replacement	In vitro and in vivo subcutaneous
Laurencin et al,[20] Cooper et al[21]	Polylactide	Total ligament replacement	In vivo (rabbit ACL)
Murray et al[22]	Collagen sponge saturated with collagen-platelet-rich-plasma gel	Healing: bridge torn ends	In vivo: partial tear (canine), complete rupture (porcine)
Badylak et al[23]	Small intestine submucosa	Total ligament replacement	In vivo (goat)
Chvapil et al[24]	Collagen fibers	Total ligament replacement	In vivo (goat)
Horan et al[25]	SeriACL device, hydrophilic silk	Total ligament replacement	In vivo (goat)
Muren et al[26]	Kennedy LAD	Graft augmentation	Clinical
Fujikawa et al[27]	Leeds-Keio artificial ligament (polyester—requires autogenous tissue implant at surgery)	Total ligament replacement	Clinical (EU, Japan)
Barry et al[28]	ABC ligament prosthetic graft (Surgicraft, Worcestershire, England): 24 polyester and carbon fibers strands or 24 polyester strands	Total ligament replacement	Clinical (EU)
Trieb et al[29]	Ligament Augmentation and Reconstruction System (LARS) (LARS Ligaments, Dollard-des-Ormeaux, Quebec, Canada)	Total ligament replacement	Clinical (EU)
Tsukazaki et al[30]	Bio-Leeds Keio artificial ligament: polyester treated with radiofrequency-generated glow discharge	Total ligament replacement with cell recruitment	In vitro
Sugihara et al[31]	Bio-Leeds Keio artificial ligament: polyester treated with radiofrequency-generated glow discharge	Total ligament replacement with cell recruitment	Clinical

3D = three-dimensional, ACL = anterior cruciate ligament, EGF = epidermal growth factor, EU = European Union, FGF = fibroblast growth factor, LAD = ligament augmentation device, MSC = mesenchymal stem cell, PDGF = platelet-derived growth factor, PGA = polyglycolic acid, PLAGA = polylactic-co-glycolic acid, PLGA = poly (lactide-co-glycolide), PLLA = poly-L-lactic acid, RGD = arginine-glycine-aspartic acid, TE = tissue engineering, TGF = transforming growth factor

Table 2

Ligament Graft Characteristics by Material

	Manufacturing	
Bone Graft Material	Graft Structure	Bundle/Fiber Diameter
Collagen gel[1,2,5,6,22,41]	Gel	N/A
Collagen fiber[18,42]	Parallel fibers	125-μm fibers, 50 fibers per graft
PGA, PLAGA, PLLA[3,7,8,19-21,38,39]	Parallel fibers, knitted, braided, 3D circular and rectangular braids	15-90 μm, 2.8-mm rabbit graft, 7,200 fibers
Alginate-chitosan[9]	Fibers	0.1-mm fibers, 50 fibers per graft
Chitosan-hyaluronan[10]	Fibrous sheets	30-μm fibers
Hyaluronic acid[11]	Multilayer cylindrical knit	125-μm fibers, 5-mm graft
Bombyx mori silk, HS[25]	Knitted	350-μm bundles, 6-mm graft
Poly DTE[19]	Parallel fibers	60-80 μm, 2.5-mm rabbit graft
Polyester[27,30,31]	Fibers	Not specified
Polyethylenetetraphthalate[29]	Fibers, twisted	Not specified
Porcine patellar tendon[43]	Bone–patellar tendon–bone xenograft	10 mm

3D = three-dimensional, DTE = desamino tyrosyl-tyrosine ethyl ester, HS = hydrophilic silk, N/A = not applicable, PGA = polyglycolic acid, PLAGA = polylactic-co-glycolic acid, PLLA = poly-L-lactic acid

Table 3

In Vitro Results of Ligament Engineering Materials

Base Graft Material	Tensile Testing	Viscoelastic Testing	Cyclic Fatigue	Cell Attachment and Migration	Mode of Bioresorption	Resorption Rate Available
Collagen gel[1,2,5,6,22,41]	X			X	Proteolytic	
Collagen fiber[18,42]	X	X		X	Proteolytic	
PGA, PLAGA, PLLA[3,7,8,19-21,38,39]	X	X		X	Hydrolytic	X
Alginate-chitosan[9]	X			X		
Chitosan-hyaluronan[10]	X			X		X
Hyularonic acid[11]				X		
Bombyx mori silk, HS[25]	X		X	X	Proteolytic	X
Poly DTE[19]	X			X	Hydrolytic	X
Polyester[27,30,31]	X			X	N/A	
Polyethylenetetraphthalate[29]	X			X	N/A	
Porcine patellar tendon[43]					N/A	

DTE = desamino tyrosyl-tyrosine ethyl ester, HS = hydrophilic silk, N/A = not applicable, PGA = polyglycolic acid, PLAGA = polylactic-co-glycolic acid, PLLA = poly-L-lactic acid

Table 4

In Vivo Results of Ligament Engineering Materials*

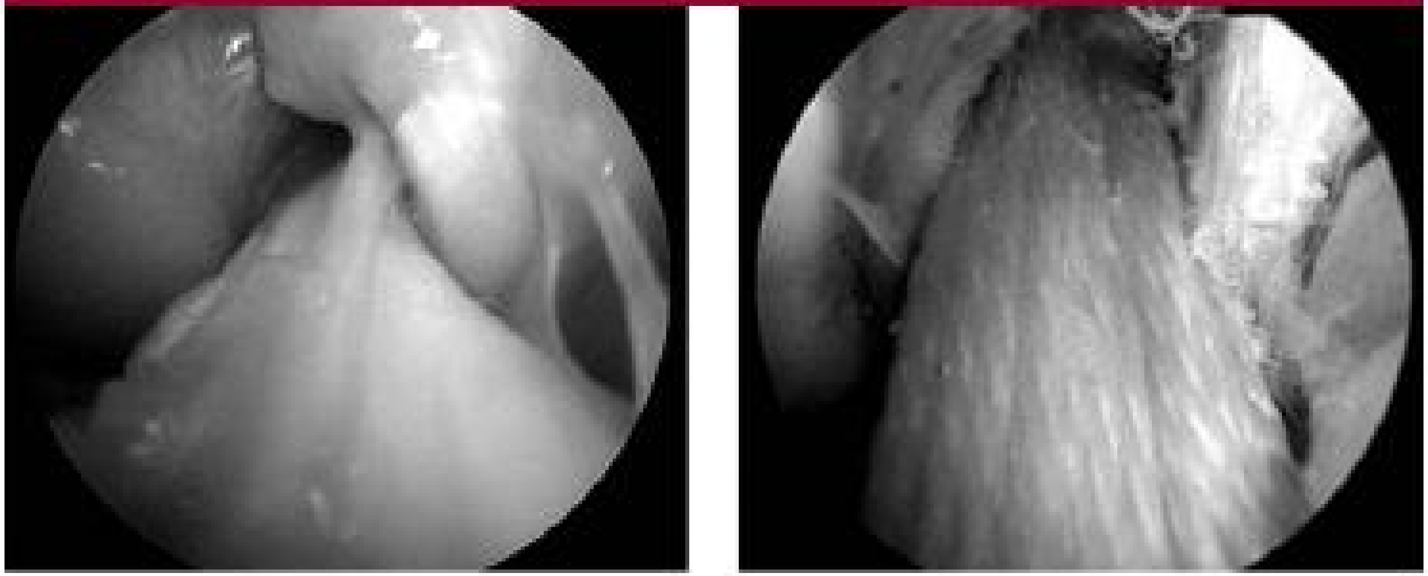
		Intra-articular Model		
Base Graft Material	Biocompatibility	Mechanics	Histology	Human Data Available
Collagen gel[1,2,5,6,22,41]		6 wks (canine[†]), 4 wks (porcine)	6 wks (canine[†]), 4 wks (porcine)	
Collagen fiber[18,42]		Goat, rabbit, dog	Goat, rabbit, dog	
PGA, PLAGA, PLLA[3,7,8,19-21,38,39]	Rat subcutaneous environment	4, 12, and 20 wks (rabbit), 48 wks (sheep)	4, 12, and 20 wks (rabbit), 48 wks (sheep)	
Bombyx mori silk, HS[25]		3, 6, and 12 mos (goat)	3, 6, and 12 mos (goat)	
Poly DTE[19]	Rat subcutaneous environment			
Polyester[27,30,31]			36 wks	European Union, Japan
Polyethylenetetraphthalate[29]				European Union
Porcine patellar tendon[43]				United States

*Alginate-chitosan, chitosan-hyaluronan, and hyaluronic acid are not included in this table because the cited studies[9-11] were not in vivo studies.

[†]40% transected

DTE = desamino tyrosyl-tyrosine ethyl ester, HS = hydrophilic silk, PGA = polyglycolic acid, PLAGA = polylactic-co-glycolic acid, PLLA = poly-L-lactic acid

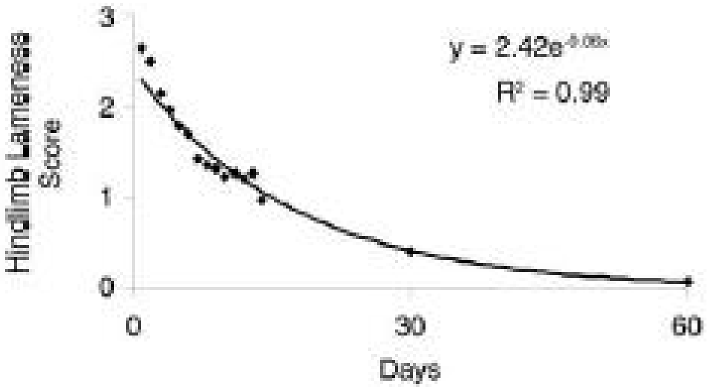
Figure 1



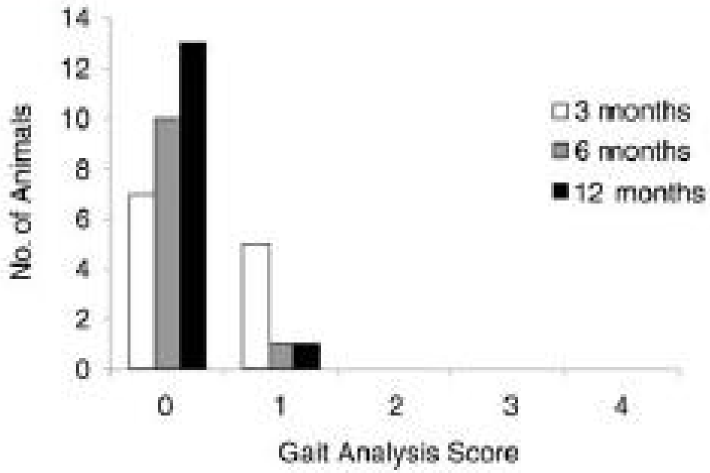
A B

Intraoperative arthroscopic images in the intra-articular space of the native goat anterior cruciate ligament **(A)** and implanted SeriACL (Serica Technologies, Inc) **(B)**. (Panel B reproduced with permission from Horan RL, Richmond J, Weitzel P, et al: Clinical, mechanical, and histopathological evaluation of a bioengineered long-term bioresorbable silk fibroin graft in a one year goat study for development of a functional autologous anterior cruciate ligament. *Am J Sports Med* 2008, in press.)

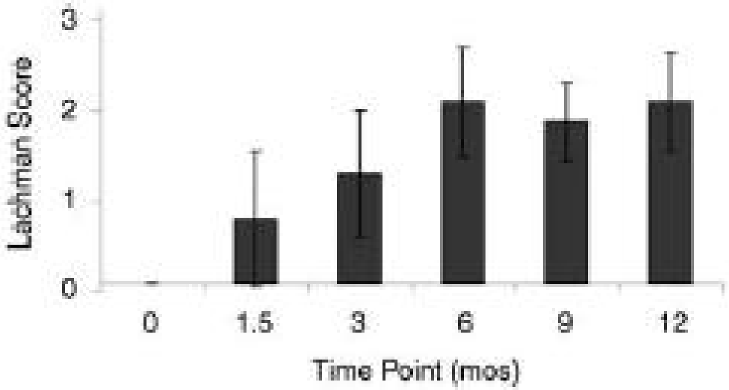
Figure 2



A



B



C

Results of postoperative clinical evaluations of the operated knee in goats implanted with engineered ACL graft material. The authors measured hindlimb lameness in the immediate postoperative period **(A)**, and performed long-term gait analysis **(B)** and Lachman analysis (range, 0 to 3) **(C)** over time. (Panel B reproduced with permission from Horan RL, Richmond J, Weitzel P, et al: Clinical, mechanical, and histopathological evaluation of a bioengineered long-term bioresorbable silk fibroin graft in a one year goat study for development of a functional autologous anterior cruciate ligament. *Am J Sports Med* 2008, in press.)

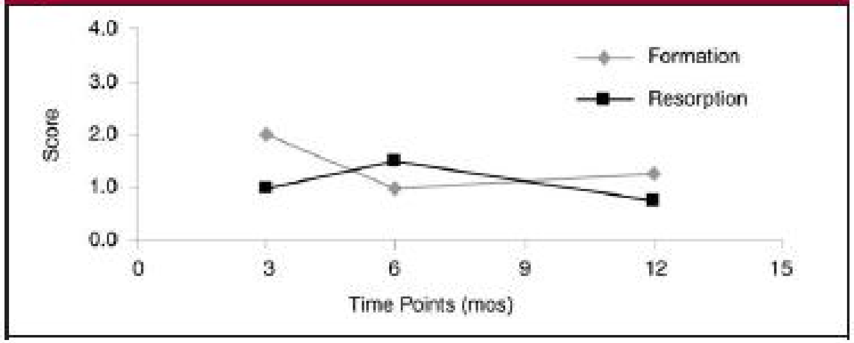
Table 5

Average Flexion and Extension of the Control Knee and the Operated Knee in Goats Implanted with SeriACL Synthetic ACL Graft

	Left (Native ACL)		Right (SeriACL)	
Time Point (mos)	Flexion (degrees)	Extension (degrees)	Flexion (degrees)	Extension (degrees)
3	141 ± 5	34 ± 4	140 ± 3	32 ± 7
6	149 ± 4	30 ± 0	143 ± 3	30 ± 2
12	145 ± 3	29 ± 2	143 ± 3	28 ± 3

ACL = anterior cruciate ligament

Figure 5



Qualitative histopathology scores indicating active modeling of tibia bone tunnels in goats treated with SeriACL graft material. (Reproduced with permission from Horan

Conclusion:

The focus of <u>ligament engineering</u> has tended toward fibrous scaffolds, with much discussion surrounding the optimal biomaterial and graft structure to meet the demanding requirements of ACL reconstruction. <u>The initial positive results of the goat study</u> highlighted here speak to the potential of bioengineered ligament devices that attempt to address all design requirements outlined by the field. In our model, the natural long-term bioresorbable silk Seri-ACL graft served as a scaffold for infiltrating and remodeling tissue over time in a demanding knee joint model system. <u>Thorough and standardized methods of evaluation are required throughout all phases of development, from initial in vitro bench screening through a large animal in vivo model</u>. Despite difficulties of the goat model and the challenges of scaling up to human instrumentation and procedures, the utility of the preclinical model is clear and is a necessary step for <u>new graft design evaluation.</u>

International Orthopaedics (SICOT)
DOI 10.1007/s00264-011-1437-x

ORIGINAL PAPER

Anterior Cruciate Ligament deficiency leads to early instability of scaffold for cartilage regeneration: a controlled laboratory ex-vivo study

Turgay Efe · Alexander Füglein · Alan Getgood · Thomas J. Heyse · Susanne Fuchs-Winkelmann · Thilo Patzer · Bilal F. El-Zayat · Stefan Lakemeier · Markus D. Schofer

Table 1 Summary of gross stability of scaffolds after 2,000 motion cycles in each group with fixation procedures and integrity of the anterior cruciate ligament

Gross stability	ACL intact		ACL deficient	
	Type of fixation			
	Press-fit only	Press-fit+fibrin glue	Press-fit only	Press-fit+fibrin glue
Intact	9	10	0	6
Marginal	7	7	3	8
Partial	4	3	17	6

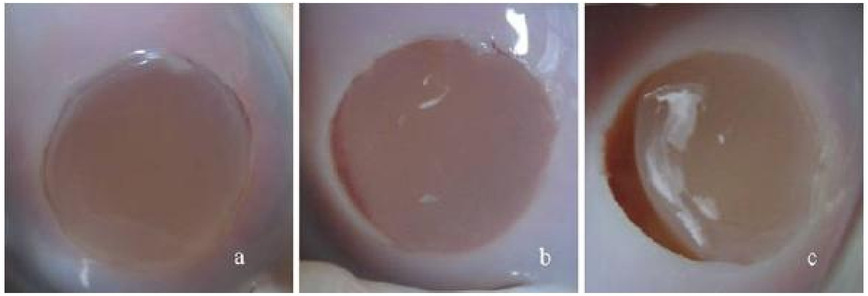


Fig. 3 Gross stability of the cell-free collagen type-I gel after 2,000 motion cycles graded as (**a**) intact, (**b**) marginally detached, and (**c**) partially detached

International Orthopaedics (SICOT)
DOI 10.1007/s00264-011-1437-x

ORIGINAL PAPER

Anterior Cruciate Ligament deficiency leads to early instability of scaffold for cartilage regeneration: a controlled laboratory ex-vivo study

Conclusion:

The study supports the importance of *an intact ACL if using tissue engineered scaffolds for cartilage repair*. Fibrin glue was shown to provide additional stability to the grafts compared to the press-fit technique in ACL deficient knees.

However, due to the limitations of this ex-vivo study, we would recommend that *tissue engineered scaffolds only be used in stable knee joints*.

Hindawi Publishing Corporation
Stem Cells International
Volume 2012, Article ID 438125, 6 pages
doi:10.1155/2012/438125

Review Article

Ligament Tissue Engineering and Its Potential Role in Anterior Cruciate Ligament Reconstruction

E. W. Yates,[1] A. Rupani,[2] G. T. Foley,[1] W. S. Khan,[3] S. Cartmell,[2] and S. J. Anand[1]

[1] *Department of Trauma and Orthopaedics, Stepping Hill Hospital, Stockport NHS Foundation Trust, Stockport, SK2 7JE, UK*
[2] *Materials Science Centre, University of Manchester, Oxford Road, Manchester, M13 9PT, UK*
[3] *Royal National Orthopaedic Hospital and Institute of Orthopaedics and Musculoskeletal Science, University College London, Stanmore, Middlesex, HA7 4LP, UK*

"Stem cells, growth factors, mechanical loading, biomimetic scaffolds, and gene therapy all play important roles in the quest to engineer the ideal ligament neotissue. Whilst repair and regeneration of ligament tissue has been demonstrated in animal studies, further research is needed to improve the biomechanical properties of the engineered ligament if it is to play an important part in the future of human ligament reconstruction surgery. Ultimately, randomised controlled trials on human populations will be required to demonstrate the clinical application of the engineered ligament. Furthermore, a cost-benefit analysis will be necessary to justify its use over conventional ACL reconstruction surgery."

Concentrado rico em plaquetas (PRP)

- Libertação de factores de crescimento:
  - *transforming growth factor-beta* (TGF-β)
  - *vascular endothelial growth factor* (VEGF)
  - *platelet derived growth factor* (PDGF)
  - começam inicialmente por libertar o conteúdo dos seus grânulos cerca de 10 minutos após a formação do coágulo
  - Num período de 1 hora libertam 95% dos factores de crescimento já sintetizados
  - Durante os restantes dias da sua vida, cerca de 7 a 10 dias, as plaquetas mantêm a síntese e libertação de mais factores de crescimento.

Concentrado rico em plaquetas (PRP)

– Estudos com nível de evidência I

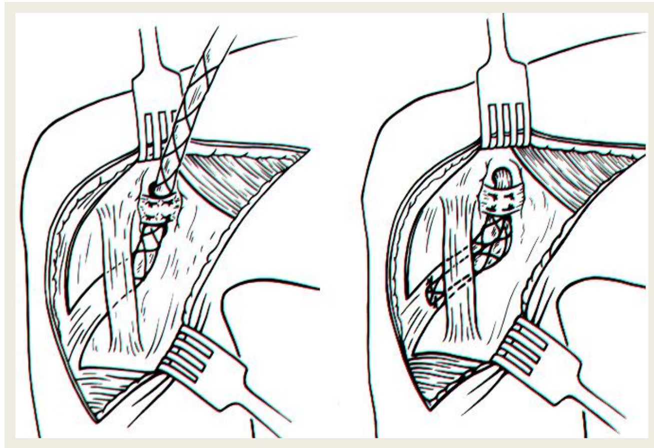
- De Vos (2010) e Shepull(2011)
  – Sem efeito na ruptura do tendão de aquiles

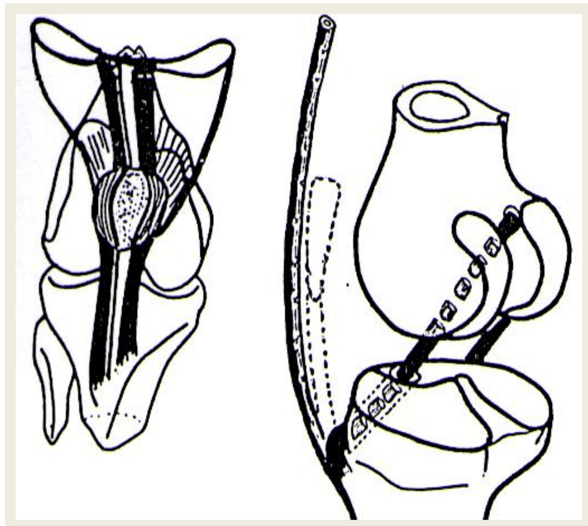
- Alcindo Silva (2009)
  – Sem efeito na reconstrução de LCA

Plastia extra-articular ?

Platia extra-articular

- Lemaire
- Müller
- Marshall-MacIntosh





■ ANNOTATION

Extra-articular techniques in anterior cruciate ligament reconstruction

A LITERATURE REVIEW

A. L. Dodds,
C. M. Gupte,
P. Neyret,
A. M. Williams,
A. A. Amis

J Bone Joint Surg Br
2011;93-B:1440–8.

This annotation considers the place of extra-articular reconstruction in the treatment of anterior cruciate ligament (ACL) deficiency. Extra-articular reconstruction has been employed over the last century to address ACL deficiency. However, the technique has not gained favour, primarily due to residual instability and the subsequent development of degenerative changes in the lateral compartment of the knee. Thus intra-articular reconstruction has become the technique of choice. However, intra-articular reconstruction does not restore normal knee kinematics. Some authors have recommended extra-articular reconstruction in conjunction with an intra-articular technique.

The anatomy and biomechanics of the anterolateral structures of the knee remain largely undetermined. Further studies to establish the structure and function of the anterolateral structures may lead to more anatomical extra-articular reconstruction techniques that supplement intra-articular reconstruction. This might reduce residual pivot shift after an intra-articular reconstruction and thus improve the post-operative kinematics of the knee.

Table I. Results of isolated extra articular anterior cruciate ligament reconstruction

Author/s	Operation	Technique	Number of patients	Follow-up period	Post-operative protocol	Scoring system used	Outcome
Amirault et al[70]	MacIntosh technique	MacIntosh technique	27	Mean 11.3 years (8 to 14.4)	Long-leg plaster for 5 weeks	Based on range of movement, arthritic change, anterior draw and pivot shift	52% good to excellent, 26% fair, 22% poor
Ireland and Trickey[82]	MacIntosh	MacIntosh	50	Mean 2.25 years	Non-weight-bearing in plaster for 6 weeks, no sport for 6 months	Clinical assessment	Abolished positive anterolateral jerk test in 42 out of 50 knees, 37 (74%) returned to active sport
Dandy[29]	MacIntosh (other techniques in same paper)	MacIntosh (as originally described)	18	Mean 69 months		Lysholm	77 at 6 years, pivot shift returned in 38% of patients
Taylor et al [91]	MacIntosh	MacIntosh lateral substitution 'over the top'	18 long term review	Mean 9.3 months	Plaster cylinder at 30° for 4 weeks, passive recovery of extension, return to sports 6 months	Cincinatti	Sustained benefit maintained up to 9 years post operation. Radiographs showed degenerative changes in most cases
Losee et al[24]	'Sling and reef' operation'	*See description in main text*	50	1 to 6.5 years	Seven weeks in padded cast (knee flexed and tibia in external rotation); long brace worn for further 3 months	Own criteria, based on stability, ability to work and arthrosis	Good in 41, Fair in 6, Poor in 3. 33 patients had anteromedial rotatory instability post-operation.
Ellison[83]	Distal ilio tibial band transfer	ITT released distally from Gerdy's tubercle, passed beneath fibular collateral ligament	18 (10 had previous surgery)	31 to 44 months	Long-leg cast for 6 weeks	Kennedy – excellent: no limitations, good: returned to sport with minor problems, poor: any other results	44% excellent results, 39% good results, 17% failures
Reid et al[31]	Ellison		32	11 years (7 to 15)		Lysholm	56% modified Lysholm less than 84. 75% positive pivot-shift test
Kennedy et al[30]	Ellison	Modification of MacIntosh/ Galway techniques	28 (13 had pes anserinus transfer)	6 months	Plaster cast at 70° flexion, 15° external rotation for 6 weeks. Resumption of activities when quads/hamstring at full strength		16 (57%) good or excellent results. 24 still had pivot-shift sign remaining. There may be 'specific indications' for the operation
Neyret et al[32]	Lemaire	*See description of Lemaire procedure in main text*	33 knees	Mean 4.5 years		Arpege score, subjective assessment, clinical assessment	Isolated extra-articular reconstruction not recommended; results better where pivot-shift was abolished
Lazzarone et al[92]	Lemaire						Success rate 80%

Table II. Results of combined extra- and intra-articular anterior cruciate ligament reconstruction

Author/s	Operation	Technique/Femoral attachment	Number of patients	Follow-up period	Post-operative protocol	Scoring system used	Outcome
Bertoia et al[70]	Macintosh lateral substitution over the top	Macintosh lateral substitution 'over the top'. Femoral attachment-posterior to proximal attachment of lateral collateral ligament	34	Mean 37 months (24 to 59)	Toe to groin plaster cast with knee in 70° flexion and full external rotation for 5 weeks. 9 to 12 months to full activity	Own results scoring system based on pain/swelling/level of physical activity	Excellent results in 23%, good in 68%, failed in 9%. 91% conversion to negative pivot-shift post-op.
Dandy[28]	Macintosh extraarticular with intra-articular patellar tendon or Leeds-Keio	Free graft from medial third of patellar tendon with Macintosh reinforcement	74/129			Lysholm	Concluded ACL reconstruction with patellar tendon and extra-articular Macintosh is a reliable technique for return to professional sport.
Dandy and Gray[71]	Leeds-Keio with Macintosh	Standard Macintosh	129	71	No post-op splintage, full extension not allowed for 6 weeks	Lysholm, Tegner	Results 'unsatisfactory' when compared with patellar tendon and Macintosh
Dejour et al[72]	Patellar tendon with Lemaire		251	Minimum 3 years			83% global functional result good or excellent, 8% fair, 9% poor. 24% equivocal pivot shifts
Dejour et al[73]	Patellar tendon with Lemaire		148	11.5 years (10 to 15)		Subjective, IKDC	Subjectively: 65% 'very satisfied', 24% satisfied; International Knee Documentation Committee (IKDC): A 22, B 49.
Edwards et al[74]	Semitendinosus intra-articular, ITT extra-articular	STT passed through femoral condyle at site of insertion of ACL. ITT passed superficial to lateral collateral, attached to femur at isometric point (Krackow)	84 knees	Mean 8 years (6.3 to 9.7)	Limited mobilisation in flexion (initially 45°) for 6 weeks	Lysholm: IKDC evaluation, Stability – KT1000 arthrometer	87% returned to sport. Lysholm: 91% excellent/good, 8% fair.
Johnston et al[75]	Macintosh lateral substitution over the top	*Strip of fascia lata – Macintosh*	84	Mean 9.8 years	Movement in brace 20° to 90° for 4 weeks, full weight-bearing after 9 weeks	Lysholm, radiological	Lysholm: 17 excellent, 35 good, 19 fair, 13 poor.
Marcacci et al[80]	Standard hamstring tendon with hamstring used extra-articular	See description in main text and diagram	54	5 years and 11 years	Partial weight-bearing after 2 weeks with range of movement to 120°, proprioceptive exercises at 4 weeks, running at 2 months, sports at 4 months	IKDC and Lysholm, Tegner	90.7% of patients good or excellent results at 11 years, ligament arthrometry using KT-2000 demonstrated only 2 patients had > 5 mm side to side difference in laxity. Mean Lysholm 97.3, joint space narrowing only in 20 with meniscal surgery
Moyen et al[76]	Marshall-MacIntosh technique versus same with addition of Kennedy ligament augmentation	Kennedy ligament augmentation – a ribbon of polypropylene as an augment	64 patients randomised	24 months	Continuous passive motion, initially, partial weight-bearing at 2 weeks, slow running at 6 months	Tegner, Lysholm, KT-1000	Addition of Kennedy augment provided no benefit
Pernin et al[78]	Bone-patellar-bone, Lemaire	Bone-tendon-bone graft as intra- articular with modified Lemaire procedure as extra-articular	148	24 years	Two different protocols, initial group in plaster	IKDC, Knee Injury and Osteoarthritis Outcome Score (KOOS), physical examination, radiographs	77% no pivot-shift, 17% moderate, 6% major.
Rackemann et al[77]	Combined	Middle third patella tendon with Macintosh extra-articular	74	70 months	Immobilised for 6 weeks	Lysholm, clinical assessment	Satisfactory in 93%, 0 positive pivot-shifts at 3 years, 1 at 6 years
Roth et al[69]	Extensor mechanism with biceps femoris advancement	Advancement of biceps femoris as extra-articular restraint	43 (50 as control group)	Mean 38 months (minimum 24 months)	Continuous immobilisation in cast for at least 6 weeks	KT 1000/clinical	No subjective, clinical objective or radiological improvement between two groups
Saragaglia et al[79]	Macintosh and Kennedy ligament augmentation device	Standard Macintosh	171 operations, 107 at medium follow up	4 and 8 years	Day 1 to 15 complete extension, 15 to 60 days rehabilitate flexion, rehab of quads from day 60	Stability, pain and functional scoring system.	Knees nearly normal in 72.9%

J Bone Joint Surg Br
2011;93-B:1440–8.

■ ANNOTATION

Extra-articular techniques in anterior cruciate ligament reconstruction

A LITERATURE REVIEW

A. L. Dodds,
C. M. Gupte,
P. Neyret,
A. M. Williams,
A. A. Amis

J Bone Joint Surg Br
2011;93-B:1440–8.

Conclusion

<u>Intra-articular ACL reconstruction is a popular and effective procedure.</u> However, attempts to improve its results and obtain a more kinematic restoration of function must address the <u>extra-articular structures that contribute to the pivot shift phenomenon.</u>

Further anatomical, biomechanical and radiological knowledge of these structures may help inform the development of <u>extra-articular "anatomical" augmentation of ACL reconstruction.</u> This may be a key factor in providing a more biomechanically faithful restoration of the knee

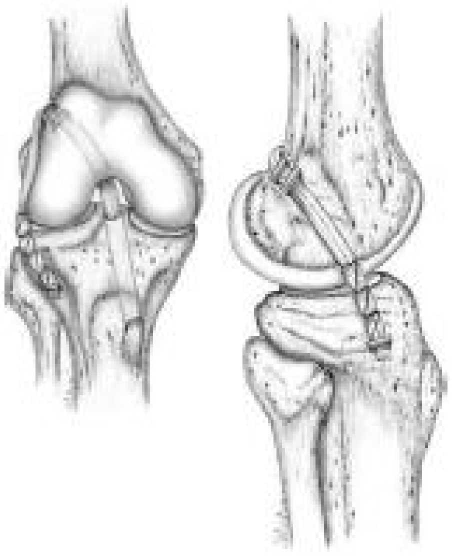
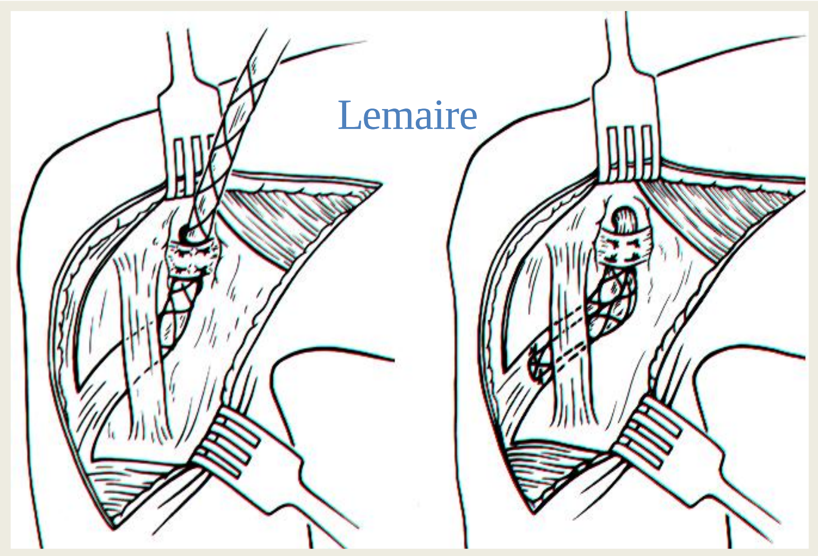
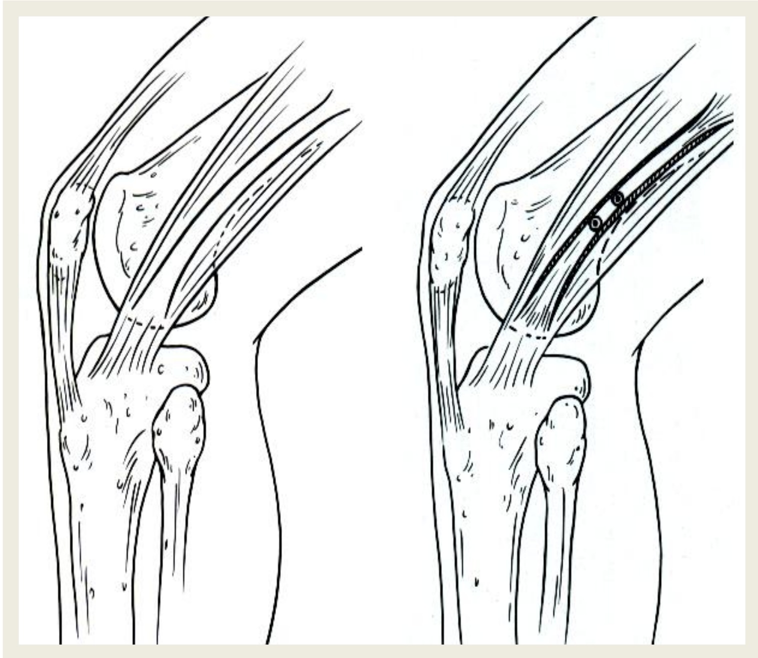


Fig. 5

Anteroposterior (left) and lateral (right) diagrams detailing the Marcacci repair.

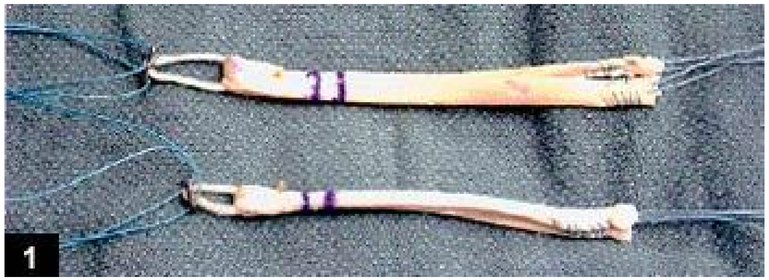
Plastias extra-articulares


Lemaire


Müller

Plastia

- Um feixe
- Dois feixes



THE JOURNAL OF BONE & JOINT SURGERY

■ KNEE: RESEARCH

The contribution of each anterior cruciate ligament bundle to the Lachman test

A CADAVER INVESTIGATION

P. S. Christel,
U. Akgun,
T. Yasar,
M. Karahan,
B. Demirel

J Bone Joint Surg Br
2012;94-B:68–74.
Received 5 January 2011;
Accepted after revision 21 September 2011

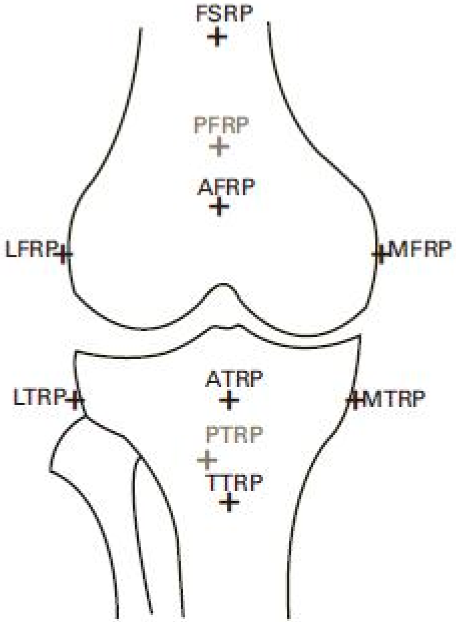


Fig. 1

Diagram showing the position of the cancellous screws that were used as reference points on the femur and tibia: FSRP, femoral shaft; PFRP, posterior femur; AFRP, anterior femur; LFRP, lateral femur; MFRP, medial femur; ATRP, anterior tibia; LTRP, lateral tibia; MTRP, medial tibia; PTRP, posterior tibia; TTRP, tibial tubercle.

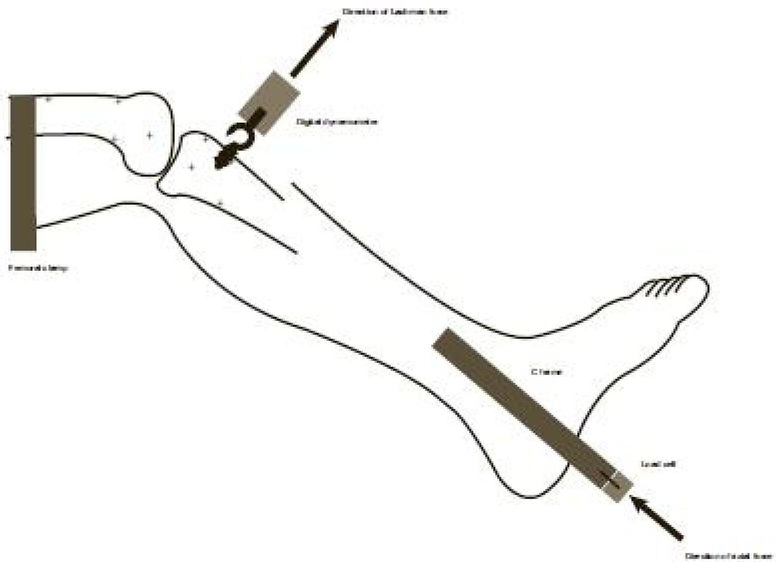


Fig. 2

Illustration of the experimental set-up for the simulated Lachman test with axial loading. A digital dynamometer attached to the metal hook was used to adjust the desired Lachman force. A load cell mounted under the C frame aligned with the tibial shaft was used to monitor the axial compression force.

FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

■ KNEE: RESEARCH

The contribution of each anterior cruciate ligament bundle to the Lachman test

A CADAVER INVESTIGATION

P. S. Christel,
U. Akgun,
T. Yasar,
M. Karahan,
B. Demirel

J Bone Joint Surg Br
2012;94-B:68–74.
Received 5 January 2011; Accepted after revision 21 September 2011

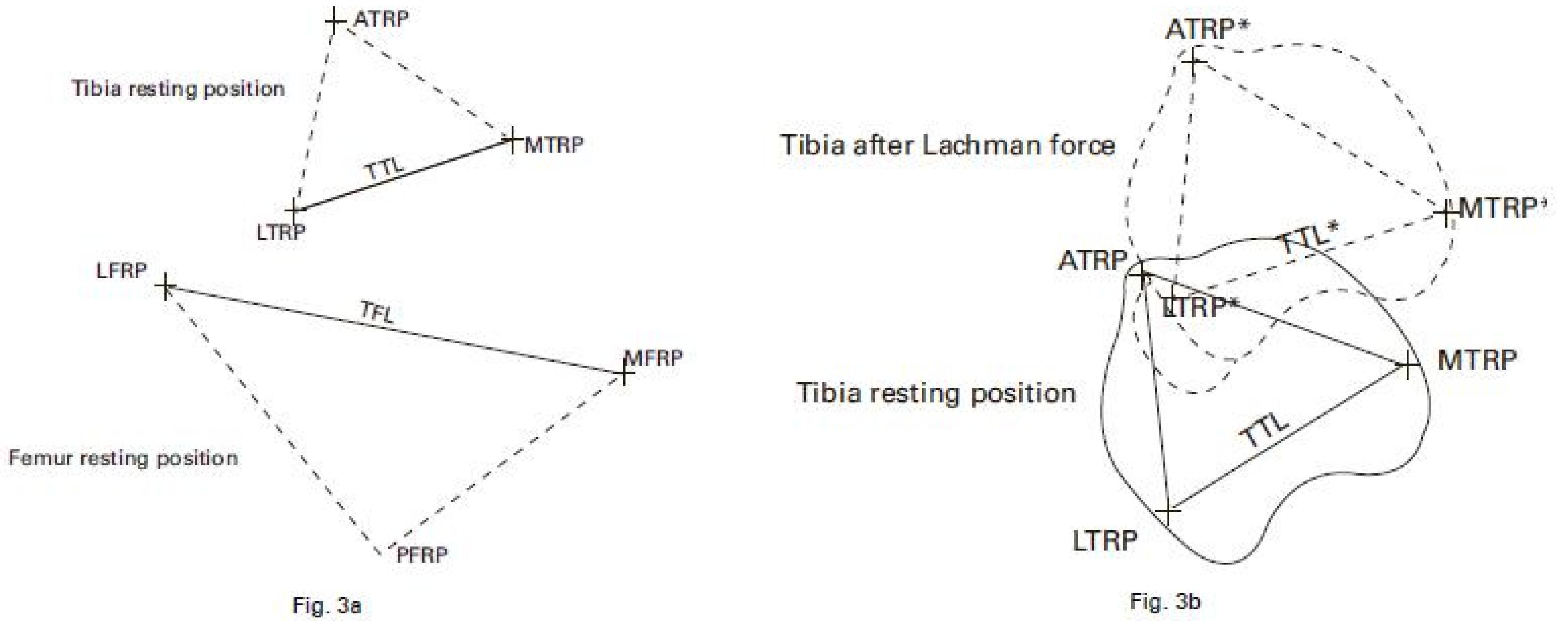


Figure 3a – axial image obtained from the MicroScribe G2X digitiser during full extension. The transverse femoral line (TFL) was drawn between the reference points on the medial (MFRP) and lateral femur (LFRP). The transverse tibial line (TTL) was drawn between the reference points on the medial (MTRP) and lateral tibia (LTRP). The angle between these lines was used to measure the 'resting angle of the tibia' (RAT) (ATRP, anterior tibia; PFRP, posterior femur). Figure 3b – axial images obtained from the MicroScribe G2X digitiser before and during the Lachman test. Dashed lines show the position of the tibia after applying the Lachman force (with asterisks denoting the new reference positions). The change in the measurements between MTRP and MTRP*, ATRP and ATRP* and LTRP and LTRP* defined tibial translation. The angle between TTL and TTL* was measured and described as 'absolute tibial rotation' (ATR) for the calculation of tibial rotation during the Lachman test.

HUC HOSPITAIS DA UNIVERSIDADE DE COIMBRA

THE JOURNAL OF BONE & JOINT SURGERY

■ KNEE: RESEARCH

The contribution of each anterior cruciate ligament bundle to the Lachman test

A CADAVER INVESTIGATION

P. S. Christel,
U. Akgun,
T. Yasar,
M. Karahan,
B. Demirel

J Bone Joint Surg Br
2012;94-B:68–74.
Received 5 January 2011; Accepted after revision 21 September 2011

Table I. Mean (SD) tibial displacement during the Lachman test for the intact anterior cruciate ligament (ACL) and after dividing the posterolateral bundle (PLB) with axial loading applied to the tibia (specimens 1, 3 and 5). In both situations the lateral tibial plateau and the anterior tibial tubercle translate more than the medial tibial plateau. The internal rotation of the tibia increases by a mean of 2° after dividing the PLB

Test condition	Medial tibial plateau (mm)	Anterior tibial tubercle (mm)	Lateral tibial plateau (mm)	ΔRot (°)
Intact ACL	13.5 (6.0)	17.4 (5.3)	20 (4.2)	9.3 (1.7)
PLB divided	11 (2.9)	19.3 (4.6)	20.1 (6.6)	11.3 (7.9)
Variation PLB divided – ACL intact	-2.5	1.4	0.1	2

Table II. Mean (SD) tibial displacement during the Lachman test for the intact anterior cruciate ligament (ACL) and after dividing the anteromedial bundle (AMB) with axial loading applied to the tibia (specimens 2, 4 and 6). In both situations the lateral tibial plateau and the anterior tibial tubercle translate more than the medial tibial plateau. Only the tibial translation is increased after dividing the AMB. There is no effect on the tibial rotation

Test condition	Medial tibial plateau (mm)	Anterior tibial tubercle (mm)	Lateral tibial plateau (mm)	ΔRot (°)
Intact ACL	11.6 (3.2)	15.6 (4.3)	15.8 (3.7)	5.9 (2.1)
AMB divided	24.6 (8.7)	29 (9)	31.1 (9.8)	6.0 (4.2)
Variation AMB divided – ACL intact	13	13.4	15.3	0.1

Table III. Mean (SD) tibial displacement during the Lachman test for the intact anterior cruciate ligament (ACL) and after dividing both bundles, with axial loading applied to the tibia (all six specimens). In both situations the lateral tibial plateau and the anterior tibial tubercle translate more than the medial tibial plateau. After complete division of the ACL there is a significantly increased translation of all measurement points. However, after division of the ACL tibial rotation does not significantly change

Test condition	Medial tibial plateau (mm)	Anterior tibial tubercle (mm)	Lateral tibial plateau (mm)	ΔRot (°)
Intact ACL	11.5 (3.9)	15.9 (4.6)	17 (4.1)	6.6 (2.3)
ACL divided	25.9 (10.7)	30.3 (10.3)	31.8 (10.7)	7.4 (3.2)
Variation divided – intact (axial load)	14.4	14.4	14.4	0.8

■ KNEE: RESEARCH

The contribution of each anterior cruciate ligament bundle to the Lachman test

A CADAVER INVESTIGATION

P. S. Christel,
U. Akgun,
T. Yasar,
M. Karahan,
B. Demirel

J Bone Joint Surg Br
2012;94-B:68–74.
Received 5 January 2011;
Accepted after revision 21
September 2011

Conclusion

During the Lachman test, in all knees and in all test conditions, lateral tibial translation exceeded that on the medial side. With an intact ACL, both anterior and lateral tibial landmarks translated significantly more than those on the medial side (p < 0.001). With sequential division of the ACL bundles, selective cutting of the posterolateral bundle (PLB) did not increase translation of any landmark compared with when the ACL remained intact. Cutting the anteromedial bundle (AMB) resulted in an increased anterior translation of all landmarks. Compared to the intact ACL, when the ACL was fully transected a significant increase in anterior translation of all landmarks occurred (p < 0.001). However, anterior tibial translation was almost identical after AMB or complete ACL division.

We found that the AMB confers its most significant contribution to tibial translation during the Lachman test, whereas the PLB has a negligible effect on anterior translation. Section of the PLB had a greater effect on increasing the internal rotation of the tibia than the AMB. However, its contribution of a mean of 2.8° amplitude remains low. The clinical relevance of our investigation suggests that, based on anterior tibial translation only, one cannot distinguish between a full ACL and an isolated AMB tear. Isolated PLB tears cannot be detected solely by the Lachman test, as this bundle probably contributes more resistance to the pivot shift

Meta-análise

Arthroscopy. 2011 Jun;27(6):849-60.

In vitro and intraoperative laxities after single-bundle and double-bundle anterior cruciate ligament reconstructions.

Gadikota HR, Seon JK, Chen CH, Wu JL, Gill TJ, Li G.

Bioengineering Laboratory, Department of Orthopaedic Surgery, Massachusetts General Hospital and Harvard Medical School, Boston, MA 02114, USA.

Abstract

PURPOSE: The purpose of this study was to objectively evaluate whether double-bundle anterior cruciate ligament (ACL) reconstruction can better restore the normal translational and rotational laxities than the conventional single-bundle ACL reconstruction among the reported biomechanical studies.

METHODS: A systematic literature search was conducted to identify in vitro and in vivo (intraoperative) biomechanical studies that compared the laxities (anterior or anteroposterior or rotational) between single- and double-bundle ACL reconstructions. Because of large variability among the loading conditions and testing methods used to determine the rotational laxities among the studies, a meta-analysis of rotational laxities was not feasible.

RESULTS: Seven in vitro and three in vivo studies were included in this analysis based on the predefined inclusion criteria. The overall mean differences calculated by the random effects model in anteroposterior laxity between the single-bundle and double-bundle ACL reconstruction techniques at 0°, 30°, 60°, and 90° of flexion were 0.99 mm, 0.38 mm, 0.34 mm, and 0.07 mm, respectively. No statistically significant difference was noted between the 2 treatments at all flexion angles. Among the 9 studies that compared the rotational laxity of single-bundle and double-bundle ACL reconstructions, 4 reported that double-bundle reconstruction can provide better rotational control than single-bundle reconstruction. The other 5 studies could not identify any significant difference between the 2 reconstructions in terms of rotational laxity.

CONCLUSIONS: Both single- and double-bundle treatment options for ACL injury result in similar anteroposterior knee joint laxity at time 0. No conclusive evidence on the superiority of 1 reconstruction technique over the other in terms of rotation laxity can be obtained because of several variations in the experimental protocol and the kinematics used to measure the rotational laxity among the studies.

LEVEL OF EVIDENCE: Level III, meta-analysis.

Original Article Clinics in Orthopedic Surgery 2011;3:285-294 • http://dx.doi.org/10.4055/cios.2011.3.4.285

Clinical Results of Technique for Double Bundle Anterior Cruciate Ligament Reconstruction Using Hybrid Femoral Fixation and Retroscrew

Doo-Sup Kim, MD, Chang-Ho Yi, MD, Hoi-Jung Chung, MD, Yeu-Seung Yoon, MD

Department of Orthopedic Surgery, Yonsei University Wonju College of Medicine, Wonju, Korea

- *Grafts are tibialis anterior tendon allograft for anteromedial bundle (AMB) and hamstring tendon autograft without detachment of the tibial insertion for posterolateral bundle (PLB). This technique creates 2 tunnels in both the femur and tibia.*

- *Femoral fixation was done by hybrid fixation using Endobutton and Rigidfix for AMB and by biointerference screw for PLB. Tibial fixations are done by Retroscrew for AMB and by native insertion of hamstring tendon for PLB. Both bundles are independently and differently tensioned.*

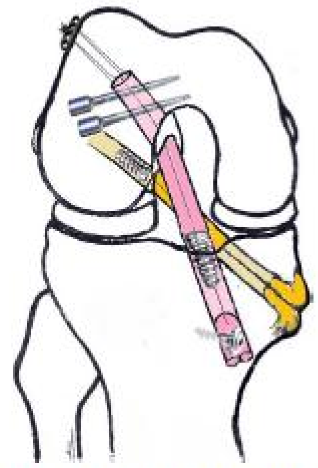


Fig. 4. Schematic view of double bundle reconstruction of anterior cruciate ligament with hybrid femoral fixation and Retroscrew.

Original Article Clinics in Orthopedic Surgery 2011;3:285-294 • http://dx.doi.org/10.4055/cios.2011.3.4.285

Clinical Results of Technique for Double Bundle Anterior Cruciate Ligament Reconstruction Using Hybrid Femoral Fixation and Retroscrew

Doo-Sup Kim, MD, Chang-Ho Yi, MD, Hoi-Jung Chung, MD, Yeu-Seung Yoon, MD

Department of Orthopedic Surgery, Yonsei University Wonju College of Medicine, Wonju, Korea

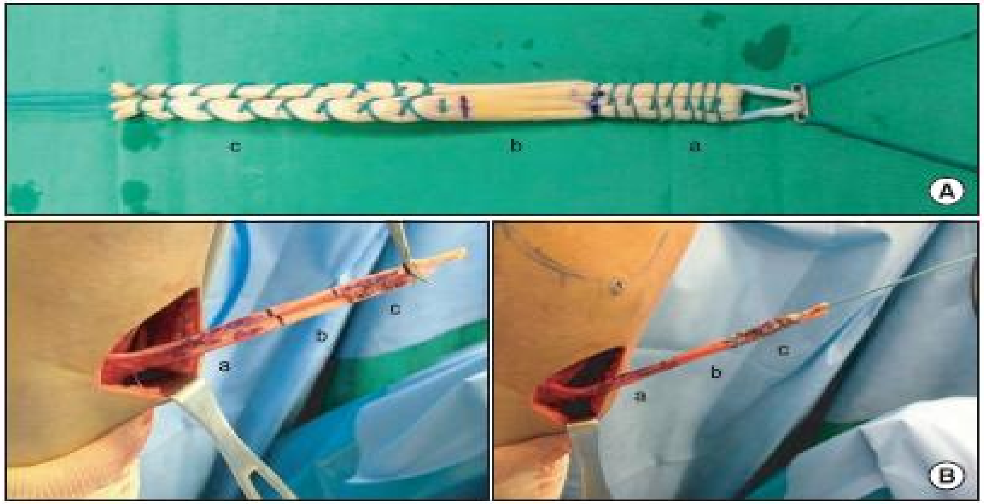


Fig. 1. (A) The tibialis allograft is prepared (a, 30 mm for the femoral tunnel; b, 30 mm for the intra-articular space; c, 40 mm for the tibial tunnel). Mersilene tape of the Endobutton is suspended at the looped portion of the allograft. Whipstitch sutures with No. 2 Ethibond are placed 3 cm below the suspended site. (B) Anterolateral view of the operative right knee: The hamstring tendon autograft was harvested and prepared. The gracillis and semi-tendinosus tendons are stripped from the femoral side without detachment of the tibial insertion site (left) (a, 40 mm for the tibial tunnel; b, 20 mm for the intra-articular space; c, 30 mm for the femoral tunnel). The portion for tibial tunnel of graft was prepared with Ethibond (right).

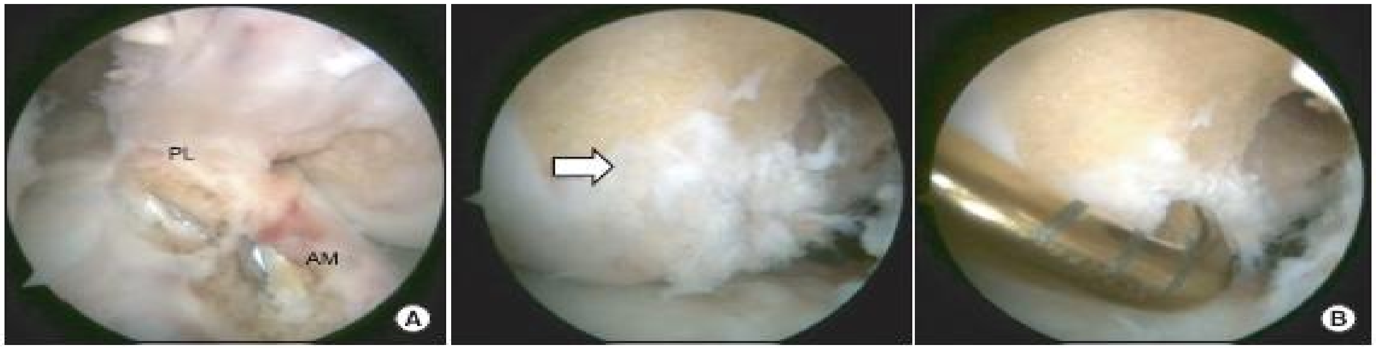


Fig. 2. (A) Tibial tunnel for posterolateral (PL) bundle and anteromedial (AM) bundle was seen on arthroscopic view. (B) Anterior cruciate ligament (ACL) footprint of PL bundle (arrow) was seen on intercondylar notch of femoral condyle (left) and femoral tunnel of the PL bundle was guided at remnant of the ACL footprint using outside-in technique (right).

Original Article Clinics in Orthopedic Surgery 2011;3:285-294 • http://dx.doi.org/10.4055/cios.2011.3.4.285

Clinical Results of Technique for Double Bundle Anterior Cruciate Ligament Reconstruction Using Hybrid Femoral Fixation and Retroscrew

Doo-Sup Kim, MD, Chang-Ho Yi, MD, Hoi-Jung Chung, MD, Yeu-Seung Yoon, MD

Department of Orthopedic Surgery, Yonsei University Wonju College of Medicine, Wonju, Korea

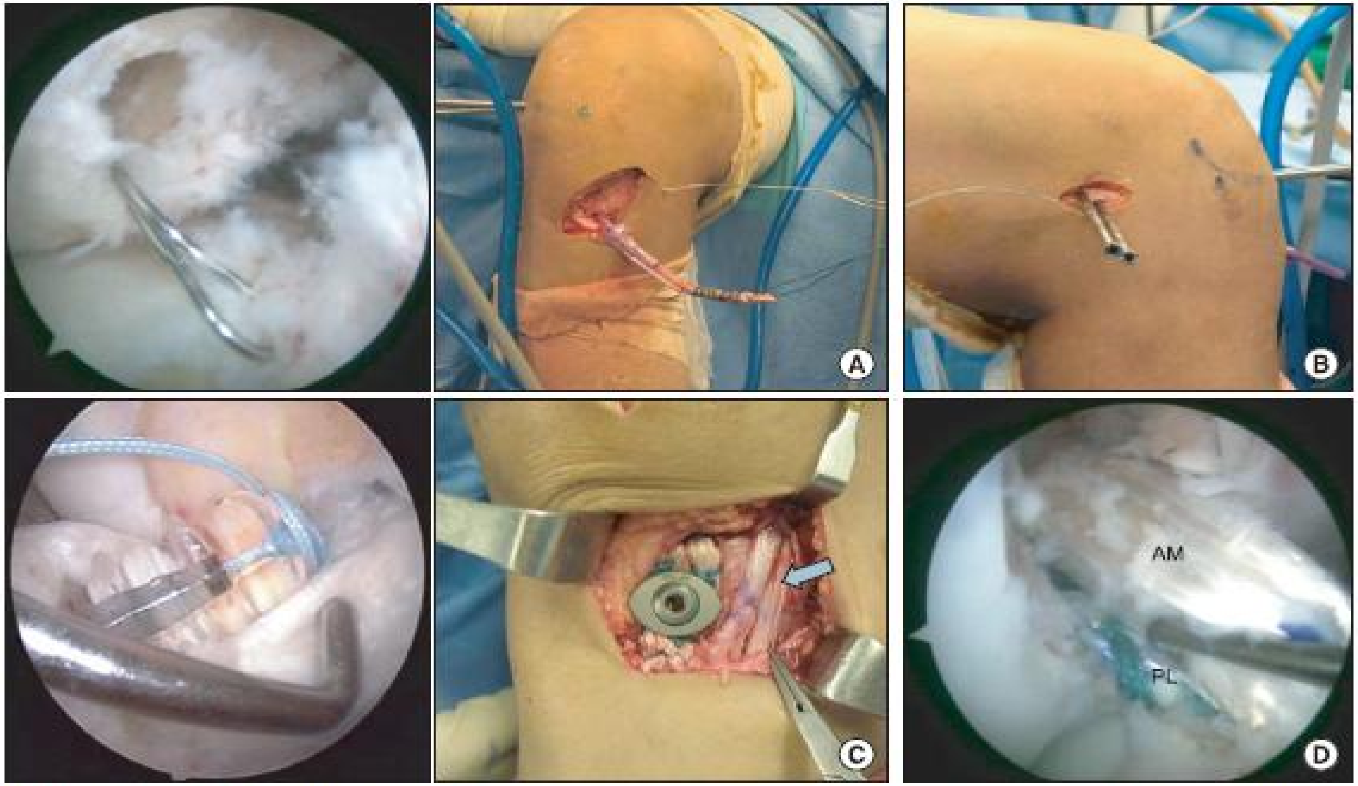


Fig. 3. (A) Wire loop is introduced through the posterolateral (PL) femoral tunnel via outside-in technique (left) and a femoral Ethibond suture of the graft for the PL bundle is suspended to a wire loop that is pulled out of the PL tibial tunnel and the graft for the PL bundle is introduced through the femoral tunnel via a wire loop (right). (B) Lateral view of operative right knee: a Rigidfix fixation guide system is introduced into the anteromedial femoral tunnel through a transtibial approach. The guide sheaths are carefully positioned in the lateral epicondylar area 1 cm above the PL femoral tunnel through the skin incision for the fixation of the bundle in order to prevent the graft from wrapping around the sheath. (C) Anteromedial (AM) bundle was fixed with Retroscrew at tibial articular side (left) and with 1 spiked washer screw outside the tibia. Hamstring autograft for PL bundle was seen at medial side of AM bundle with no fixation (arrow) (right). (D) Final view of the construct at 90° of flexion showing the PL bundle crossing the AM bundle from the back.

Original Article Clinics in Orthopedic Surgery 2011;3:285-294 • http://dx.doi.org/10.4055/cios.2011.3.4.285

Clinical Results of Technique for Double Bundle Anterior Cruciate Ligament Reconstruction Using Hybrid Femoral Fixation and Retroscrew

Doo-Sup Kim, MD, Chang-Ho Yi, MD, Hoi-Jung Chung, MD, Yeu-Seung Yoon, MD
Department of Orthopedic Surgery, Yonsei University Wonju College of Medicine, Wonju, Korea

Table 1. Results of Lachman and Pivot-Shift Test

Test		No. of cases (%)		
		Preoperative	Last follow-up	*p*-value
Lachman	Negative	0	18 (38.3)	< 0.05
	1+	0	27 (57.4)	
	2+	7 (14.9)	2 (4.3)	
	3+	40 (85.1)	0	
Pivot shift test	Negative	7 (14.9)	42 (89.4)	< 0.05
	1+	0	4 (8.5)	
	2+	8 (17.0)	1 (2.1)	
	3+	32 (68.1)	0	

Table 2. Results of KT-1000 Manual Maximum Side-to-Side Differences

Differences (mm)	No. of cases (%)	
	Preoperative	Last follow-up
< 3	0	45 (95.7)
3-5	2 (4.3)	2 (4.3)
6-10	38 (80.8)	0
> 10	7 (14.9)	0
Mean (mm) ± SD	8.3 ± 2.3	1.4 ± 1.2

SD: standard deviation.

Table 3. Last Follow-up IKDC Grade

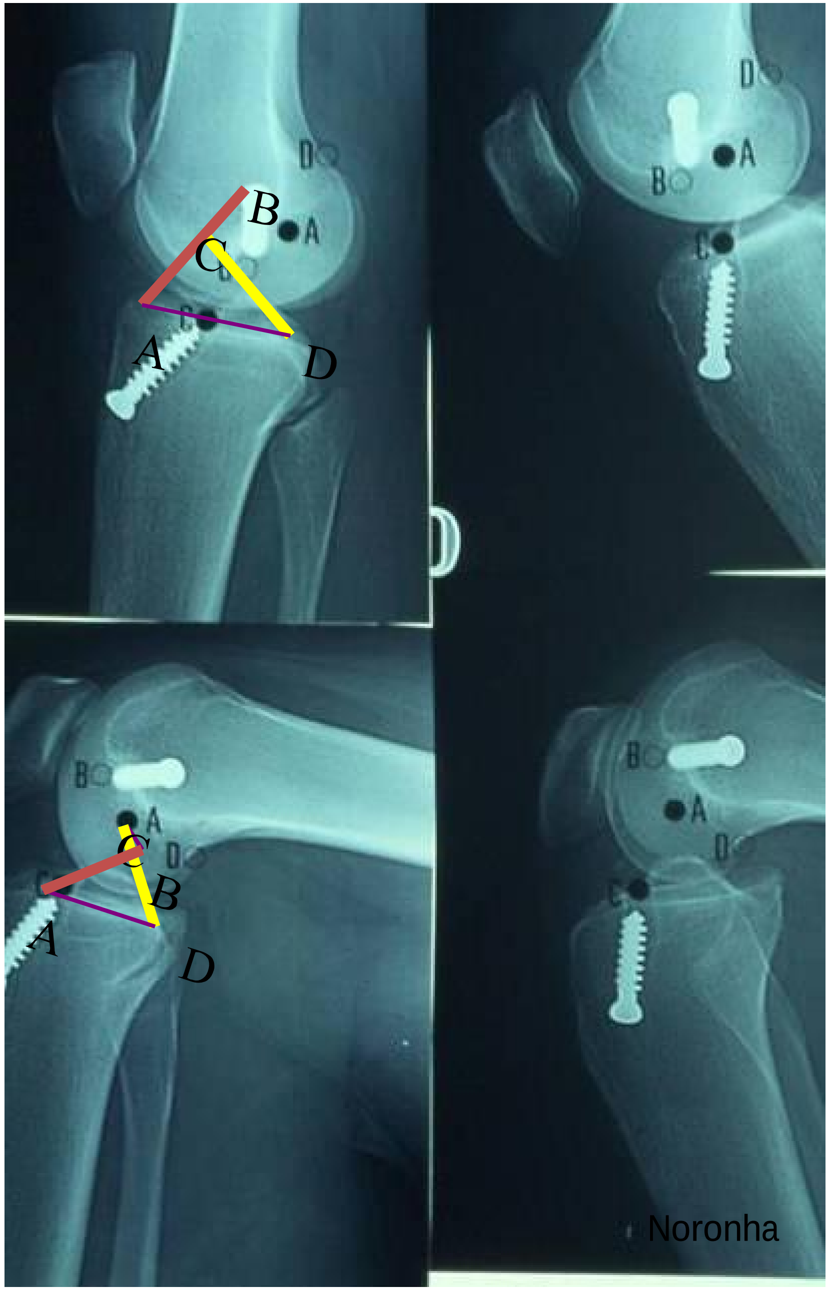
	A	B	C	D
Patient subjective assessment	41	5	1	0
Symptom group	40	6	1	0
Range of motion group	43	3	1	0
Ligament examination	45	1	1	0
Final evaluation	35	11	1	0

IKDC: International Knee Documentation Committee.

Túnel femoral

Causa de falência mais comum

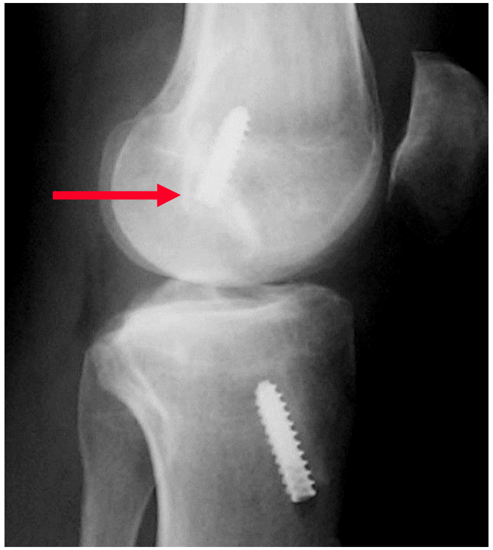

650700411
ABSM
1997
T.T.A.


B
C
A
D
Noronha

Posicionamento femoral

Parece ... mas não é fácil

Dieter Kohn *, Curso avançado na
Hannover Medical School
4 montagens perfeitas em 24



** Kohn D., Busche T. and Carls J.*
Drill hole position in endoscopic anterior cruciate ligament reconstruction. Results of an advanced course.
Knee Surg, Sports Traumatol, Arthrosc (1998) 6 [Suppl I]: S13-S15

International Orthopaedics (SICOT) (2007) 31: 49–55
DOI 10.1007/s00264-006-0118-7

ORIGINAL PAPER

Raffaele Iorio · Antonio Vadalà · Giuseppe Argento ·
Vincenzo Di Sanzo · Andrea Ferretti

Bone tunnel enlargement after ACL reconstruction using autologous hamstring tendons: a CT study

F1, femoral tunnel at the notch, axial

F3, femoral tunnel in the middle point, on coronal ima reconstruction

F4, femoral tunnel in the middle point, on sagittal ima reconstruction

FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

XXII CURSO
DE REABILITAÇÃO
E TRAUMATOLOGIA
DO DESPORTO

International Orthopaedics (SICOT) (2007) 31: 49–55
DOI 10.1007/s00264-006-0118-7

ORIGINAL PAPER

Raffaele Iorio · Antonio Vadalà · Giuseppe Argento ·
Vincenzo Di Sanzo · Andrea Ferretti

Bone tunnel enlargement after ACL reconstruction using autologous hamstring tendons: a CT study

Table 2 Tunnel diameter measurements

	Femoral				Tibial			
Patient	F1	F2	F3	F4	T1	T2	T3	T4
1	9.9	10.4	12.4	10.6	10.6	11.6	10.7	12.2
2	9	9	8.8	10.1	10	10.4	11.5	11.1
3	9	9.6	10.7	9.4	10.1	10.2	10.5	11.4
4	8.3	9.2	10.3	9.2	9.8	9.8	11.1	11.2
5	9	9.9	10	10.8	10.8	10.3	10.7	9.9
6	10.6	9.2	8.7	8.4	10	10.6	10.8	11.5
7	9	8.5	9.3	9	10	10.7	9.5	9.7
8	8.8	9.2	9.3	8.7	11.4	11.4	9.8	11.1
10	10.3	10.7	11.2	11.9	10.5	11.4	11	12.5
11	8.1	7	8.7	8.2	8.6	8.9	9.1	9.6
12	7.2	7.4	8.6	7.5	9.2	9.3	9.8	9.6
13	10	11.5	12	12	10.7	10.1	10.3	11.1
14	10	11.5	12.4	11.7	10.06	10.4	10.3	10.9
15	7.7	8.6	9.7	6.8	8.8	9.2	9	10.2
16	9.2	9	10.6	9.2	9.7	11	11.2	11
17	9.7	8.5	8.5	7.6	8.7	8.5	9.8	9.7
18	8.6	8.8	9.1	8.8	10.2	10.4	9.1	10.2
19	8.9	8.6	8.6	9.1	9	9.5	9.1	9.1
20	8	8.9	9.5	9.1	9	9.4	9.1	10.3
21	11	10	10	9.1	10.5	10.7	9.6	9
22	9.1	9.1	8.5	8.5	9	10.3	9.4	10.4
23	9.1	9.1	8.5	9.6	9.5	10	9.7	10.1
Mean	9.113636	9.259091	9.790909	9.331818	9.387311	10.18636	10.05	10.53636

HUC
HOSPITAIS
DA UNIVERSIDADE
DE COIMBRA

International Orthopaedics (SICOT) (2007) 31: 49–55
DOI 10.1007/s00264-006-0118-7

ORIGINAL PAPER

Raffaele Iorio · Antonio Vadalà · Giuseppe Argento ·
Vincenzo Di Sanzo · Andrea Ferretti

Bone tunnel enlargement after ACL reconstruction using autologous hamstring tendons: a CT study

Table 1 Preoperative and postoperative scores (*IKDC* International Knee Documentation Committee)

	Preoperative	Postoperative
Tegner	6.6 (preinjury)	6 (range 3–10)
Lysholm	50.2±14	94.6±16
IKDC	18.2: 14 (61%) group C, 9 (39%) group D	86.8: 10 (43%) group A, 13 (57%) group B
KT-1000 side-to-side at 30 lb	7.6±2.6	2.8±1.7

Conclusion

The rate of tunnel widening observed in this study seems to be lower than that reported in previous studies using different techniques. We conclude that using an anatomical fixation with stiff and strong fixation devices combined with a less aggressive rehabilitation program could contribute to minimizing tunnel enlargement after ACL reconstruction with doubled hamstrings.

Cirurgia assistida por computador

Figure 2: On the tibial side, the precise location of the tip of the aimer is identified in relation to the PCL, lateral meniscus, medial tibial eminence, and the medial and lateral walls and roof of the intercondylar notch.

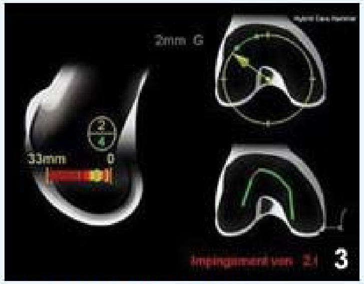


Figure 3: The femoral tunnel is identified with respect to distance from the over-the-top position and the clock-face location.

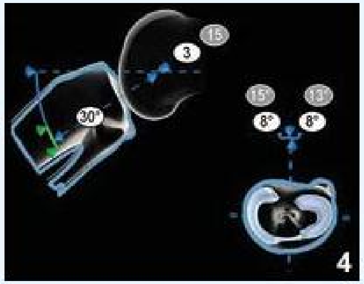
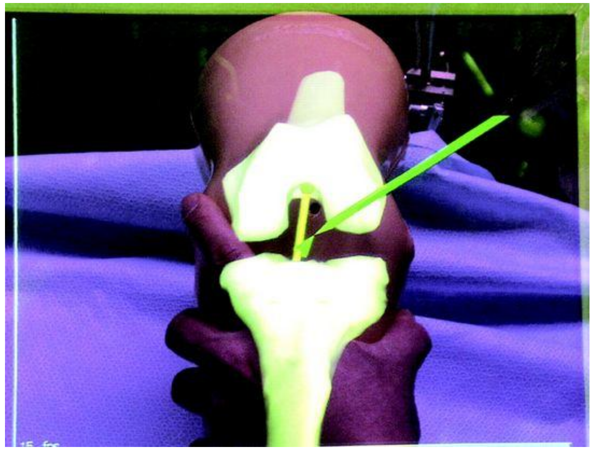


Figure 4: Postoperative measurement of AP and rotational stability is displayed and recorded.

Figure 5: After standard preparation of the graft and the intra-articular stump and notch, two Kwires are placed into the femur and tibia, and rigid bodies with reflective markers are attached.



In Orthosupersite.com

FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

THE COCHRANE LIBRARY
Independent high-quality evidence for health care decision making

- Abstract
- Background
- Anterior cruciate ligament (ACL) reconstruction is one of the most frequently performed orthopaedic procedures. The most common technical cause of reconstruction failure is graft malpositioning. Computer assisted surgery aims to aid graft placement.
- Objectives
- To assess the effects of computer assisted reconstruction surgery versus conventional operating techniques for ACL or posterior cruciate ligament (PCL) deficient knees in adults.
- Search strategy
- We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (October 2010), the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2010, Issue 3), MEDLINE (1966 to March 2010), EMBASE (1980 to March 2010), CINAHL (1937 to March 2010), article references and prospective trial registers.
- Selection criteria
- Randomised controlled trials (RCTs) and quasi-randomised controlled trials that compared computer assisted surgery (CAS) of the ACL and PCL with conventional operating techniques not involving CAS, were included.
- Data collection and analysis
- Two authors independently screened search results, assessed risk of bias and extracted data. Where appropriate, data were pooled using risk ratios or mean differences, both with 95% confidence intervals.
- Main results
- Four randomised controlled trials were included (266 participants). All involved ACL reconstructions performed by experienced surgeons. Risk of bias assessment was hampered by poor reporting of trial methods. Pooled data from two trials showed no statistically or clinically significant differences at two years or more follow-up in self-reported quality of life outcomes: International Knee Documentation Committee (IKDC) subjective scores (mean difference 2.05, 95% CI -2.16 to 6.25) and Lysholm scores (mean difference 2.05, 95% CI -2.16 to 6.25). A third trial also found a minimal difference in IKDC subjective scores (mean difference = 0.2). Pooled data from three trials for normal or nearly normal IKDC knee examination grades at final follow-up showed no significant differences between the two groups (risk ratio 1.01, 95% CI 0.96 to 1.06). No significant differences were found for other objective measures of knee function. The only adverse effects reported were some loss in range of motion in two versus three participants in one trial. CAS use was associated with longer operating times (range 9.3 to 26 minutes).
- Authors' conclusions
- A favourable effect of computer assisted surgery for cruciate ligament reconstructions of the knee compared with conventional reconstructions could neither be demonstrated nor refuted. There is insufficient evidence to advise for or against the use of CAS. There is a need for improved reporting of future studies of this technology.

Computer assisted surgery for knee ligament reconstruction

Duncan E Meuffels[1,*], Max Reijman[1], Rob JPM Scholten[2], Jan AN Verhaar[1]

HUC HOSPITAIS DA UNIVERSIDADE DE COIMBRA

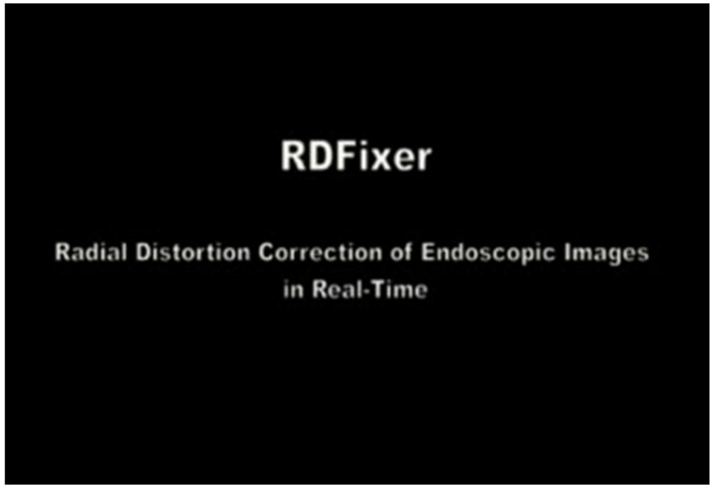
The ArthroNav Project

Computer Assisted Navigation in Orthopedic
Surgery using Endoscopic Images

The ArthroNav Project started in 2008 and is financially supported by the Portuguese Foundation for Science and Technology through grant PTDC/EEA-ACR/68887/2006. The principal contractor is the Institute for Systems and Robotics, University of Coimbra (ISR-UC), in collaboration with Hospitals of University of Coimbra (HUC) and Faculty of Science and Technology, University of Coimbra (FCTUC).

RDFixer

Radial Distortion Correction in Endoscopy



Idade

Existe limite?

J Orthopaed Traumatol (2011) 12:177–184
DOI 10.1007/s10195-011-0167-6

REVIEW

Management of anterior cruciate ligament rupture in patients aged 40 years and older

Claudio Legnani · Clara Terzaghi ·
Enrico Borgo · Alberto Ventura

Table 1 Summary of studies included in the present paper reporting results of ACL reconstruction in middle-aged patients

Author	No. of patients	Level of evidence	Mean age (range)	Follow-up period (range)	Graft type
Barber et al. [19]	33	II prospective clinical trial	44 years (40–52)	21 months (12–36)	12 BPTB, 21 Allograft
Heier et al. [24]	45	III retrospective cohort study	44.6 years (40–62)	37 months (24–96)	BPTB
Plancher et al. [25]	75	III retrospective cohort study	45 years (40–60)	55 months (26–117)	BPTB
Viola et al. [20]	11	III retrospective case–control study	42.6 years (40–47)	29 months (12–42)	BPTB
Brandsson et al. [21]	30	III retrospective case–control study	43 years (40–51)	31 months (22–60)	BPTB
Zysk et al. [22]	102	III retrospective case–control study	46 years (40–59)	29 months (12–46)	Primary suture with or without semitendinosus tendon augmentation
Kuechle et al. [13]	47	III retrospective cohort study	45 years (40.2–60.8)	59.7 months (24–110)	Allograft
Barrett et al. [26]	63	III retrospective cohort study	47.13 years (40–58) Allograft	36.4 months (24–74) Allograft	38 Allograft, 25 BPTB
			44.52 years (40–54) BPTB	44.4 months (24–99) BPTB	
Javernick et al. [27]	84	III retrospective cohort study	45 years (40–56)	43 months (12–72)	Hamstrings
Marquass et al. [29]	28	IV case series	45.4 years (40–61)	30.4 months (14–57)	Hamstrings
Khan et al. [30]	21	IV case series	44 years (40–56)	24.5 months (12–37)	Hamstrings
Barber et al. [15]	11	III retrospective case–control study	44 years (40–56)	35 months (24–58)	BPTB allograft
Blyth et al. [28]	31	III retrospective cohort study	54.5 years (50–66)	46 months (24–95)	10 BPTB, 21 hamstrings
Stein et al. [14]	19	IV case series	54 years (49–64)	24 months (9–48)	Allograft
Dahm et al. [31]	35	IV case series	57 years (50–66)	72 months (25–173)	23 Allograft, 12 BPTB
Trojani et al. [32]	18	IV case series	57 years (51–66)	31 months (12–59)	Hamstrings
Osti et al. [23]	20	III retrospective case–control study	56 years (50–62)	32 months (24–49)	N/a

N/a not available, *BPTB* bone-patellar tendon-bone

Table 2 Results of subjective and objective evaluations

Author	IKDC score	Lysholm score	Tegner score	Arthrometer (laxity ≤ 3 mm vs. normal knee)
Barber et al. [19]	N/a	95	5.7	15 (79%)
Heier et al. [24]	A: 4 B: 25 C: 14 D: 2	91	N/a	31 (78%)
Plancher et al. [25]	A: 21 B: 49 C: 5 D: 0	94	N/a	50 (67%)
Viola et al. [20]	A: 1 B: 8 C: 2 D: 0	88.5	5.3	7 (64%)
Brandsson et al. [21]	A: 10 B: 12 C: 6 D: 2	91	5	21 (70%)
Zysk et al. [22]	N/a	88 Augmentation 80 Primary suture	N/a	23 (66%) Primary suture 60 (90%) Augmentation
Kuechle et al. [13]	N/a	89.7	N/a	22 (81%)
Barrett et al. [26]	N/a	91 Allograft 92 BPTB	4.1 Allograft 4.3 BPTB	33 (86%) Allograft 34 (96%) BPTB
Javernick et al. [27]	N/a	94	5	N/a
Marquass et al. [29]	83.4	91.5	4.5	16 (57%)
Khan et al. [30]	83	92	6	19 (90%)
Barber et al. [15]	N/a	88.8	6.6	30 (91%)
Blyth et al. [28]	A: 5 B: 20 C: 6 D: 0	93	5.2	11 (41%)
Stein et al. [14]	N/a	92	N/a	18 (95%)
Dahm et al. [31]	90	92	4.3	N/a
Trojani et al. [32]	A: 7 B: 7 C: 3 D: 1	N/a	N/a	N/a
Osti et al. [23]	91	89	N/a	15 (75%)

N/a not available, *IKDC* International Knee Documentation Committee, *BPTB* bone-patellar tendon-bone

J Orthopaed Traumatol (2011) 12:177–184
DOI 10.1007/s10195-011-0167-6
REVIEW

Management of anterior cruciate ligament rupture in patients aged 40 years and older

Table 3 Complications and failure rates

Author	Complications	Graft failures (%)
Barber et al. [19]	1 (3%) loss of postoperative motion	0 (0)
Heier et al. [24]	1 (2%) loss of postoperative motion 1 (2%) anterior knee pain	2 (4)
Plancher et al. [25]	4 (4%) hardware intolerances 1 (1%) patellar ligament inflammation 3 (3%) losses of postoperative motion	0 (0)
Viola et al. [20]	1 (9%) loss of postoperative motion	0 (0)
Brandsson et al. [21]	2 (6%) bleeding complications 8 (27%) losses of postoperative motion	0 (0)
Zysk et al. [22]	1 (1%) bleeding complication 6 (6%) losses of postoperative motion 7 (6.9%) deep vein thromboses 1 (1%) lung embolism	0 (0)
Kuechle et al. [13]	2 (4%) superficial wound infections 13 (28%) hardware intolerances 2 (4%) losses of postoperative motion	1 (2)
Barrett et al. [26]	1 (2%) anterior knee pain 1 (2%) sterile synovitis	1 (2)
Javernick et al. [27]	0 (0%)	0 (0)
Marquass et al. [29]	None reported	0 (0)
Khan et al. [30]	1 (5%) superficial wound infection 1 (5%) deep vein thrombosis	0 (0)
Barber et al. [15]	None reported	0 (0)
Blyth et al. [28]	2 (6%) wound healing problems	0 (0)
Stein et al. [14]	2 (8%) recurrent knee effusions	0 (0)
Dahm et al. [31]	2 (16%) hardware intolerances	3 (9)
Trojani et al. [32]	3 (17%) losses of postoperative motion 1 (5%) posterior knee pain 4 (22%) cases of tibiofemoral pain	0 (0)
Osti et al. [23]	None reported	1 (5)

J Orthopaed Traumatol (2011) 12:177–184
DOI 10.1007/s10195-011-0167-6

REVIEW

Management of anterior cruciate ligament rupture in patients aged 40 years and older

J Orthopaed Traumatol (2011) 12:177–184
DOI 10.1007/s10195-011-0167-6

REVIEW

Management of anterior cruciate ligament rupture in patients aged 40 years and older

Conclusion:

The main limit of this systematic review is that there was a considerable lack of high-level studies supporting ACL reconstruction in the middle-aged population. <u>This growing body of papers has broadly changed the approach of surgeons towards the management of the ACL-deficient knee in elderly patients</u>. Recently, reports of ACL reconstruction in patients over 50 years have been published. <u>With increasing numbers of activity-related injuries, and to comply with patient requests to return to pre-injury levels, the cutoff age for surgical treatment has been increased</u>. However, at present, there is a limited evidence base for ACL reconstruction in middle-aged patients, so the expertise of physicians still represents the most useful tool in clinical practice. Further randomized trials and comparative studies are required in order to aid surgeons in determining the correct therapeutic approach for the ACL-deficient knee in the elderly population.

Conclusão

- A cirurgia do LCA é uma cirurgia madura e reprodutível
- As grandes questões que se colocam são:
  - É realmente eficaz evitando a progressão da artrose?
  - Será a engenharia de tecidos uma solução alternativa evitando a morbilidade das zonas dadoras
  - Como compensar o ressalto rotatório residual
    - Duplo túnel
    - Plastia extra-articular?
    - CAOS

Agradecimentos

José Carlos Noronha
Rui Dias
João Pedro Oliveira
Pedro Simões