REVIEW ARTICLE

MANAGEMENT OF ANTERIOR CRUCIATE LIGAMENT LESIONS : SURGICAL FASHION, PERSONAL WHIM OR SCIENTIFIC EVIDENCE ? STUDY OF MEDIUM- AND LONG-TERM RESULTS

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The medium- and long-term results of conservative and surgical treatment of ACL lesions were evaluated by analysis of the current literature. Only reports with a minimum follow-up of 4 years were taken into account. Concerning conservative treatment, the literature search revealed only 7 papers with a total of 636 cases. Reports on the results of surgical treatment were separated into four categories : primary repair, with 13 papers (1205 cases), extraarticular tenodesis, with 4 papers (232 cases), ACL reconstruction, with 26 papers (2693 cases) and ACL prosthetic replacement (reconstruction using synthetics) with 5 papers (370 cases).

The mean functional scores show about 70% good and excellent results for all treatment regimens. Clinical laxity persists in almost all conservatively treated cases, in almost half of the cases with primary repair, extra-articular tenodesis, and synthetic substitution, and in almost one-third of the cases with ACL reconstruction. The incidence of secondary ACL surgery was lowest in the conservative group (4.6%), whereas secondary meniscus surgery was lowest in the ACL reconstruction group (3.5%). Compared with the conservative group (12%), surgical treatment evolved to a higher osteoarthritic morbidity. Sports participation was higher in the ACL reconstruction group. This analysis may provide a more realistic view on the outcome of treatment of ACL lesions, and on the relationship between treatment, activity level and osteoarthritis.

Keywords : knee ; anterior cruciate ligament ; medium & long term results.

Mots-clés : genou ; ligament croisé antérieur ; résultats à moyen et long terme.

INTRODUCTION

Social behavior, recreational and sports activities, as well as occupational and traffic accidents seem to be generating an epidemic of knee and especially ACL injuries.

This led some authors (11, 30) to project figures of more than 250,000 ACL injuries per year worldwide. It is estimated that between 60,000 and 75, 000 surgical ACL reconstructions/year are presently performed per year in the U.S.A. (30, 39). This trend towards operative treatment was further enhanced by reports of progressive joint degeneration due to chronic ligamentous pathology (14, 29). Recent review articles and editorials challenged this view however and reimphasized the value of conservative treatment (32, 38, 39, 46).

Although the orthopedic literature is replete with the management of ACL problems, most reports on treatment concern details of surgical technique, and/or short-term results. The fundamental questions concerning the treatment of the ACL lesions thus remain unsolved.

The aim of this study was therefore to search the literature to provide an analysis of the available

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medium- and long-term reports of conservative and surgical treatments of ACL lesions.

MATERIAL AND METHODS

The main orthopedic journals and monographs were researched from 1975 until mid-1998 for reports on medium- and long-term results of ACL treatments.

It was the initial intention of the author to use a strict methodology for paper selection, focusing on objectively measurable variables, separate evaluation of different pathologies (chronic versus acute, partial versus total ACL tears, isolated versus combined lesions), population groups (low versus high demand, young versus middle-aged), and randomized treatment modalities.

These scientific standards had to be abandoned however, as almost none of the available papers fullfilled the above-mentioned criteria. The only selection criterion that could possibly be maintained was a minimum follow-up of 4 years.

Reports with a mean follow-up of 4 years or more, but including cases with less than a 4-year follow-up were not taken into account owing to possible biases related to favorable short-term results.

The following data were analyzed if available : number of cases reported, percentage of cases followed, length of follow-up (mean and range), type of ACL lesion (partial versus total, acute versus chronic), treatment regimen, residual laxity (Lachmann test, instrumented Lachmann test, pivot shift test), type and value of functional score, sports participation, secondary meniscal and ACL surgery, loss of motion and osteoarthritis.

The reports on conservative treatment, on primary surgical repair, on extraarticular tenodesis, on ACL reconstruction and on ACL prosthetic replacement, were evaluated separately.

Treatment results of acute and chronic ACL lesions, as well as of different surgical reconstructive techniques could not be analyzed separately, owing to the limited number of reports available. A statistical evaluation and comparison between the different treatment groups could not be performed because of the lack of precise data in most reports.

RESULTS

A. Conservative treatment

Only seven reports (6, 13, 15, 20, 62, 69, 72) concerning 636 cases reach the benchmark of 4 years of follow-up. Five of the 7 reports include patients with more than 10 years of follow-up. The main follow-up rate is 78.5% (range 57-96%) (table I).

Although the functional results are satisfactory with a mean of 70% good and excellent results (range 57-82%), the clinical evaluation demonstrated the persistence of knee laxity, with 89% positive Lachmann's (range 9 to 100%), 58.5% positive instrumented Lachmann's (range 9 to 84%) and 59% positive pivot shifts (range 5 to 84%).

Sports participation is rather low (mean 45%, range 30 to 55%). The amount of high-level sports participation never exceeds 30%, even in series reporting specifically on "athletes". A constant trend is the decline in sports participation over time after the index injury. However in most series which mention this phenomenon, this decline is not related to the knee injury in one-third to one-half of the cases. This non-knee related decline in sports participation also increases with length of follow-up.

Secondary ACL reconstructions are rare (mean 4.6%, range 0 to 18%) and are in most series related to gross or recurrent instability during activities of daily living.

Secondary meniscal surgery is also limited (mean 12%, range 3.5 - 23.7%).

The mean occurrence of osteoarthritis is moderate (12%), but with a wide range of values (7 to 61%).

B. Primary repair

The reports on primary repair include sutures as well as reinsertions of the torn ACL remnants, or repairs augmented with autogenous tissue, be it fascia lata, patellar or hamstring tendons (6, 7, 10, 16, 26, 28, 35, 36, 41, 47, 68, 71, 75) (table II).

It is striking that only 13 papers report on a follow-up of more than 4 years, with only 4 papers including patients with more than 10 years of follow-up. All reports together amount to only 1205 cases of ACL ruptures of which 1 out of 5 was lost to follow-up.

Although many scores are in the good and excellent range, residual laxity is not rare, with

Table I. — Long-term results of conservative treatment

Author	Year	N cases	% F.U.	Years F.U.			Type ACL	Diagnosis	% Lachmann +	Instrumented Lachmann			% Pivot +	Funct. Score		% Sports	% Second. Surg.		% Arthritis
				Min.	Max.	Mean				Type	Force	Value		Type	Value		% meniscus	% ACL	
Anderson	89	59	96	3.75	6	4.8	—	arthroscopy	93	Stryker	90 n	mean 4 mm	51	Lysholm	mean 86	30 (competition)	23.7	2.5	—
Pattee	89	68	72	4	10.2	5.5	—	—	100	KT 1000	89 n	mean 3.1	42	Lysholm	67% G.E.	43	5	18	15
Sommerlath	92	19	—	9	15	12.2	partial	arthroscopy	36	Stryker	90 n	14% +	5	Lysholm	82% G.E.	32	5.2	0	61
Cicotti	94	52	57	5	13	7	62% Isolated	clinical	97	KT 1000	max. man.	mean 6 mm	67	Lysholm	57% G.E.	—	13.3	0	7
Daniel	94	56	75	3.8	9.4	5.3	39% partial	KT stable	—	KT 2000	max	9% +	8	—	—	48	7	3.5	—
		191					14% partial	KT unstable			man.	84% +	84			44	20	2.3	—
Shirakura	95 B	59	89	3.7	11.1	6.9	—	arthroscopy	—	KT		72% +	—	—	—	—	7.5	5	18
Casteleyn	96	109	83	5	12	8.5	9% partial	arthroscopy	—	KT 2000	134 n	45% +	64	IKDC	72% A + B	55	3.5	5.4	23.2

Table II. — Meta-analysis of reports concerning primary repair of ACL

Author	Year	N Cases	% F.U.	Years F.U.			% Isol. Acl	Treatment	% Lachm. +	Arthrometer			% Pivot +	Functional Score		% Sports	Second. Surg.		% Loss Motion	% Arthritis
				Min.	Max.	Mean				Type	Force	Value		Type	Value		% Men.	% Acl		
Feagin	76	64	50	5	—	—	100	suture	94	—	—	—	—	—	—	37	34	25	—	—
Andersson	89	111	96	4	6	—	18	20% suture	65	Stryker	—	mean 2mm	—	Lysholm	91	30	30.4	13.1	—	—
								26% suture augm.	59	Stryker	—	mean 2 mm	—	Lysholm	92	70	3.4	0	—	—
Engebretsen	89	84	88	4	9	—		suture	35	KT	57 N	31% +	24	Lysholm	90.3	—	13.1	—	—	17.8
Kaplan	90	70	74	5	13	6	17	suture	23	KT	89 N	"0,42 +"	13.4	HSS (50p)	41.8	86.5	5.7	1.9	—	—
Andersson	91	167	93	4	6.6	—	20	15% suture	—	Stryker	—	mean 4 mm	23	Lysholm	90	27	—	12	—	—
								30% suture augm.	—	Stryker	—	mean 7 mm	30	Lysholm	92	61	—	-	—	—
Sherman	91	106	47	4	7	5	38	suture	32	KT	man.max	54% +	30	HSS(100p)	85.9	92	6	4	28	22.4
Sommerlath	91	60	88	9	16	12	9.4	82% suture	21	Stryker	90 N	57% +	6	Lysholm	86	43	18.3	11.6	47	65
Cross	93	47	64	5	7	—	23	suture augm.	40	KT		73% +	10	Lysholm	93.2	76.6	6.6	—	—	—
Grondtvedt	95	74	70	5	7	6	—	25% suture									15.3	38		44
								26% suture augm.	—	—	—	—	—	—	—	—		0		(M.R.I.)
Träger	95	130	77	5	—	-	—	26% suture	31	—	—	—	8	Lysholm	54% GE	85	—	—	96	0
								74% suture augm.	16	—	—	—	9		51% GE	74				59
Bak	96	105	69	7	16	10	17	suture	41	—	—	mean 3.6 mm	—	Lysholm	91	50	—	16	—	—
Grontvedt	96	100	82	5	7	6		50% suture	44	KT	89 N	65% +	51	Lysholm	73% GE	27	?	14	5 ext. 10 flex.	34
								50% suture+synt. augm.	28			48% +	36		85% GE		?	16	14 ext. 12 flex.	47
Lundberg	97	40	—	10	—	-	0	suture	35	OSI	90 N	—	55	Lysholm	92	—	7.6	2.5	—	10
Besnard	98	68	69	6	10	8	—	suture + carbon augm.	78	Bercovy	—	-	32	Lysholm	86.5	51	2.1	—	62 ext. 15 flex.	68

Table III. — Meta-analysis of reports of extraarticular tenodesis

Author	Year	N cases	% F.U.	Years F.U.			Treatm.	% Lachm. +	Arthrometer			% Pivot +	Functional Score		% Sports	Second. Surg.		% Motion loss	% Arthritis
				Min.	Max.	Mean			Type	Force	% +		Type	Value		% Men.	% ACL		
Amirault	88	40	67	8	14	11	Mac Intosh	37	—	—	—	—	Own	52% G.E.	1	—	—	—	—
Dahlstedt	88	39	71	5	8	6	Ellison	72	KT	89 N	64	57	Lysholm	88% G.E.	—	5.1	25.6	—	14.3
Reid	92	46	67	7	15	11	Ellison	91	—	—	—	75	Lysholm	44% G.E.	62.5	28.1	18.7	10	38
Grontvedt	95	107	48	5	14	9	Pat. tendon	38	KT	man.max.	63	33	Lysholm	82% G.E.	44	11.2	6.5	—	51.9

21 to 94% (mean 41.9%) positive manual Lachmann tests. The instrumented Lachmann's show even less good values of about 31 to 73% (mean 52.5%) positive tests. The results of the pivot shift tests are less reliable, since the values differ widely between series, with a range from 6 tot 55% (mean 23.7%).

About 45.2% of this primary repair patient population returned to sports participation after the ACL injury and repair. The information on secondary meniscal and ACL surgery remains fragmentary, with widely scattered values. The incidence of secondary meniscal surgery ranges from 2 to 38% (mean 16.4%) ; that of secondary ACL surgery from 0 to 25% (mean 12.0%).

C. Extraarticular tenodesis

The reports available concern isolated extraarticular tenodeses, without intraarticular ACL reconstruction, for chronic ACL deficiencies (5, 17, 34, 65) (table III). Although extraarticular tenodeses have apparently been used widely, the number of long-term reports is limited, with only four papers, dealing with 232 patients of whom only 60% have been followed.

The scores do not seem too bad and range from 52 to 82% good and excellent results. The validity of the scores is however directly challenged by the high number of positive Lachmann (mean 54.3%, range 37%-91%), instrumented Lachmann (mean 63.0%, range 63%-64%) and pivot shift tests (mean 47.4%, range 33%-75%). Sports participation after the procedure is reduced to a mean of 54.2%.

Secondary meniscal and ACL surgery (respectively 5 to 28%, mean 23.4% and 6 to 26%, mean 13.6%) as well as arthritic degeneration (13 to 51%) is frequent.

D. ACL reconstruction

Again, the number of reports and cases with a follow-up of more than 4 years is fairly low : only 26 papers or 2693 patients, of whom 23% were lost to follow-up (1, 3, 4, 8, 9, 20, 22, 36, 37, 40, 44, 45, 50, 52, 53, 54, 57, 61, 63, 64, 66, 67, 73, 74, 78, 79), 7 papers include cases with 10 years or more of follow-up (table IV).

Only three of these papers (3, 36, 57) deal exclusively with acute ACL lesions ; two others report separately on acute and chronic ACL lesions (20, 50), and seven reports combine the results of acute and chronic cases (8, 9, 37, 40, 45, 61, 63). All other studies are limited to chronic ACL lesions.

Many studies also combine the results of different types of grafts, of operative techniques, of various types of isolated intraarticular reconstructions or of intraarticular reconstructions combined with extraarticular tenodeses. The evaluation of each technique is therefore almost impossible. In addition the majority of these studies are retrospective, and when combining techniques, without randomization.

Again, as with the primary repairs, we can witness a discrepancy between rather good functional scores (Lysholm 66% to 100% good and excellent, Cincinatti 66% to 85% good and excellent, IKDC 47% to 77% A and B) and rather fair and poor results concerning laxity (positive Lachmann : 4 to 91%, mean 34.8%, positive instrumented Lachmann : 6 to 70%, mean 31.1%, positive pivot shift : 3 to 52%, mean 20.8%).

The data concerning secondary meniscal and ACL surgery are fragmentary and fall within a wide range of values from 0 to 15% (mean 3.5%) for meniscal surgery and from 0 to 14% (mean 8.0%) for ACL surgery.

Only 14 papers, reporting on 865 cases (or 31% of all analyzed cases), studied the appearance or aggravation of osteoarthritis with radiographs and/or bone scans. These papers show 37.4% of cases (range 12-100%) to have developed osteoarthritis, mostly of a mild-to-moderate grade.

E. Ligament prostheses

The synthetics were studied separately, as including them in the global evaluation of the ACL reconstructions could be considered to create a negative bias in the evaluation of the latter.

Only five long-term reports on ACL prostheses are available with two including patients with

Table IV. — Meta-analysis of reports of ACL reconstruction

Author	Year	N Cases	% F.U.	Years F.U.			Acute/ Chron.	Treatment	% Lachm.	Arthrometer			% Pivot	Functional	Score	% Sports	Second. Surg.		% Loss Motion	% Arthritis
				Min.	Max.	Mean			+	Type	Force	% +	+	Type	Value		% Men.	% ACL		
Johnson	84	134	65	5	10	8	A + C	P.T. Auto B.T.	66	Own	?	31.3	9.7	Lysholm	96% G.E.	92	1.1	6.7	0 - 8° Ext. 0 - 22° Flex.	14
Kornblatt	88	60	63	4	9	5	C	P.T. Auto B.T. Q.T. Auto O.T.T.	55	—	—	—	23 O.T. 19 B.T.	H.S.S.	Mean 40.6	100	—	—	54% Ext. 58% Flex.	—
Sandberg	88	30	100	4	8	5	C	P.T. Auto B.T.	87	—	—	—	17	Lysholm	Mean 92	—	—	—	—	—
Mitsou	90	273	89	4	9	5	C	F.L. Auto O.T.T. E.T.	46	—	—	—	31	Lysholm	71% G.E.	—	0.4	—	—	—
Wndsor	90	71	87	5	10	8	C	F.L.. O.T.T.	39	—	—	—	18	H.S.S.	Mean 89	48	1.6	—	0	36
Holmes	91	90	83	5	—	—	C A	P.T. + E.T. S.T. + E.T. S.T. + E.T.	Mean 2 mm	KT	98 N	Mean 1.4	Mean 1.2	Cincinatti	74% G.E. 50% G.E. 85% G.E.	—	—	—	—	—
Rackeman	91	103	72	6	—	—	C	P.T. O.T.T. + E.T.	58.1	—	—	—	mean 1.4	Lysholm	Mean 95	78	15	—	23% Ext. 16% Flex.	26
Aglietti	92	44	96	4	10	7	C	P.T. Auto B.T. + E.T.	7	KT	Max. Man	43	—	own	66% G.E.	63	2.3	—	23% Ext. 34% Flex.	61
Dempsey	93	69	68	4	—	9	C	F.L. O.T.T. + E.T.	5	—	—	—	6	Lysholm	64% G.E.	—	8.5	—	—	40
Anderson	94	217	32	5	9	7	C A	S.T. / GR. B.T. + E.T.	19	KT	89 N	43	mean 1.4	Zarins	90% G.E.	—	—	—	Mean 8 ° Flex.	51
Daniel	94	91	97	5	—	—	A 49% C 51%	S.T. Auto 32% P.T. Auto 59% F.L. 9%	—	KT	Max. Man	67 70	36 52	—	—	44 55	4	—	—	—
Levitt	94	214	84	4	8	5	A 17% C 83%	P.T. Allo 23% Achilles Allo 67%	—	KT	—	13.% > 5 mm	—	Feagin	79% G.E.	—	7	—	—	—
Saragaglia	94	171	62	4	8	—	C	P.T. B.T. + LAD	—	Bercovy	Max. Man	27.1	17	Class/ Arpege	83% G.E.	90	1.9	—	7.5% Ext.	41
Marcacchi	95	82	100	4	6	5	A 28%	P.T. Auto, F.L. + LAD	52	KT	—	26	48	IKDC	74% A + B	90	0	7	8% Ext. 36% Flex.	—
							C 72%		52			40	59		64% A + B	74	5.0		17% Ext. 22% Flex.	—
Pritchard	95	79	51	9	14	11	A 39% C 61%	F.L. Allo O.T.T. / B.T. + E.T.	5	KT	Max. Man	22.5		IKDC	47.5% A + B	77	15	14	25% Ext. 33% Flex.	30
Spechiulli	95	75	100	5	12	8	C 60%	60% S.T. Auto (Lindeman)	24	—	—	—	29	Lysholm	74% G.E.	83	—	—	20% Ext.	12
								40% P.T. auto	4	10		90% G.E.	79							
Zavras	95	14	100	6.5	11	8.5	C	P.T. Auto O.T.T. + E.T.	91	KT	Max. Man	Mean 4.41	16	IKDC	75% A + B	60	5.8	—	4% Ext. 9% Flex.	—
Aglietti	96	77	90	4	8	5	A	S.T./GR. O.T.T. Auto	—	KT	134 N	50	7.25	IKDC	85% A + B	92	1.45	4.34	5% Ext.	—
Grondtvedt	96	50	96	5	—	—	A	P.T. Auto B.T.	10	KT	89 N	21	8	Lysholm	96	87	—	0	17% Ext. 26% Flex.	56
Mitsou	96	384	87	5	9	—	C	P.T. Auto B.T.	42	KT	89 N	22	28	Lysholm	89.5% G.E.	—	2.4	—	9.6% Ext.	—
Noyes	96	96	71	5	9	7	A	P.T. Allo B.T. F.L. Allo B.T.	—	KT	89 N	18 23	3 3	Cincinatti	79% G.E. 68% G.E.	75 66	2.9	14.0	9% Ext. 13% Flex.	25
Taylor	96	21	86	7	10	9	C	F.L. O.T.T.+/ E.T.	22.2	—	—	—	11	Cincinatti	61% G.E	85	0	0	—	38
Aglietti	97	101	88	5.4	7	8.6	C	P.T. Auto B.T.	11	KT	134 N	16	30	IKDC	77% A + B	85	6.7	—	26% Ext. 3% Flex.	22
Bach	98	97	86	5	—	9	A 25% C 75%	P.T. Auto	40	KT	Max. Man.	30	16	Lysholm H.S.S.	81% G.E. 82% G.E.	82	7.2	—	0	—
Otto	98	80	81	5	—	—	A 59% C 41%	P.T. Auto 23% Flex.	35.4	—	—	—	20	IKDC	80	77	3	4.4	26% ext.	28
Meystre	98	30	90	9	10	11	C	S.T. + E.T.	—	knee-lax.	132 N	18.5	22	IKDC	81.5	81	11	?	—	18.5

N.B. : P.T. = Patellar tendon, Q.T. = Quadriceps tendon, F.L. = Fascia lata, S.T. = Semitendinosus tendon, G.R. = Gracilis tendon, Auto = Autograft, Allo = Allograft, B.T. = Bone tunnels, O.T.T. = Over the top, E.T. = Extraarticular tenodesis.

more than 10 year follow-up (19, 23, 48, 49, 51) (table V).

The total number of cases (370) is very low, but with a follow-up of 77%. Two of the reported series were treated with the Leeds-Keio synthetic ligament scaffold, but the arthroscopic, operative and histological follow-up data show that it does not induce a valid neoligament and therefore acts as a prosthesis. The synthetic reconstructions were overwhelmingly performed in chronic cases. Fifty-eight percent of the patients (range 17 to 85%) demonstrated a positive Lachmann, 38.6% (range 31%-50%), a positive instrumented Lachmann and 41.7% (range 25 to 62%) a positive pivot shift.

In contrast with the other treatment regimens we seem to find a better correlation between the laxity values and the functional score, with a low 71.3% of Lysholm good and excellent scores (43 to 78%). The mean sports participation was 54.6% (range 52 to 83%).

The protective effect of the synthetic ACL reconstruction against further meniscal lesions is questionable, given the 23.2% incidence (range 14 to 40%) of postreconstruction meniscal surgery.

Synthetic ACL grafts seem doomed to failure through fatigue and abrasion, and this is reflected by a 17.6% incidence (range 7 to 51%) of further ACL surgery. The fragmentary data in the reports concerning postoperative loss of motion seem to indicate a lower rate of iatrogenic loss of motion, but the degree of secondary osteoarthritic degeneration towers above the results of all other procedures (50% to 83%).

F. Comparison of the different procedures

The analysis of the long-term results of primary repair, extraarticular tenodesis, reconstruction and prosthetic replacement of the ACL confirm that the best results have been obtained with ACL reconstructions (table VI).

ACL reconstructions were also compared with conservative treatments (table VII). The mean follow-up of the conservatively treated series is somewhat longer, with also substantially more reports (71% versus 27%) including patients with at least 10 years of follow-up. The most striking difference between both treatment regimens concerns the residual knee laxity.

After conservative treatment almost all patients (89%) still demonstrate a positive Lachmann and 2 out of 3 (59%), a positive pivot shift.

The surgical treatment can abolish the Lachmann and instrumented Lachmann in about 2 out of 3 cases (respectively 34.8 and 31.1% positive tests) and the pivot shift in about 4 out of 5 cases (20.8% positive tests).

The mean functional scores seem to yield nearly identical results with surgical (73% good and excellent results) and conservative (70% good and excellent results) treatments.

There is a marked difference in the incidence of secondary ACL surgery after conservative (4.6%) and surgical (8.0%) treatment, the latter surprisingly being twice as frequent. The lower rates of secondary meniscal surgery after ACL reconstruction (3.5% versus 12% after conservative treatment) show the protective role of the surgical reconstruction.

The broad range of secondary meniscal surgery after conservative treatment (3.5-23.7%) indicates however that persistent ACL deficiency is not the only factor in the genesis of further meniscal injury. The reported percentages of secondary osteoarthritis are somewhat higher after surgical treatment (37.4% versus 12% after conservative treatment).

DISCUSSION

Reviewing the above-mentioned medium-term reports and results, one is astonished by the paucity of the available data concerning a rather frequent pathology, for which surgical techniques have often been advocated.

The scientific value of this analysis can be questioned, owing to the poor scientific standard of almost all published reports.

Arbitrary selection of patients, short follow-ups with low follow-up rates, and nonrandomised treatment regimens are the main culprits inducing unacceptable biases and limiting the usefulness of most reports.

Table V. — Meta-analysis of reports of ACL reconstructions with protheses

Author	Year	N Cases	% F.U.	Years F.U.			Acute/ Chronic	Treatment	% Lachm. +	Arthrometer			% Pivot +	Functional Score		% Sports	Second. Surg.		% Loss Motion	% Arthritis
				Min.	Max.	Mean				Type	Force	% +		Type	Value		% Men.	% ACL		
Dandy	94	160	73	4	6	9	C	L.K. + E.T.	85	—	-	—	40	Lysholm	74% G.E.	66	14	7.1	—	—
Denti	95	50	74	5	7	6	C	L.K.	24	KT	134 N	38.0	34.0	IKDC	67% A + B	70	—	10	16% Flex. 22% Ext.	—
Makisalo	96	50	74	413	8		25% A 75% C	Carbon	17	Stryker	—	mean 2.5	—	Lysholm	43% G.E.	—	-	—	0	76
Marcacchi	96	40	100	5	6	6	A	L.K.	50	KT	134 N	50	25	IKDC	55% A + B	87	—	7.5	—	50
Maletius	97	70	79	7	11	9	C	Dacron	—	Stryker	90 N	31	62	Lysholm	67% G+ E	50	40	51	—	83

N.B. :
L.K. : Leeds - Keio

Table VI. — Comparison of the meta-analysis of different surgical treatments for ACL

Treatment	N° reports		Total N° cases	% F.U.	% Lachm. + (range)	% instr. Lachm. + (range)	% Pivot + (range)	Second. Surg.		% Sports
	> 4 y F.U.	some cases > 10 y F.U.						% Men.	% ACL	
Primary repair	13	4	1.205	80	41.9 (21 - 94)	52.5 (31 - 73)	23.7 (6 - 55)	16.4 (6 - 38)	12.0 (0 - 25)	45.2 (27 - 92)
Extraarticular tenodesis	4	3	232	60	54.3 (37 - 91)	63.0 (63 - 64)	47.4 (33 - 75)	23.4 (5 - 28)	13.6 (6 - 26)	55.2 (44 - 74)
Reconstruction	26	7	2.693	77	34.8 (4 - 91)	31.1 (16 - 70)	20.8 (3 - 52)	3.5 (0 - 15)	8.0 (0 - 14)	74.4 (8 - 100)
Synthetics	5	2	370	77	58.0 (17 - 85)	38.6 (31 - 50)	41.7 (25 - 62)	23.2 (14 - 40)	17.6 (7 - 51)	54.6 (52 - 83)

Table VII. — Surgical versus conservative results

	Conservative treatment	Surgical treatment
% Lachmann +	89 (9 - 100)	34.8 (4- 91)
% instrumented Lachmann +	58.5 (9 - 84)	31.1 (16 - 70)
% Pivot +	59 (5 - 84)	20.8 (3 - 52)
% good / exc. funct. score	70 (57 - 82)	73 (47 - 100)
% sports participation	45 (30 - 55)	74.4 (8 - 100)
% secondary ACL surgery	4.6 (0 - 18)	8.0 (0 - 14)
% secondary meniscal surgery	12.0 (3.5 - 23.7)	3.5 (0 - 15)
% osteoarthritis	18 (7 - 61)	37.4 (12 - 100)

This is therefore not an ideal meta-analysis which can provide indisputable results and conclusions.

It is however the only available pooled evaluation of medium- and long-term results of ACL treatments, and it could have informative value concerning ACL management.

Many of the reports on primary repair concern a fair number of isolated and partial ACL lesions, which can generate a favorable bias.

Isolated extraarticular tenodeses show an unacceptable recurrence rate of knee laxity over time and most authors agree that these techniques should no longer be used. Short-term reports on the association of extraarticular tenodeses with intraarticular ACL reconstructions yield conflicting results (56, 59, 77).

The results of surgical reconstructions can be biased by the pooling of results of chronic and acute cases, as the results of treatment of chronic ACL deficiency are less optimal (58).

It is difficult to group and compare studies concerning intraarticular reconstructions of the ACL, owing to the wide spectrum of different techniques used.

The reconstruction can be performed open or arthroscopically, through tibial and femoral bone tunnels, or with the graft routed "over the top" of the lateral femoral condyle.

The graft materials, for which the relative strength and stiffness were extensively studied, are mostly fascia lata, patellar tendon and/or quadriceps tendon, and hamstring tendons.

Autografts as well as allografts, also of the Achilles tendon, have been used (57, 58).
The latter have been processed deep-frozen, freeze-dried, sterilized with ethylene oxide, or with gamma radiation. These processings also influence the mechanical characteristics of the grafts (80).

Xenografts on the other hand have been relatively rapidly discarded, because of deleterious short-term results.

The fixation of the graft is performed with sutures, bone screws, interference screws, staples or special anchors. Surgical techniques also evolve over time, sometimes on unproven grounds (32), but also based upon better knowledge of graft materials and intraarticular anatomy.

It has been suggested, but not demonstrated, that the iatrogenic complications, as well as some poor outcome results after ACL reconstruction, are related to imperfect surgical techniques and inadequate or suboptimal anatomic reconstructions (4, 27).

One can question this view, considering the tremendous emphasis on surgical techniques for ACL reconstruction to be found in the literature and the huge number of ACL reconstructions performed (30).

Moreover, the laxity after surgical treatment remains worrisome, as it is seen to progress over time (18, 36, 64, 66, 79), and since a notable proportion of patients will ultimately not be stabilized by the procedure.

A few reports (36, 37, 61, 64, 66, 79) studied the laxity and the functional scores at different time intervals. Johnson found no difference in laxity scores after 5 to 7.5 years of follow-up, compared with 7.5 to 10 years of follow-up (37).

A recent paper did not report an increasing laxity between 1 and 5 years of follow-up (61).

Most other sequential reports show a deterioration to occur, mostly between 2 and 5 years of follow-up. This probably explains Johnson's absence of difference, as the laxity had already recurred before the 5- to 7.5-year time interval. The deterioration is mainly visible in the laxity data, less in the functional scores. The latter can paradoxically improve, but this is mostly the effect of regaining some motion which had been reduced due to the reconstructive procedure.

Due to many pessimistic short- and medium-term reports, the use of synthetics has nowadays been virtually discontinued (33, 43, 55, 60). De Smedt (24) has clearly demonstrated that the broad dissemination of these unproven techniques and devices fooled numerous surgeons, and led thousands of patients to be submitted to operative treatments of which the results could have been predicted by a few scientifically sound reports.

The high number of prosthetic ligament failures, combined with foreign body reactions to abrasion

particles even generated the development of specific revision techniques (32).

The association of mechanical degradation through laxity and meniscal loss, with biological degradation through particle-induced foreign body synovitis, probably explains the high rate of secondary osteoarthritis after procedures using synthetics.

The present analysis also shows a discrepancy between functional scores and clinical laxity tests. Laxity values obtained by static laxity tests are of course useful evaluation data, but their value and relevance have to be considered with caution.

Indeed, the forces applied to the articular structures of the knee during these tests are probably very small compared to the forces generated during activities of daily living and sports. The acceleration and the resultant tissue strain could also be extremely different.

This hypothesis explains the higher percentages of positive instrumented Lachmann's found when testing the same knees with increasing displacement forces, e.g. as with the KT 1000 at 89 and 134 Newton and at maximal manual displacement force (3, 20).

On the other hand, Vergis and Gillquist have shown that ACL deficient knees, when tested with an electrogoniometric system during single step ascents and descents, were able to keep the active dynamic laxity within normal limits, despite revealing abnormal laxity during static tests (76). This emphasizes the role of proprioception and knee muscle activity.

As all functional scores are based partially on the patient's subjective assessment and symptoms, it is clear that the latter, and therefore also the scores, are closely activity-related.

A cascade of events has been described going from ACL disruption (associated or not with meniscal injuries) over to secondary reinjuries with meniscal tears and to joint arthritis (21).

The effect of ACL reconstructive surgery on this cascade of events remains unclear, and the further evolution of osteoarthritis is clearly not exclusively meniscus-related.

Whereas the surgical reconstructions suffer fewer secondary meniscal lesions, they end up with a higher percentage of osteoarthritis. Sommerlath had already demonstrated that there was a significant variation in osteoarthritis in ACL-deficient knees, not only related to the degree of meniscal loss, but also to the activity level (70). These clinical impressions were confirmed by Daniel *et al.*, who reported an increased incidence of osteoarthritis, diagnosed by radiology and bone scanning, in patients with "successfully" reconstructed knees. This could not be explained by a significantly higher incidence of meniscal surgery in patients who had undergone ACL reconstructions (20).

Similar findings were also reported by Fritschy *et al.* (31) and Aglietti *et al.* (2). The common link between these reports is a higher activity level in the ACL reconstructed knees, perhaps allowed by the ACL reconstruction.

The ratio of Noyes and Barber (56), 1/3 worse, 1/3 unchanged, 1/3 improved, is often quoted as what to expect from nonoperative treatment protocols. However the present analysis of nonoperative treatments of acute ACL injuries demonstrates clearly better results.

Series reporting the results of conservative treatment in lower activity level populations, and others in which treatment included patient counseling to avoid cutting, pivoting and jumping sports also report markedly lower rates of secondary meniscal surgery (13, 62) compared with series of conservative treatment in higher activity level populations with unrestricted sports participation (6, 15, 20). The rather low activity level, resulting in a reduced incidence of secondary meniscal lesions, can also explain the low rate of osteoarthritis. The only conclusion that can be drawn from the comparison of scores of surgical and conservative treatment, is that both treatment regimens offer almost equal results, but probably at different activity levels, as illustrated by the difference in sports participation which is almost twice as frequent after surgical treatment (74%) as after conservative treatment (45%).

Sports participation has to be questioned as an outcome criterion of ACL treatment. Whereas

sports participation at the same level, with the same frequency and intensity, was considered in former years "the" success criterion of ACL treatment, more thorough data on the imperfect nature of available ACL treatments have now shed a different light on ACL treatment outcome (27, 32).

The real benchmarks of success have to be the avoidance of treatment morbidity, secondary surgery and osteoarthritis. This supports the hypothesis of Dye of the "envelope of function" as a zone in which articular homeostasis can be maintained in relation to some intensity and frequency of articular loading (25). This "envelope of function" can probably not be totally restored by ACL reconstruction, and unrestricted loading disrupts the homeostasis, which leads to osteoarthritis. On the other hand a more limited activity level with an unreconstructed knee can still allow articular homeostasis.

Nonetheless the orthopedic community has until now failed to produce sufficient well documented, randomised , long-term reports in order to establish a scientific evidence basis for the management of ACL lesions.

Even taking into account the difficulties related to, and the energy required by these studies, surgeons frequently confronted with ACL pathology should consider participation in these studies as an ethical duty, notwithstanding patient demands and economic pressures.

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SAMENVATTING

P. P. CASTELEYN. De behandeling van letsels van de voorste kruisband : heelkundig modeverschijnsel, persoonlijke voorkeur of wetenschappelijke gegrondheid ? Een studie van middellange en lange termijn resultaten.

De middellange en lange termijnresultaten van conservatieve en heelkundige behandelingen van voorste kruisbandletsels, werden door middel van literatuurstudie nagegaan. Enkel artikels met een minimale follow-up van 4 jaar werden hiervoor in aanmerking genomen.
Wat de conservatieve behandelingen betreft, kon de literatuurstudie enkel 7 artikels terugvinden, met een totaal van 636 gevallen.
De artikels betreffende de heelkundige behandelingen werden in 4 categorieën ingedeeld : primair heelkundig herstel, vertegenwoordigd door 13 artikels (1205 gevallen, extra-articulaire tenodese, vertegenwoordigd door 4 artikels (232 gevallen), voorste kruisbandreconstructies, vertegenwoordigd door 26 artikels (2693) en prosthetische synthetische vervanging, vertegenwoordigd door 5 artikels (370 gevallen).
Wat ook het type behandeling is, geven de functionele scores ongeveer 70% goede en uitstekende resultaten weer.
De klinische laxiteit blijft echter beduidend in bijna alle conservatief behandelde gevallen, in de helft van de gevallen met primair herstel, extra-articulaire tenodese en prosthetische vervanging en in bijna 1/3 van de gevallen met reconstructie van de voorste kruisband.
De incidentie van secundaire heelkunde ter hoogte van de voorste kruisband was het laagst in de conservatief behandelde groep (4.6%), daar waar secundaire heelkunde ter hoogte van de menisci het laagst was in de groep met reconstructie van de voorste kruisband (3.5%). Nochthans evolueerde deze laatste groep, in vergelijking met de conservatief behandelde groep naar een hogere morbiditeit in verband met osteoarthrose. Sportdeelname was wel belangrijker in de groep met reconstructie van de voorste kruisband.
Deze analyse biedt dus een wellicht meer realistische kijk op de resultaten van de behandeling van de voorste kruisbandletsels, en illustreert het verband tussen behandeling, activiteitsniveau en osteoarthrose.

RÉSUMÉ

P. P. CASTELEYN. Le traitement des lésions du ligament croisé antérieur : mode chirurgicale, préférence personnelle, ou évidence scientifique ? Étude des résultats à moyen et long terme.

Les résultats à moyen et long terme des traitements conservateurs et chirurgicaux des lésions du ligament croisé antérieur ont été évalués sur base d'une analyse de la littérature. Seules, les séries comportant un follow-up minimum de 4 ans ont été prises en considération.
En ce qui concerne les traitements conservateurs, l'étude de la littérature ne permet de retrouver que sept articles comprenant au total 636 cas.
Les articles concernant les traitements chirurgicaux ont été répartis en quatre catégories : les réparations primaires, avec 13 articles (1205 cas) les ténodèses extra-articulaires, avec 4 articles (232 cas), les reconstructions du pivot central avec 26 articles (2693 cas) et les remplacements prothétiques du ligament croisé antérieur, avec 5 articles (370 cas).
Les scores fonctionnels atteignent à peu près 70% de bons et excellents résultats, quel que soit le traitement.
La laxité clinique persiste dans quasi tous les cas traités de façon conservatrice, dans près de la moitié des cas des réparations primaires, des ténodèses extraarticulaires, et des remplacements prothétiques, et dans quasi un tiers des reconstructions du ligament croisé antérieur.
L'incidence d'interventions de reconstruction secondaire du pivot central, est la plus faible dans le groupe des traitements conservateurs (4.6%), alors que l'incidence de la chirurgie méniscale secondaire est la plus basse dans le groupe des reconstructions du pivot central (3.5%). Cependant, les traitements chirurgicaux évoluent plus souvent que les traitements conservateurs vers une morbidité liée à l'arthrose. La pratique sportive est cependant plus importante dans le groupe des reconstructions chirurgicales.
Cette analyse de la littérature permet une appréciation plus réaliste des résultats des traitements des lésions du ligament croisé antérieur, et met en exergue les relations entre traitement, niveau d'activité et arthrose.