Mucoid degeneration of the anterior cruciate ligament. Complete resection as equivalent treatment to partial resection

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Mucoid degeneration (MD) of the anterior cruciate ligament (ACL) is a benign knee pathology, which is often indicated for surgical treatment if symptomatic. Most authors believe that partial ACL resection is the treatment of choice in symptomatic MD of the ACL. This study concerns complete ACL resection as a treatment of mucoid degenerated ACL.

Thirteen patients were treated with complete ACL resection for symptomatic MD of the ACL from 2006-2016. Symptoms included limited range of motion (ROM) and posterior knee pain.

Preoperative and postoperative results of eleven patient were compared. Postoperative recovery was four weeks on average. All patients (100%, n=11) reported an improvement in pain. All patients with a preoperative limited ROM (100%, n=9) reported a return to a normal (subjective) ROM. Eight patients (72.7%, n=8) reported an improvement of knee instability, while three patients (27.3%, n=3) experienced an unchanged knee stability. All patients (100%, n=11) reported a good to very good surgery satisfaction. Preoperative and postoperative KOOS questionnaires were compared and showed improvement in all categories.

Complete resection of the ACL without ACL reconstruction is a reliable treatment for symptomatic cases of mucoid degenerated ACL.

Keywords : Anterior cruciate ligament ; mucoid degeneration ; posterior knee pain ; limited flexion ; complete arthroscopic resection.

INTRODUCTION

Mucoid degeneration of the anterior cruciate ligament (ACL) is a benign knee pathology observed primarily in middle-aged patients with a prevalence by MRI of 1.8 to 9.2% [2,10,18,32]. When examined histologically, this prevalence can increase to 62% [9]. However not all lesions are symptomatic and this pathology is often not known or mistaken for a partial or complete tear by radiologists [2,7,14,19,23,26,30,32]. This degenerative disease was first described in 1999 [20,25], but still no consensus exists about the precise etiology of this knee pathology. One hypothesis is that the mucoid degenerative ACL is a consequence of repeated microtraumata of the ACL fibers [12,20,33]. Though, most authors believe that this degeneration of the

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ACL is part of a continuum of degenerative changes of the knee joint, which includes degenerative meniscal tears and osteoarthrosis, but also mucoid cysts and ganglia of the ACL *(1,3,4,10,11,16-25)*. Symptoms of ACL mucoid degeneration are described very generally in literature as knee pain and limited range of motion with a gradual onset. According to some authors, this limited ROM is mainly present as limited knee flexion *(4,17,20,25,26,27)*, however other authors claim a predisposition for an extension deficit *(4,11,14,15,16,19,24,27,28)*. This difference in symptomatology could be attributed to the degeneration of either the anterolateral or the posterolateral bundle of the ACL which would lead respectively to a flexion or extension deficit *(4,6,15)*.

MRI is the gold standard to diagnose this knee pathology *(2,23)* and is necessary, as arthroscopy is sometimes insufficient to visualize mucoid degeneration of the ACL *(2,17,20)*.

Symptomatic mucoid degeneration of the ACL is treated with surgery, however treatment options range from periligamentous reduction plasty to complete resection of the diseased ACL, with or without a notchplasty *(15,20,26,30)*. Most authors prefer a debridement or partial resection of the mucoid degenerated fibers of the ACL as this pro-cedure would be sufficient to resolve the symptoms and the remaining fibers would provide enough joint stability in the middle-aged population *(4,6,14, 15,17,20,21,23,25,26,27,28,30)*. Consequently, minimal research has looked at the complete resection of the ACL as a treatment option as many authors believe this would lead to knee instability in the absence of subsequent ACL reconstruction *(16,20)*.

Therefore, the aim of this study was to assess the outcome of patients with a mucoid degenerative ACL treated with arthroscopic complete resection of the ACL without an ACL reconstruction.

MATERIALS AND METHODS

The inclusion criteria of this retrospective monocentric cohort study were all patients older than eighteen years who were diagnosed with a mucoid degenerative ACL between 2006 and 2016 and who underwent a complete arthroscopic resection of the ACL without having ACL reconstruction

surgery. From 2006-2016, nineteen knees (nine-teen patients) were diagnosed with a mucoid degenerative ACL in the universitary hospital of Leuven. In all cases, the mucoid degenerative ACL was diagnosed preoperatively by MRI using the criteria of Bergin et al *(2)*, with an indication of pre-existing persisting symptoms of knee pain and reduced knee mobility. The average age of this patient group at time of diagnosis was 50.0 years [36-76]. Five knees were excluded due to: lost to follow up (n=1), mucoid ACL resection with a simultaneous ACL reconstruction (n=1), mucoid ACL cyst resection without complete removal of the ACL (n=1), posttraumatic presentation with an incidental finding of a mucoid ACL (n=1) and a conservative (no known surgical) treatment of the mucoid ACL (n=1). The other fourteen patients were all treated with a complete resection of the mucoid degenerative ACL without ACL reconstruction and were therefore included in this study. All fourteen patients underwent arthroscopic surgery during which the diagnosis of ACL mucoid degeneration was confirmed and subsequently the complete ACL resection was performed. One patient had an extensive history of knee problems which would possibly bias the results (n=1) and was excluded. In the remaining patient group (n=13), the average age at time of diagnosis was 50.3 [41-69]. This group consisted of eight men and five women (M : F ; 1.6 :1) with an average age at time of diagnosis of respectively 48.6 and 53.2 years. Ten right knees and three left knees had surgery. Remarkably, nine of these thirteen patients had at least one meniscectomy (eight partial medial, one complete medial and one partial lateral meniscectomy) in their history with an average of 8 [1-21] years between the (last) meniscectomy and the ACL resection. Two patients had a concomitant meniscectomy (both partial medial) with the ACL resection and two patients never had knee surgery before. At the moment of ACL resection, all patients were known with associated knee pathologies. Associated knee pathologies included Medial Tibial Femoral Com-partment (MTFC) cartilage damage (n=10), medial meniscal tears (n=8), lateral meniscal tears (n=2), ACL mucoid cysts (n=3), chondrocalcinosis (n=1) and ITB-friction syndrome (n=1). In four cases, a

possible causal traumatic event was mentioned in the patient's history: rotation trauma (n=2), a fall on the knee (n=1) and a traffic accident with knee injury (n=1). In all thirteen cases, the reason for surgery was the mucoid degenerated ACL, however in ten cases, the ACL resection was combined with one or more associated procedures: a medial meniscectomy (n=7), a lateral meniscectomy (n=2), a cyst resection (n=3), a notchplasty (n=1) and a valgisation osteotomy (n=1). In no case was a biopsy performed. Only two patients underwent subsequent knee surgery after the ACL resection: a not otherwise specified operation performed in an external hospital (n=1) and a meniscectomy of the same knee as the ACL resection (n=1).

During 2016, all patients were invited for a pro bono consultation at the UZ Leuven hospital, campus Pellenberg or were contacted by phone. This clinical examination comprised completing the KOOS questionnaire, asking the patient about the evolution of the preoperative and postoperative knee pain, knee stability, knee range of motion and general satisfaction of the surgery, testing the knee range of motion (ROM) as well as performing knee stability tests including the anterior drawer test and the Lachmann test. The patients contacted by telephone were asked to complete the KOOS sent to them by post. This telephone survey included the same verbal quality and functional assessments as the clinical visits. Two patients did not return the KOOS and did not want to complete this survey by phone. Consequently, postoperative at the end of follow-up data were available from eleven patients.

The final data collection was obtained by using the preoperative and postoperative data available from the patients' electronic charts (n=13) combined with the information obtained during the clinical examination or telephone contact (n=11).

The preoperative and postoperative KOOS and knee stability tests (anterior drawer test and Lachman test) were compared with each other. Preoperative ROM was compared with post-operative knee ROM after four weeks as well as with the knee ROM measured during the end of

Table I — Scoring of knee pain, knee instability,
knee mobility and surgery satisfaction questioned postoperatively at the end of follow-up

SUBJECTIVE KNEE SCORES	0	1	2	3
KNEE PAIN	NO PAIN	LITTLE PAIN ; ONLY DURING INCREASED ACTIVITY	MODERATE PAIN ; CONTINUOUS PAIN	SEVERE PAIN ; CON-TINUOUS PAIN WITH FUNCTIONAL IMPAIRMENT
KNEE INSTABILITY	NONE	LITTLE INSTABILITY ; FEELING OF INSTABLE KNEE WITH NO OR FEW EPISODES OF KNEE GIVING OUT	MODERATE INSTABI-LITY ; EPISODES OF KNEE GIVING OUT	SEVERE INSTABILITY; FREQUENT EPISODES OF KNEE GIVING OUT, FUNCTIONAL IMPAIR-MENT
KNEE MOBILITY	NORMAL	LIMITED, THOUGH ENOUGH FOR NORMAL FUNCTIONING	SEVERLY LIMITED ; FUNCTIONAL IMPAIR-MENT	NONE
SURGERY SATISFACTION	VERY GOOD POSTOPERATIVE CONDITION, (PRAC-TICALLY) COMPLETE SYMPTOMATOLOGY RESOLUTION. VERY SATISFIED, WOULD REPEAT SURGERY IMMEDIATELY	BETTER POSTOPERA-TIVE CONDITION ALTHOUGH NO COM-PLETE SYMPTOMA-TOLOGY RESOLUTION	SAME SYMPTOMS AS BEFORE SURGERY ; FEELING OF HAVING HAD UNNECESSARY SURGERY	WORSE POSTOPERATIVE SYMPTOMS ; STRONG DISSATISFACTION, WOULD NEVER REPEAT SURGERY.

Table II — Results of the RO

ROM KNEE	PREOPERATIVE (n=13)		POSTOPERATIVE 4 WEEKS (n=13)		END OF FOLLOW-UP (n=11)	
	EXTENSION	FLEXION	EXTENSION	FLEXION	EXTENSION	FLEXION
AVERAGE ± SD	5.38° ± 8.77	110.38° ± 16.26	1.15° ± 2.20	130.38° ± 6.28	2.27° ± 2.61	131.36° ± 4.52
RANGE	[0-30°]	[90-135°]	[0-10°]	[120-135°]	[0-5°]	[120-135°]

Table III — Comparison of the ROMs

ROM KNEE	PREOPERATIVE – POSTOPERATIVE 4 WEEKS (n=13)		POSTERATIVE 4 WEEKS – POSTOPERATIVE END OF FU (n=11)		PREOPERATIVE – POSTOPERATIVE END OF FU (n=11)	
	EXTENSION	FLEXION	EXTENSION	FLEXION	EXTENSION	FLEXION
AVERAGE ± SD	4.23° ± 9.22	20.0° ± 15.21	-0.14° ± 2.02	1.82° ± 4.62	4.09° ± 8.31	21.82° ± 15.21
RANGE	[0-30°]	[0-45°]	[-5-0°]	[-5-10°]	[-5-25°]	[0-45°]

Table IV — Preoperative status of knee pain,
knee instability and knee mobility questioned postoperatively at the end of follow-up (n=11)

PREOPERATIVE (n=11)	0	1	2	3
KNEE PAIN	0	0	3 (27.3%)	8 (72.7%)
KNEE INSTABILITY	0	2 (27.3%)	6 (45.4%)	3 (27.3%)
KNEE MOBILITY	2 (18.2%)	0	9 (81.8%)	0

Table V — Postoperative status of knee pain,
knee instability and knee mobility as well as surgery satisfaction questioned postoperatively at the end of follow-up (n=11)

POSTOPERATIVE (n=11)	0	1	2	3
KNEE PAIN	4 (36.4%)	7 (63.6%)	0	0
KNEE INSTABILITY	2 (18.2%)	7 (63.6%)	2 (18.2%)	0
KNEE MOBILITY	10 (90.9%)	1 (9.1%)	0	0
SURGERY SATISFACTION	8 (72.7%)	3 (27.3%)	0	0

follow-up clinical examination. During the clinical examination or telephone contact, the patient was asked to rate preoperative as well as postoperative knee pain, knee instability, knee mobility and surgery satisfaction on a scale of 0-3 (Table I). In any case, the patient was explained very clear that all these questions were about the ACL resection surgery and therefore these questions had to be answered with this ACL resection in mind to avoid bias of earlier or later knee operations. In doing so, emphasis was placed on the date of surgery as well as the side of knee surgery.

RESULTS

While all patients diagnosed from 2006 - 2016 were included, no patients were diagnosed with a mucoid degenerative ACL earlier than 2010. The average follow-up was 3 [1-6] years.

On average, flexion and extension four weeks postoperative improved 20.00° [0-45°] and 4.23° [0-30°] respectively when compared with the preoperative examination (Table II-III). From four weeks postoperative until the end of follow-up KOOS administration (2016), flexion only increased another 1.82° and no further extension

improvement (-0.14°) was seen. When rating the preoperative and postoperative ROM (Table IV-V), nine patients (81.8%) indicated a severely limited knee mobility preoperatively. The preoperative clinical examinations (n=13) showed a flexion

deficit in eleven patients (84.6%) and an extension deficit in six patients (46.1%). The two other patients (15.4%) indicated to have a normal ROM preoperatively, which agreed with the findings of the preoperative clinical examination. These two patients had a preoperative ROM of 0-130° and their reason for presentation was severe knee pain. All patients with preoperative subjective limited ROM (81.8%, n=9) demonstrated postoperatively a return to (subjective) normal knee mobility. Indeed, at the end of follow-up, all cases (100%, n=11) showed a near to normal knee ROM with an average flexion and extension of respectively 131.36° [120-135°] and 2.27° [0-5°]. One patient indicated that knee mobility only improved moderately, however this patient showed a near to normal (5-130°) ROM during the postoperative clinical examination.

All patients suffered from severe knee pain preoperatively, which was demonstrated by the preoperative VAS, KOOS and postoperative sub-jective documentation. (Table IV-VI). Of the nine included patients who filled in the VAS pre-operatively, the average VAS was 63.0/100 [29-90]. Ten patients (76.9%) reported that pain was the main reason for consultation. Pain was also present in the other three patients (23.1%), although in these cases it was mainly limited knee mobility combined with knee instability that promoted consultation. At the end of follow-up, all patients (100%) indicated that the knee pain in general ameliorated after surgery, though in only four cases (36.4%) disappeared completely. The other seven patients (63.6%) reported knee pain with increased activity, though with no functional limitation in ADL activities. Most likely, this is attributable to the fact that all patients (100%) had associated knee pathologies.

At the end of the follow-up (n=11), only three patients (27.8%) had positive knee instability tests. The remaining eight patients (72.7%) had a firm stop when examining knee stability. When rating the preoperative and postoperative instability, no patients reported a greater feeling of instability

postoperatively (Table V). Eight patients (72.7%) indicated that the feeling of stability improved after surgery and three patients (27.8%) reported that stability remained the same in comparison with preoperatively. This can be attributed to the fact that all patients had an intense physiotherapeutic revalidation existing of quadriceps tonification after the ACL resection.

All eleven patients (100%) seen for clinical examination indicated that surgery had a positive influence on the symptoms (Table V). Eight patients (72.7%) reported that surgery brought complete symptom resolution. Three patients (27.8%) indi-cated that surgery ameliorated symptoms although knee pain and knee instability did not resolve completely postoperatively. Important, these three patients already had an extensive knee history before the ACL procedure consisting of meniscectomy. Therefore, most likely, the persistence of the knee pain and instability is contributable to the already present knee damage.

KOOS questionnaire

Postoperatively, KOOS results greatly impro-ved in comparison with preoperative results. Preoperative KOOS results were available from ten patients (Table VI) and postoperative KOOS results were available from eleven patients (Table VII), however there were only eight patients with preoperative and postoperative KOOS which could be used for comparison (Table VIII). KOOS results considering sports were available preoperative from eight patients and postoperative from nine patients. Return to sport could only be evaluated in five patients since the other patients indicated that they did not perform any types of sports anymore. Comparison of stiffness was not possible since this parameter was measured preoperatively with the WOMAC questionnaire.

DISCUSSION

Mucoid degeneration of the ACL is a common knee pathology, with an estimated prevalence by MRI of 1.8-9.2% *(2,10,18,32)*. However, the pre-valence of a disabling, i.e. symptomatic enough

Table VI — Results of the preoperative KOOS questionnaires

KOOS PREOPERATIVE (n=10)	PAIN /100	SYMPTOMS /100	STIFNESS/100 (WOMAC)	ADL /100	SPORTS/100 (n=8)	QOL /100
AVERAGE ± SD	45.5 ± 12.4	47.3 ± 22.9	46.3 ± 17.7	56.9 ± 14.7	23.8 ± 17.7	30.0 ± 14.1
RANGE	[27.7-61.1]	[21.4-92.8]	[25-75]	[35.2-86.7]	[0-50]	[6.2-43.7]

Table VII — Results of the postoperative KOOS questionnaires completed at the end of follow-up

KOOS POSTOPERATIVE (n=11)	PAIN /100	SYMPTOMS /100	STIFFNESS /100 (KOOS)	ADL /100	SPORTS /100 (n=9)	QOL /100
AVERAGE ± SD	91.6 ± 6.7	92.7 ± 6.8	86.6 ± 19.2	93.7 ± 7.1	66.1 ± 37.5	69.9 ± 13.4
RANGE	[82.1-100]	[77.8-100]	[50.0-100]	[77.9-100]	[15-100]	[50-93.8]

Table VIII — Comparison of the preoperative and postoperative end of follow-up KOOS questionnaires' results

KOOS PREOPERATIVE – POSTOPERATIVE(n=8)	PAIN /100	SYMPTOMS /100	STIFFNESS /100 (WOMAC- KOOS)	ADL /100	SPORTS /100 (n=5)	QOL /100
AVERAGE ± SD	42.2 ± 16.9	44.2 ± 26.2	NA	33.0 ± 19.6	39.0 ± 34.4	41.4 ± 14.5
RANGE	[-3.5-67.9]	[16.7-69.5]	NA	[-8.8-54.5]	[5-85]	[18.8-62.6]

to seek medical help, mucoid degenerative ACL is much lower (2,4,14,20,21,26,32). In this study, only nineteen cases of symptomatic mucoid degeneration of the ACL were observed in the period of 2006-2016. This knee pathology is mainly present in middle-aged patients (2,10,18,32). The average age of all nineteen cases was 50.4 [36-76] years, which is similar to previous studies (21).

In this study, ACL mucoid degeneration is presented clinically with a flexion deficit (84.6%) with or without an extension deficit (46.1%), if a knee ROM of 0-130° is considered as normal. In all cases, knee pain was the most common symptom. Resection of the complete mucoid degenerative ACL provided pain alleviation in all cases, although only in four (36.4%) of the thirteen cases complete pain relief was obtained. Knee pain was mostly present posteriorly and provoked with flexion, however some patients reported lateral or medial knee pain, likely attributable to the associated knee problems (14,15,25,30), mainly of the MTFC and the medial meniscus. A predisposition to MTFC cartilage damage and degenerative medial meniscal tears has already been described in previous reports (4,10,14,15). Therefore, we also believe that mucoid degeneration of the ACL is part of a whole knee degenerative process, including cysts and ganglia of

the ACL (2,4,7,10,19,23). In this study, three (23.1%) of the included patients had concomitant cysts of the ACL. Though four (30.8%) of the included patients had a history of knee trauma, we do not believe that knee trauma has an influence on the pathogenesis of mucoid degeneration of the ACL (11,15,26,27).

Several surgical treatment options are cited in the literature regarding symptomatic mucoid degeneration of the ACL, of which partial ACL resection is best studied. Complete resection as well as partial resection of the mucoid ACL gives good outcomes towards pain and knee mobility (18,20). In this study, we found a flexion and extension deficit improvement of 20.00° and 4.23° respectively after four weeks. These deficit improvements as well as the average time of recovery of four weeks are consistent with previous reports (21). While many authors believe that a complete ACL resection would increase the risk of knee instability problems (16,20,21,31), in our study, all patients (100%) had a same or better subjective knee stability. Only three patients (27.2%) had positive knee stability tests at the end of follow-up, albeit without functional limitations. Therefore, we believe that partial resection of the degenerative ACL does not provide an added value in the middle-aged sedentary population for the following reasons. In most cases, the remaining

ACL fibers are diseased and have insufficient mechanical strength to prevent excessive knee motion and likely tear eventually *(13,17,23,25,26,31)*. This is presumably because also the remaining ACL fibers are diseased even though it is not visible during arthroscopy *(2,17,20)*. Secondly, the interstitial degenerated portion of the ACL may be missed or underdiagnosed, given the difficulty in diagnosing the affected portion based on arthroscopic findings alone and therefore, it is doubtful whether partial resection would completely relieve the preoperative symptoms *(17)*. In this study, only one patient was treated with a notchplasty and so we believe that a notchplasty is not necessary in treating ACL mucoid degeneration *(4,15,22,27,28)*.

Many authors also believe that after complete ACL resection without ACL reconstruction the absence of an ACL would lead to more knee joint damage *(5,8,29,34,35)*. However, recent literature is available stating that conservative treatment (i.e without ACL reconstruction) is as good as the surgical treatment in the elderly sedentary population and that there is no difference in degenerated knee damage between conservatively treated patients and surgically treated patients after 10 years of follow-up *(1,3,36)*.

Therefore, we believe that a complete ACL resection without a notchplasty and without an ACL reconstruction is a reliable treatment for mucoid degenerated ACL in the middle-aged sedentary population**,** if combined with intense postoperative physiotherapy.

Weaknesses and limitations of this study were the retrospective design and the small number of included patients, which would make statistical analysis of the data irrelevant. The strength of this study is the fact that minimal research is done about complete ACL resection as a treatment of mucoid ACL degeneration *(16,21)*, since most literature available about this knee pathology is concerning partial ACL resection. Consequently, this study adds concrete results concerning this treatment to the literature.

CONCLUSION

Mucoid degeneration of the ACL is a frequent pathology in middle-aged patients, however most cases are asymptomatic. Symptomatic mucoid degenerated ACLs present with posterior knee pain and a flexion deficit with or without an extension deficit of the knee joint. Surgical treatment of this knee pathology is often indicated. Complete resection of the mucoid degenerated ACL without notchplasty gives good objective and subjective results concerning knee pain, knee ROM and knee stability. After resection, an ACL reconstruction is not necessary in the middle-aged sedentary population if there is intense physiotherapy postoperatively.

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