Meniscal problems: to repair and to replace

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Long-term clinical outcome of open meniscal allograft transplantation.

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ABSTRACT

Background: Meniscal allograft transplantation for the symptomatic post-meniscectomized knee in younger patients has become an accepted treatment. However, long-term data on the clinical outcome of this procedure are scarce.

Hypothesis: Cryopreserved meniscal allograft transplantations can be in the long-term a good alternative for the symptomatic post-meniscectomized knee in younger patients.

Study Design: Case series; Level of Evidence, 4.

Methods: Sixty-three meniscal allografts were transplanted with an open procedure in 57 patients. Clinical outcome and failure rate of 40 lateral and 23 medial meniscal allografts were evaluated at a mean follow-up of 13.8 years ± 2.8 years. Mean age at time of transplantation was 39.4 years ± 6.9 years.

Results: Eight medial allografts (35%) and ten lateral allografts (25%) failed. Overall failure rate was 29%. A significant improvement in overall mean Lysholm score was seen, from 36 ± 18 points (range, 5-86 points) preoperatively to 61 ± 20 points (range, 21-91 points) at long-term follow-up. Long-term and preoperative Lysholm scores were not significantly different in the following subgroups; medial allografts, female patients and left treated knees. All subgroups had a poor Lysholm score at mean follow-up of 13.8 years, except the male patient group which had a fair Lysholm score. Short-term Lysholm scores at a mean follow-up of 3.1 ± 1.5 years (range, 0.5-7.3 years) was overall 79 ± 19 points (range 19-100). A significant difference between short- and long-term Lysholm scores was found for all subgroups. Significant differences for KOOS and IKDC scores were only present between male and female patients. No significant differences in Lysholm scores were seen between post-transplanted survivors and post-transplanted non-survivors who received a total knee arthroplasty.

Conclusions: Long-term follow-up results show that meniscal allograft transplantation is a beneficial procedure. Good improvements in clinical function and pain relief have previously been shown at short-term follow-up in this population. Despite the deterioration over time in function scores, there is still improvement in level of function at long-term follow-up, but not at high level. This means that meniscal allograft transplantation is a good option for the treatment of degenerative arthritis of the symptomatic, post-meniscectomized knee. Meniscal allograft transplantation can be used to postpone total knee arthroplasty in younger patients.

INTRODUCTION

Menisci have an important role in load transmission, shock absorption, joint stability, lubrication and nourishment of the joint. In the initial report of Fairbank, the natural clinical history of meniscectomy on the knee was demonstrated.[7] Since then many clinical and biomechanical investigations have shown that meniscectomy can lead to progressive degenerative changes in the knee.[11,12,24] In addition it has been shown that the risk of post-meniscectomy arthritis correlates with the amount of meniscal tissue resected.[1,18] Arthritic disease after meniscectomy in active, younger patients (<55 years) is not uncommon and its prevalence is expected to increase. Surgical options for these patients by placing a total knee arthroplasty (TKA) or unicompartmental knee arthroplasty (UKA) remain controversial. The survival rate of TKA for younger patients (<55 years) in literature is scarce and varies between 85 and 99 at a minimum of 13 years follow-up.[6,8] In younger patients with a normal aligned knee, intact cruciate ligaments and disabling compartmental osteoarthritis meniscal allograft transplantation is another treatment option. Since the first human meniscal allograft transplantation in 1984 by Milachowski et al.[19], meniscal allograft transplantation has become an acceptable option for treatment of the post-meniscectomized arthritic knee. Short- and mid-term studies showed pain relief, functional improvement and improvement in the clinical and radiological survival of the allograft after transplantation.[4,23,25] Van Arkel et al. have already published an extended report about the short-term and mid-term results of this study population.[2,3] However, data on long-term follow-up of meniscal allografts is scarce.

The purpose of this study was to report the long-term results of 63 meniscal allograft transplantations with a mean follow-up of 13 years. We evaluated if meniscal allograft transplantation is an effective manner to improve patients' satisfaction and clinical outcome in younger patients because total knee arthroplasty has to be postponed. We paid special attention to the failure rate at long-term follow-up.

MATERIALS AND METHODS

Between 1989 and 1999, 57 patients received 63 cryopreserved non-tissue-antigen-matched human meniscal allografts. The study group consisted of 40 men and 17 women with a mean age of 39.4 ± 6.9 years (range, 26-55 years) at time of transplantation. The medial meniscus was transplanted in 17 patients (with and without sufficient ACL), the lateral meniscus in 34 patients, and six patients were transplanted with both menisci in the same knee. The mean interval period between total meniscectomy and meniscal allograft transplantation was 16.2 ± 7 years (range, 2-33 years). Details of the meniscal allografts and patient characteristics are given in Table 1 and 2. The indication, preopera-

tive planning, surgical procedure and postoperative management were described in detail in 1995.[2] Briefly; in the first series of 23 transplantations an open procedure was used to transplant unmatched, cryopreserved meniscal allografts in patients under the age of 55 years with disabling compartmental osteoarthritis after meniscectomy. No further inclusion criteria were used here. Inclusion criteria changed after the first series of 23 transplantations. In this first series 8 patients had an abnormal aligned knee (3˚ varus to 6˚ valgus) and 6 patients had a ruptured ACL. In the second series only patients under the age of 45 years with disabling compartmental osteoarthritis after meniscectomy and a stable, normal aligned knee were included. A diagnostic arthroscopy was performed before transplantation and routine radiographs were taken. Joint space narrowing was not scored. The grafts were fixed, without bony fixation, using six to nine absorbable and non-absorbable sutures. No immunosuppression was used. Intra-operative cartilage damage was scored using the Outerbrigde classification.[20]

Multiple attempts were made to contact all 57 patients by telephone. If they could be reached they were asked to complete postal questionnaires after they had given their informed consent. If patients could not be reached, their general practitioner was requested to give information about the patients' medical history. The patients were not evaluated in the outpatient clinic. Study instruments included the Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm and the International Knee Documentation Committee (IKDC) scoring system.

The criteria for failure of an allograft were complete resection of the graft, with or without placement of UKA or TKA.

Statistical analyses were performed using the paired samples *t* test, Spearman's rank correlation test and Levene's test. Survival rates were calculated using the Kaplan-Meier survival function. Alpha was set on 0.05 for statistical significance.

RESULTS

Eleven patients (two died and nine could not be traced) were lost to follow-up, three of them were known to have a TKA and their failure was included with the failures reported. The mean follow-up after meniscal transplantation was 13.8 ± 2.8 years (range, 9-18 years). Two patients had a total resection of a meniscal allograft and received a new meniscal allograft. The remaining 46 patients (81%) representing 49 allografts (78%) completed KOOS, Lysholm and IKDC-scores. The Lysholm score was categorized in four groups: excellent (94-100 points), good (84-94 points), fair (65-83 points) and poor (less than 65 points). Preoperatively eight patients (2 lateral and 6 medial) showed instability of the joint due to an insufficient ACL. In two patients an ACL reconstruction with the Slocum

procedure was performed simultaneously with a medial allograft transplantation.[21] In the remaining six patients no ACL reconstruction was performed.

Data of preoperative arthroscopy showed at least 19 patients (33%) with grade IV chondropathy and 24 patients with grade III, while preoperative arthroscopic data of 14 patients could not be retrieved (Table 1).

Table 1. Patient characteristics. Variables are presented as mean and range.

Allograft	Medial	Lateral	Combined	Total
N	17	34	6	57
Sex (female/male)	6/11	9/25	2/4	17/40
Mean age (yrs)	41 (30-55)	39 (26-51)	40 (31-47)	39 (26-55)
Mean interval (yrs)	16 (3-33)	16 (2-27)	15 (6-25)	16 (2-33)
Lost to follow-up	1	7	3	11
Mean follow-up (mths)	162 (105-206)	171 (106-221)	133 (107-183)	165 (105-221)
Number of ACL insufficiency (reconstructed)	6 (2)	2 (0)	0 (0)	8 (2)
Degree of chondropathy 3/4	9/4	13/14	2/1	24/19
Number of failure	5	7	3	15
Mean time to failure	82 (51-97)	161 (100-208)	95 (67-140)	123 (51-208)

Overall, eight medial allografts (35%) and ten lateral allografts (25%) failed. The combined failure rate was 29% (Table 2). Twelve patients (21%) were converted to TKA at mean follow-up of 10.8 ± 4.1 years (range, 5.6-17.3 years). Three patients (5%) had a resection of the graft at mean follow-up of 8.4 ± 4.8 years (range, 4.3-13.7 years). Four medial allografts (67%) failed in an ACL insufficient knee. A survival point of 52.5% was found after 16 years of follow-up (Figure 1).

Table 2. Failure rates of meniscal allografts.

Allograft	Right	Left	Total	Number of failure
Medial	12 (19%)	11 (18%)	23 (37%)	8 (35%)
Lateral	31 (49%)	9 (14%)	40 (63%)	10 (25%)
Total	43 (68%)	20 (32%)	63 (100%)	18 (29%)

A significant improvement in the overall mean Lysholm score was seen, from 36 ± 18 points (range, 5-86 points) preoperatively to 61 ± 20 points (range, 21-91 points) at long-term follow-up. The long-term and preoperative Lysholm scores were not significantly different in the following subgroups; medial allografts, female patients and left treated knees. All subgroups had a poor Lysholm score at a mean follow-up of 13.8 years, except the male patient group which had a fair Lysholm score. A significant difference between Lysholm scores of male and female patients was found (*P<0.001*). No significant differences for Lysholm scores at long-term follow-up were found between lateral and medial

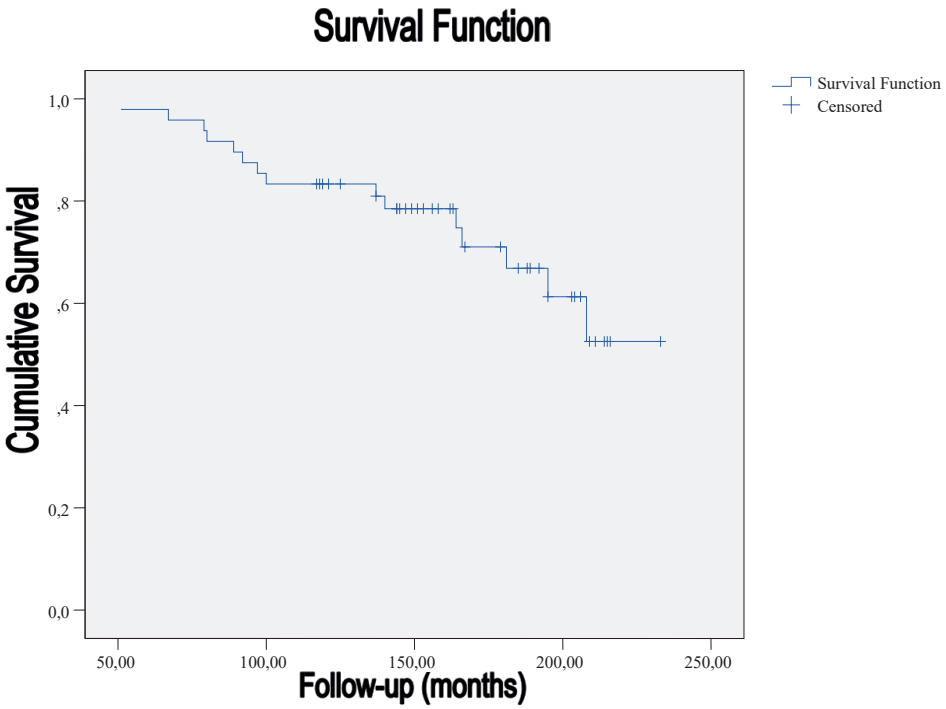

Figure 1. Survival curve of meniscal allografts

transplanted allografts or between right and left knees. No significant difference in Lysholm scores were seen between patients still having an allograft in situ at long-term and patients already converted to TKA at long-term follow-up (Table 3). A comparably significant difference between male and female patients was seen for the IKDC score (P=0.002) and three subgroups of the KOOS score: pain, symptoms and function, daily living (*P=0.014*).

In spite of the difference in function of both menisci; where a medial meniscus has a function as secondary stabilizer of the knee joint, the replacement of either a medial or lateral menisci had no effect on the final result. There were no significant differences between the lateral and medial allografts in long-term Lysholm, KOOS and IKDC scores. Likewise, no statistically significant difference was found between left and right treated knees.

Short-term Lysholm scores of the same population at a mean follow-up of 3.1 ± 1.5 years (range, 0.5-7.3 years) were used to compare with the long-term data. At short-term follow-up overall Lysholm score was 79 ± 19 points (range 19-100). As shown in table 3 a significant difference between short- and long-term Lysholm score was found for all subgroups. Lysholm scores were significantly improved at short-term follow-up compared to preoperative Lysholm scores for all subgroups (*P<0.001*). Patients with TKA after meniscal allograft transplantation presented the same scores at long-term follow-up as patients

Table 3. Function and pain scores at long-term follow-up.

Allograft	Med (n=17)	Lat (n=34)	p value	M (n= 40)	F (n=17)	p value	R (n=43)	L (n= 20)	p value	Allograft (n=33)	TKA (n=10)	p- value	Overall
Lysholm preop	44.00 (15-86)	37.10 (6-65)	0.304	38.52 (6-86)	43.40 (28-68)	0.465	37.77 (6-86)	44.45 (15-65)	0.302	40.00 (6-86)	27.50 (5-66)	0.127	36.36
Lysholm short-term	78.50 (55-100)	81.11 (34-100)	0.191	84.43 (55-100)	72.60 (34-99)	0.071	82.75 (34-100)	76.73 (55-100)	0.444	N/A	N/A	N/A	79.22
Lysholm long-term	55.36 (23-90)	63.90 (21-91)	0.278	68.74 (37-91)	43.40 (21-71)	**0.0001**	62.86 (21-91)	57.45 (23-90)	0.475	61.10 (21-91)	61.30 (18-100)	0.501	61.06
p value PO vs ST	**0.0001**	**0.0001**		**0.0001**	**0.005**		**0.0001**	**0.0001**		**0.0001**	NA		NA
p value PO vs LT	0.134	**0.000**		**0.0001**	1.000		**0.001**	0.053		**0.0001**	**0.001**		**0.001**
p value ST vs LT	**0.001**	**0.000**		**0.0001**	**0.000**		**0.000**	**0.001**		**0.0001**	NA		NA
IKDC long-term	37.20 (8-92)	50.98 (12-86)	0.115	53.92 (26-92)	27.93 (8-64)	**0.002**	48.85 (12-91)	40.44 (8-92)	0.328	46.50 (8-92)	51.12 (9-82)	0.265	39.99
KOOS long-term													
Pain	52.64 (19-100)	66.70 (22-100)	0.143	70.78 (42-100)	44.30 (19-83)	**0.003**	37.77 (22-100)	44.45 (19-100)	0.413	62.76 (19-100)	63.20 (22-100)	0.582	64.72
Symptom	54.09 (29-100)	60.10 (32-96)	0.448	65.43 (29-100)	46.00 (32-71)	**0.014**	59.00 (29-96)	60.63 (29-100)	0.839	59.55 (29-100)	63.30 (18-93)	0.255	61.41
ADL	61.09 (34-100)	72.75 (37-100)	0.219	77.17 (41-100)	50.70 (26-90)	**0.003**	71.64 (26-100)	64.18 (41-100)	0.418	69.15 (26-100)	70.00 (31-100)	0.560	71.31
S&R	23.18 (0-100)	40.00 (0-100)	0.132	40.00 (5-100)	23.50 (0-90)	0.157	34.77 (0-100)	35.45 (0-100)	0.953	35.00 (0-100)	44.50 (0-100)	0.239	36.09
QoL	27.36 (0-100)	43.00 (6-100)	0.127	43.96 (6-100)	26.30 (0-75)	0.810	41.64 (6-100)	32.55 (0-100)	0.372	38.61 (0-100)	41.40 (0-100)	0.498	39.81

PO = preoperative Lysholm score, ST = short-time Lysholm score, LT = long-term Lysholm score, NA = not available.

with initial meniscal allograft transplantation. No significant differences in Lysholm, KOOS and IKDC scores were found between these groups. Patients with TKA after meniscal allograft transplantation had a significantly better Lysholm score compared to the preoperative situation. Lysholm scores of patients with a TKA were not available at short-term.

A weak negative correlation (-0.017) between preoperative cartilage grades and preoperative Lysholm scores was found. A positive correlation (0.149 and 0.058) between was found between postoperative cartilage grades and Lysholm scores at mid-and long-term follow-up. None of the correlations found, were significant.

DISCUSSION

Meniscal allograft transplantation is a procedure that can be used to treat young patients with a disabling and painful post-meniscectomized knee joint. Since the first meniscal allograft transplantation, numerous studies related to meniscal transplantation have been published.[3,4,19,23] Long-term data however, are scarce and most report follow-up of small numbers of patients.[14,26,27]

With this study we showed, after more than nine years of follow-up, that the life span of meniscal allografts is restricted, despite the ability of the allograft to attach to the knee capsule followed by revascularization and restoration of adequate biomechanical status.[2]

Other factors like graft size, graft selection, surgical techniques, fixation of the graft and patient selection play an important role in the durability of the graft.[15] Besides that, long-term follow-up results are expected to be affected by the initial condition of the cartilage. This could be an explanation of the deterioration in clinical function score over time as we showed in our study.

In our study 21% of the patients (= 24% of the allografts) received TKA after meniscal transplantation at mean follow-up of ten years. However, 79% of the patients (= 76% of the allografts, re-implanted allografts included) are still expected to have at least one meniscal allograft in situ, with a function better than prior to meniscal allograft transplantation. This survival rate is equivalent to those of TKA in young patients as reported in the available literature.[19] However, some of the in situ allografts could be extruded or worn down. To confirm the presence of the allografts radiographic evaluation using MRI would be needed.

Survival analysis of this population showed a survival point of 52.5% after 16 years. Surviving data of 15 years or longer of an equal population having a TKA at young age are very scarce in literature, varying from 87 to 95%.[5,6] However, it would be interesting to have life-time follow-up of both groups to see the overall quality of life after revision or primary TKA. The difference between both groups is that the patients after meniscal allograft transplantation still have the possibility to receive a primary TKA. Patients with a failed primary TKA need revision surgery at younger age which could give problems later

in life. As far as we know no studies are published about re-revisions of TKA. This is the reason that primary TKA in younger patients is still controversial in orthopedic surgery.

We also showed that patients with TKA after meniscal allograft transplantation function as well as those patients who still have a meniscal allograft in situ. The Lysholm scores for both groups should be compared with young patients having primary TKA after meniscectomy in a randomized controlled trial to examine the effect of meniscal allograft transplantation on TKA.

The failure rate, pain scores and function scores at long-term follow-up for this population is expected to be affected by the interval between meniscectomy and transplantation. Besides that, clinical outcome of this population is also affected by the amount of preoperative chondropathy, fixation of the allograft, ACL insufficiency and patient selection, as shown in earlier literature.[3, 16, 17]

The mean interval of 16 years between meniscectomy and meniscal allograft transplantation is long, leading to a higher level of chondropathy prior to transplantation. As seen in this population at least 33% of the patients had grade IV chondropathy of the tibia and/or femur. A high grade of chondropathy on the femur negatively influenced the pain and function outcomes at long-term follow-up.[16] That is why we see grade IV chondropathy, especially on the femur condyle, as a contraindication for transplantation. We expect that, to make meniscal allograft more successful, the interval between meniscectomy and meniscal allograft transplantation should be smaller than at least 16 years to prevent the progression of chondropathy at time of transplantation.

By improving the indication for meniscal allograft transplantation, improvement in long-term results can be achieved. An intact ACL is very important, because laxity of the knee leads to higher demands on menisci.[13] That is also the reason for fewer failures in lateral allografts compared with medial allografts. These differences can be explained by the anatomical and functional differences between both menisci. The medial meniscus is a secondary stabilizer of the knee joint. In the ACL insufficient knee, the medial meniscus plays an even more important role in joint stability.[13] Absence of the ACL leads to damage or detachment of the allograft. This explains the negative correlation found between success of the medial meniscal allograft and presence of intact ACL in our population. The difference between preoperative and increased long-term follow-up Lysholm scores between medial and lateral menisci is probably due to the difference in the presence of an insufficient ACL in both groups. Based on published literature[16] and our own results we know that ACL instability should be addressed either prior to or concurrent with meniscal allograft transplantation. We state that ACL insufficiency is an absolute contraindication for meniscal allograft transplantation.

As described earlier we used peripheral suturing to fixate the allograft. This fixation technique produces more peripheral extrusion and leads to a higher contact pressure between the tibia and femur.[16] Higher contact pressure probably has a negative influ-

ence on pain and function at long-term follow-up. By using bony fixation of the allograft and by preserving the outer rim of the damaged meniscus, particularly on the medial side, extrusion and contact pressure will decrease[16] and clinical outcomes at long-term are expected to improve. Nowadays indications for surgery have changed. Only patients younger than 50 years with symptomatic compartmental osteoarthritis (≤ grade III) after meniscectomy in a stable knee with normal alignment are suitable for transplantation.[16] Surgical techniques have also changed and have advanced along with instrumentation. Current meniscal allograft transplantation is performed arthroscopically using bony fixation. Results at long-term follow-up for these indications and surgical technique have not been reported, but improvement on survival, pain and function scores are expected.

The significant differences between male and female are hard to explain. Probably the differences in anatomical dimensions play a role in meniscal allograft transplantation. Differences in anatomical dimensions of the distal femur, proximal tibia and patella between both sexes are well described.[9,10] To prevent potential clinical differences based on sex, femoral implants are now designed with the known sex differences in mind. But further analysis on this topic in meniscal transplantation is still necessary.

Differences in level of activity could be an explanation for the significant differences between male and female. Because of lack of preoperative IKDC-scores and incomplete preoperative and long-term Tegner-scores further comparison on these topics was restrained.

As in all meniscal allograft studies, a lack of a control group, consisting of matched conservatively treated patients, limits the power of this study to detect a chondroprotective effect and the possibility to delay TKA or even on long-term an early revision. Additional and long-term studies are needed to evaluate the optimal timing and technique for meniscal allograft transplantation. Evaluation of long-term results of arthroscopic assisted meniscal allograft transplantation should follow to see if it is superior to an open procedure. The most important question is whether or not this procedure provides long-term prevention or delay of articular cartilage degeneration and osteoarthritis.

In conclusion, open meniscal allograft transplantation is a salvage treatment option for postponing TKA in the young patient with post-meniscectomy arthritis. There is a significant reduction of pain and improvement in function, clinical and radiological survival of the allograft after transplantation at short-term. At long-term follow-up both significant and insignificant improvement is seen after meniscal allograft transplantation. Patients younger than 50 years, with a normally aligned, stable knee joint with sufficient ACL are the best candidates for meniscal allograft transplantation. The aim of this treatment option is to delay the need for total knee arthroplasty.

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