Magnetic reasonance imaging of the surgically repaired meniscus

A 13-year follow-up study of 13 knees

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Background **This study was initiated to evaluate the long-term outcome of meniscal sutures and to correlate clinical findings with MRI findings. We were interested to see if a clinically healed meniscus also showed as such on MRI and if degenerative changes were present**

Patients and methods **We studied prospectively 13 patients (7 men) aged between 29 and 50 years, who had undergone closed meniscus repair between 1985 and 1988 using an inside-out technique, clinically and with MRI, with a mean follow-up time of 13 years.**

Results **Meniscal suture gave good clinical long-term results: all patients got a Hospital for Special Surgery score of more than 75%. In all patients the site of the previous suture was still visible on MRI, mainly from small metal artefacts in the meniscus. 4 of 7 patients with an unrepaired ACL lesion had signs of arthrosis and cartilage degeneration. MRI showed signs of mucoid degeneration or scar tissue in 6/13 of the patients.**

Interpretation **We believe that asymptomatic meniscal tears produce abnormal MR signals even though they have stable unions, and that MR signals at the site of repair represent edematous scar tissue, not true nonunions.**

Meniscal tears comprise 75% or more of all internal derangements of the knee (Shands et al. 1936). Although initially reported by Annandale in 1885, meniscus repair has not received widespread attention and acceptance until the last 2 decades, because of an awareness of the functional significance of normal menisci, documentation of the consequences of meniscus loss, increasing awareness of the healing potential of certain meniscus tears, and the development of reliable open and arthroscopic repair techniques (DeHaven 1999). Today's approach includes nonoperative treatment, partial meniscectomy, and meniscal repair as alternatives to routine meniscectomy. Long-term follow-up of meniscal repair procedures is important in order to ascertain that repaired menisci will survive, function effectively, and prevent the late degenerative changes seen after meniscectomy (Dandy and Jackson 1975, DeHaven 1999). This is a long-term follow-up.

Patients

Between 1985 and 1988, 20 consecutive arthroscopic meniscal repairs using an inside-out technique were performed on 20 knees of 20 patients. 13 patients returned for a clinical examination and MRI evaluation after 13 years of follow-up. The remaining 7 patients were interviewed by telephone. This study includes only those 13 patients who returned for a complete examination, including MRI evaluation.

MRI technique

All patients were examined with a sagittal fast spin-echo proton density and T2-weighted sequence (3 mm thickness), followed by a coronal mixed T1 and T2 weighted gradient-echo imaging technique (2 mm). For evaluation of cartilage, a

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sagittal T2*-gradient-echo technique was performed (3 mm).

Methods

History, physical examination, and preoperative CT-scan were always used to identify ligamentous or meniscal injury in all patients (Verdonk et al. 1991). The presence of a meniscal lesion was confirmed in all patients at the time of intervention.

Each patient was questioned regarding pain, swelling, symptoms of giving-way and, in an attempt to establish the functional level, his or her ability to return to sports or work. The knee was examined for an effusion, soft tissue swelling, joint line tenderness, intraarticular crepitus, and ability to squat. McMurray's test (Stone et al. 1990) was also performed. Muscle power, thigh circumference and range of knee motion were measured and compared to those of the contralateral extremity.

A modification of the Hospital for Special Surgery (HSS) knee rating system (Stone et al. 1990) was used for evaluation. Patients were assigned to either excellent, good, fair, or poor groups based on their HSS score. The study population consisted of 13 otherwise healthy, athletic persons (7 men, 7 right knees) whose mean age was 35 (29–50) years at the time of follow-up. The follow-up averaged 13 (12–15) years. The location and the extent of the tear were described by zones (R-R (red), R-W (white) and W-W) based on the distance from the Synovial Meniscal Junction (SMJ) and the length of the tear: length 1, 0–3 mm long; length 2, 4–6 mm; and length 3, > 6 mm. 4 patients had a tear between 0-3 mm in length, 6 patients between 3–6 mm and 3 patients had a tear of more than 6 mm. 2 tears were located in the red-red zone, 10 were in the red-white zone and 1 was in the white-white zone (Table). We used the hooked palpator with markings to make the measurements.

Techniques

20 patients underwent an arthroscopic meniscal repair using an inside-out technique as described by Henning (1983) and Cannon and Morgan (1994). We used absorbable sutures with double-barrelled tapered Keith needles that were custom-bent at surgery. Posteromedial and posterolateral cutaneous incisions and a popliteal retractor were routinely used to protect and retract neurovascular structures where the needles penetrated the posterior capsule as the sutures were tied over the capsule. During the procedure, the body of the meniscus and the peripheral rim were meticulously prepared. The sutures were placed at 3–4 mm intervals.

The aftercare included a 3-week period of maximum protection to provide the best opportunity for healing to occur. This was followed by a period of continued protection from heavy stresses during maturation of the repair tissue, until 3 months after surgery. After 3 months, a gradual return to full-speed running, agility, and unrestricted activities was encouraged as desired and tolerated.

Results

Based on a modification of the HSS knee evaluation form, 2 patients had an excellent result, 9 patients a good result, and 2 patients had a fair result. There were no poor results. Age did not change the outcome, probably because the selection criteria for meniscus repair were stricter in the older age group.

The sex of the patient had no effect on the outcome. All acute tears (injury-to-repair interval < 2 weeks) and 8/10 of all chronic tears (injury-to-repair interval > 2 weeks) had good-to-excellent results. The 2 patients in the fair group had a chronic tear. 2 of all tears were R-R tears. All R-R tear repairs and 8/10 of all R-W tear repairs showed good-to-excellent results. Only 1 W-W tear was repaired. This patient scored as having a good result. Patients with a tear-length between 0–3 mm had a good-to-excellent result. 2 patients with a tear-length between 3–6 mm had a fair result. All other patients had good-to-excellent results. Of the 13 patients at follow-up, 7 showed an associated ACL injury. 1 was reconstructed, 6 years after meniscal repair. Of these 6 patients, only 1 had a fair result and the other 5 patients had good-to-excellent results (Table). Complications included 1 superficial infection managed with antibiotics and 1 saphenous neurapraxia. No patient had permanent functional impairment. 7 patients of the initial group of 20 patients were interviewed by telephone. This group had similar results to the group of 13 patients who were examined (Table).

Patient distribution and results at 13 years of follow-up. MRI evaluation and results of patients interviewed by telephone

Patient	Age	Sex	Side	ACL	Zone	Location	A/C	Score	MRI evaluation
1	44	M	L		2	R-W	Acute	Excellent	Hyperintense area
2	50	M	L	Rupture	3	W-W	Chronic	Good	Hyperintense area, new tear
3	48	M	R	Rupture	1	R-W	Acute	Good	Cartilage degeneration (grade 3)
4	31	M	L	Rupture	2	R-W	Chronic	Good	Cartilage degeneration (grade 3)
5	35	M	R	Rupture	1	R-W	Acute	Good	Cartilage degeneration (grade 3)
6	38	M	R		2	R-W	Chronic	Fair	
7	37	M	L	Repaired	1	R-R	Acute	Good	Hyperintense area, cartilage degeneration (grade 1)
8	31	F	R		1	R-W	Chronic	Excellent	
9	29	F	L	Rupture	3	R-W	Chronic	Fair	Cartilage degeneration (grade 1)
10	32	F	R		2	R-W	Acute	Good	Hyperintense area
11	34	F	L		2	R-W	Chronic	Good	
12	31	F	R	Rupture	3	R-R	Acute	Good	Cartilage degeneration (grade 3)
13	44	F	R		2	R-W	Chronic	Good	Hyperintense area
1	42	M	R		2	R-R	Acute	Excellent	
2	37	M	L		3	R-W	Acute	Good	
3	34	M	R	Rupture	1	R-W	Chronic	Fair	
4	41	M	L		2	R-W	Chronic	Good	
5	33	F	R		1	R-R	Acute	Good	
6	36	F	L		3	R-W	Chronic	Good	
7	37	F	L		1	R-R	Acute	Excellent	

MRI evaluation

We used MRI, which is at least as accurate as arthrography in assessing meniscal repair (Van Trommel et al. 1998). In all patients (n = 13) the site of the previous suture could still be detected, mainly by the small micrometal artefacts in the meniscus, evident on the gradient echo images (Figure 1). In 1 patient, a new tear was found. This tear was not repaired. There were no signs of this tear in 1999. In 5 patients hyperintense areas were discovered in the meniscus, in the area of the previous intervention. We presume that this corresponds to mucoid degeneration or scar tissue (Figure 2). 7 patients had an ACL rupture, of which 1 was repaired 6 years after meniscal repair: 4 patients clearly showed an early onset of arthrosis and cartilage degeneration (grade 3) (Figure 3) and 2 showed minor signs of cartilage degeneration (grade 1) (Recht et al. 1993). The patients with grade 3 lesions had good-to-excellent functional results (Table). 1 patient showed a localized area of avascular necrosis on the posterior part of the femoral condyle at 7 years of follow-up. In 1999, these signs had clearly diminished. The knot of the meniscal suture had been at this level and had presumably caused this lesion through direct pressure. As the knot gradually resorbed, the condyle recovered (Figures 3 and 4). In 1994, the site of the previous suture was also visible in all patients.

Discussion

In our study, chronicity of the tear was found to affect the percentage of satisfactory results. All the menisci repaired within 2 weeks of injury had a good-to-excellent result. 7 patients sustained an ACL injury (1 reconstructed). All patients had good-to-excellent results. Stability of the knee did not seem to affect the result of meniscal repair. A study by Hanks et al. (1990) described meniscus repair in y ACL-deficient knees, with a 13% failure rate. These authors concluded that even though the failure rate may be higher in an unstable knee, meniscus repair was not contraindicated in an ACL-deficient knee. Roos et al. (1995) concluded that OA of the knee after injury to the ACL or meniscus became increasingly severe with increased time between joint injury and examination. The OA changes appeared sooner in the older patients than in the young. In our study also, the youngest patient showed only minor cartilage degeneration.

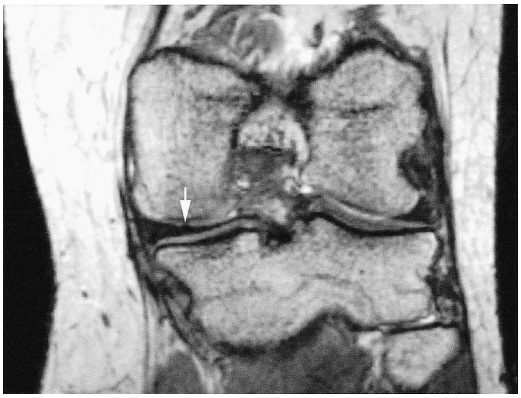

Figure 1. Coronal gradient-echo MRI image. Small micrometal artefacts in the meniscus or cartilage, showing the previous site of suture (arrow).

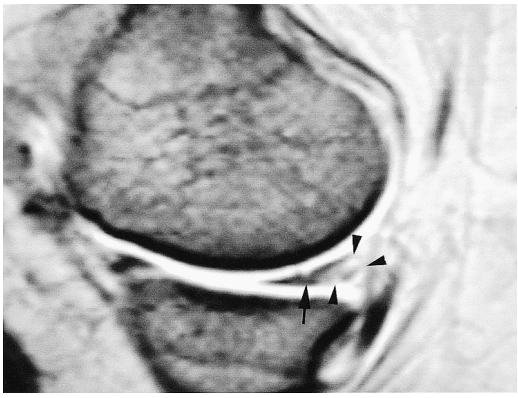

Figure 2. Sagittal T2*-weighted gradient-echo image showing a hyperintense area in the meniscus due to mucoid degeneration (arrowheads). A surface incongruity is also visible (arrow).

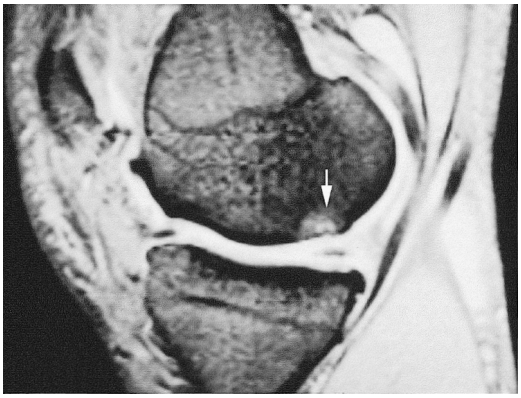

Figure 3. Sagittal T2*-weighted MR image showing arthrosis and cartilage degeneration (grade 3), most evident opposite the posterior horn of the sutured medial meniscus (arrow). This is a localized area of avascular necrosis in the subchondral bone with trabecular bone resorption (arrow).

Figure 4. The same patient as in Figure 3 at final follow-up. 5 years later, there are no longer signs of localized necrosis but only subchondral sclerosis. There is a localized area of cartilage thinning opposite the posterior horn of the sutured meniscus.

Neither the age of the patient, nor the length or extent of the tear seemed to affect the result of meniscal repair. We believe that in symptom-free patients, the meniscus is either histologically healed or acts as an autograft and fulfills the mechanical tasks of an injured meniscus. Only one W-W tear was repaired and this patient scored a good result. Rubman et al. (1998) recommended arthroscopic repair for meniscal tears extending into the avascular zone in select cases. The 20% reoperation rate in their study should not be interpreted as the rate of meniscal healing, but as the incidence of tibiofemoral joint symptoms.

Link et al. (2003) concluded in their study that cartilage lesions, bone marrow edema pattern, and meniscal and ligamentous lesions were frequently seen on MR images in patients with advanced osteoarthrosis. Clinical findings, however, showed no significant correlations with Kellgren-Lawrence scale score and extent of findings at MR imaging. Long-term studies evaluating the development of arthrosis in patients with clinically healed meniscal tears after arthroscopic repair may provide more evidence to support this hypothesis. We found the presence of mucoid degeneration or scar tissue in 5/13 patients after an average follow-up of more than 13 years. Thus, we believe that asymptomatic menisci produce abnormal MRI signals even though they have stable unions, and that MRI signals at the site of repair represent edematous

scar tissue, not true nonunions. Eggli et al. (1995) found similar findings in their study. Englund et al. (2001) reported in their study that the long-term outcome of meniscal injury and surgery appears to be determined largely by the type of meniscal tear. Furthermore, their findings supported the use of minimal meniscal resection in the treatment of degenerative tears. They suggested that the disease processes associated with the development of OA of the joint cartilage may also be active in the meniscus, and that a tear in a meniscus with degenerative changes might be regarded as the first sign of OA of the joint.

Our current protocol for the repair of meniscal tears relies on several technical details that we think are essential for the successful repair of meniscal tears. A careful examination is required to determine the integrity of the tissue and assess chronic changes, such as deformation or degeneration. The meniscus must contain a reducible tear with good tissue integrity that will maintain its position in the joint once repaired. Degenerative, poor-quality meniscal tissue is not strong enough to hold the sutures and should not be considered for repair. Stable fixation of the meniscal tear decreases the possibility of motion between the meniscal fragments and allows a postoperative rehabilitation program that emphasizes early motion and weight bearing.

Multiple, nonabsorbable sutures, in both the superior and inferior surfaces of the meniscus, should be placed every 3–4 mm to ensure that the repair will be held in position to allow healing to occur. A recent report of the results of repair of longitudinal meniscal tears evaluated arthroscopically found that no tear with a rim width of greater than 4 mm healed (Van Trommel et al. 1998). The sutures in that study were placed at least 4 mm apart. We believe that complex tear patterns and meniscal tears in the central region are subjected to higher stresses than those incurred in single longitudinal tears located at the periphery, and therefore require sutures to be placed at closer intervals. Because the location of the tear within the meniscus is not a primary consideration for which tears are amenable to repair, we no longer measure the rim width at the time of repair.

Partial meniscectomy for complex tear patterns or tears that extend into the avascular zone require removal of a large portion of the meniscus and they may render it nonfunctional. If meniscus repair is performed, the long-term data in our study show that at 13 years after surgery, most patients will be symptom-free.

No competing interests declared.

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