Rate of Knee Cartilage Loss After Partial Meniscectomy

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ABSTRACT. ***Objective.*** Surgical removal of the meniscus of the knee is thought to be a risk factor for later appearance of knee osteoarthritis (OA). We examined whether there is a difference in cartilage loss in those who undergo a partial meniscectomy compared to healthy controls.

Methods. Eight patients who underwent a meniscectomy (5 partial medial, 3 partial lateral) and 13 controls with normal knee radiographs and magnetic resonance imaging (MRI) had an MRI at baseline and at a mean 28.6 ± 7.6 months followup. Articular cartilage volumes were determined by processing images acquired in the sagittal plane using T1 weighted fat saturation MRI on an independent work station.

Results. The mean ± SD of percentage rates of cartilage loss from baseline volume were 4.1 ± 2.8% per year for the meniscectomy subjects and –2.3 ± 3.0% per year for the controls (difference 6.5% per year, 95% CI 3.7–9.3% per year; $p < 0.001$). After adjustment for age, body mass index, and sex the difference increased slightly to 6.9% per year (95% CI 3.4–10.3%; $p = 0.001$).

Conclusion. This study suggests that significant rates of cartilage loss are seen in subjects post partial meniscectomy compared with healthy controls. This may be a useful model in which to examine therapies to prevent OA. (J Rheumatol 2002;29:1954–6)

Key Indexing Terms:
MENISCECTOMY KNEE CARTILAGE LOSS LONGITUDINAL STUDY

Surgical removal of the meniscus of the knee is thought to be a risk factor for knee osteoarthritis (OA)[1,2]. There is considerable variation between studies that examined the radiological outcome after meniscectomy. This can be explained in part by the large differences in study design. Studies have often had large dropout rates, involved different surgical procedures, included people with different types of injuries, and often lacked control groups. A recent study examined radiological outcome in patients who underwent open meniscectomy in 1973 and showed that, compared to sex and age matched controls with healthy knees, the relative risk for the presence of advanced, radiological OA was 14 (95% CI 3.5–121.2)[3]. Some studies suggest that partial removal of the meniscus, compared with total removal, may result in a lower risk of tibiofemoral OA[4,5]. However, the only published randomized study failed to show a difference in OA prevalence for partial and total meniscectomy[6].

In most epidemiological studies joint space narrowing is used as a surrogate measure for joint cartilage and is the recommended outcome measure for anatomical progression of disease[7]. However, this measure is not sensitive to small changes and increasingly, cartilage volume measured from magnetic resonance imaging (MRI) is being investigated[8,9]. Cartilage volume measured by MRI has been shown to be valid and reproducible[10-12]. This technique has been used to explore factors that influence knee cartilage in healthy adults[11] and children[12], and recent studies have shown measurable changes in cartilage volume over 1–2 years in subjects with OA[8,9]. We examined whether there is a difference in cartilage change in those who undergo a partial meniscectomy compared to healthy controls.

MATERIALS AND METHODS

Eight subjects who underwent a meniscectomy (5 partial medial and 3 partial lateral) and 13 controls who had normal knee radiographs and MRI were recruited. Controls were recruited from subjects who underwent MRI for clinical indications (pain < 3 mo). Former patients were included if they had structurally normal knee MRI (i.e., no cartilage, bone, or meniscal pathology and no evidence of joint effusion). Subjects completed a questionnaire that included demographic data and physical activity. All subjects had a knee MRI on the same 1.5 T whole body MR unit (Signa Advantage, GE Medical Systems, Milwaukee, WI, USA) in 1996–97 as in 1999, using the described sequence[11,12]. The meniscectomy subjects had their baseline MRI within 2 months prior to surgery. Articular cartilage volumes were determined using 3D image processing as reported[11,12]. The coefficient of variation (CV) for tibial cartilage volume was 2.8%[11,12].

Data analysis. Descriptive statistics for characteristics of the meniscectomy and control groups were tabulated. Principal outcome measures in analyses were the rate of loss (per year) in tibial cartilage volume and the annual percentage reduction from baseline cartilage volume, obtained as 100 × (final – baseline)/baseline. Student t tests were performed to assess differences in mean outcome between meniscectomy and control groups, followed by multiple linear regression to adjust for age, body mass index (BMI), and sex. Analyses were performed using the Stata statistical package (version 6, Stata Corp., College Station, TX, USA).

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RESULTS

Baseline characteristics of the 2 groups are presented in Table 1. The control group had a slightly higher mean age, lower mean BMI, and lower proportion of females than the meniscectomy group. Two subjects in each group had small osteophytes on MRI. The individuals' rates of cartilage loss are illustrated in Figure 1. As shown, there is greater heterogeneity in cartilage volumes in the control group than in the meniscectomy group. Despite this, the variability in the rates of cartilage loss was quite similar between the groups (Table 1).

The mean ± SD of the rates of cartilage loss were 144.1 ± 104.3 ml/yr for the meniscectomy subjects and –60.7 ± 82.0 ml/yr for the controls (difference 204.8 ml/yr, 95% CI 119.3–290.2, $p < 0.001$). The difference increased slightly after adjustment for age, BMI, and sex (214.4 ml/yr, 95% CI 106.5–321.8, $p = 0.001$). The mean ± SD of the percentage rates of cartilage loss from baseline volume were 4.1 ± 2.8% per year for the meniscectomy subjects and –2.3 ± 3.0% per year for the controls (difference 6.5% per year, 95% CI 3.7–9.3% per year, $p < 0.001$). The difference increased slightly to 6.9% per year after adjustment for age, BMI, and sex (95% CI 3.4–10.3%, $p = 0.001$). When the results were reexamined excluding the subjects with osteophytes, the results were unchanged.

Table 1. Descriptive statistics and comparison of tibial cartilage volume for 21 subjects.

	Meniscectomy Subjects, n = 8	Control Subjects, n = 13
Age, mean ± SD, yrs	41.3 ± 13.2	49.2 ± 17.8
Sex, (% female)	6 (75)	8 (62)
BMI	26.0 ± 1.4	24.2 ± 3.6
Mean activity score	6.0 (0.2)	6.2 (0.2)
Duration of followup, yrs, mean ± SD	2.9 ± 0.5	2.1 ± 0.5
Baseline tibial cartilage volume, μl, mean ± SD (min, max)	3317 ± 379 (2844, 3868)	3490 ± 1260 (1676, 5581)
Annual volume of tibial cartilage lost, μl/yr, mean ± SD (min, max)	144.1 ± 104.3 (16.4, 271.9)	–60.7 ± 82.0 (–176.0, 74.5)
Annual percentage reduction in tibial cartilage volume*, mean ± SD, (min, max)	4.1 ± 2.8 (0.6, 7.1)	–2.3 ± 3.0 (–6.7, 2.3)

*Calculated as 100 × [(tibial cartilage volume at start of study – tibial cartilage volume at end)/tibial cartilage volume at start]/followup time.

DISCUSSION

We showed that after a partial meniscectomy, subjects lose tibial cartilage volume compared to healthy controls even after adjustment for age, BMI, and sex differences between the groups.

Our results support previous studies using radiological definition of OA that suggest that meniscectomy is associated with increased risk of OA[1-5]. Although the risk is thought to be less in those undergoing a partial meniscectomy, studies suggest that an increased risk of OA exists[6]. Our study has extended these findings using a novel outcome measure, MRI tibial cartilage volume, which enabled us to quantify the rate of cartilage loss. Our data suggest that measurable changes in cartilage volume can occur over a period as short as 3 years.

Most of our subjects were older than 30 years at the time of their operation. It has been suggested that people aged over 30 at the time of the operation have a higher incidence of OA[13]. It is possible that cartilage loss may not be as high in a younger age group. Our meniscectomy subjects had a higher mean BMI than our controls. Obesity has been described as a risk factor for OA[14]. However, the effect on cartilage volume over time is unknown. Our previous cross sectional studies have shown little effect of weight,

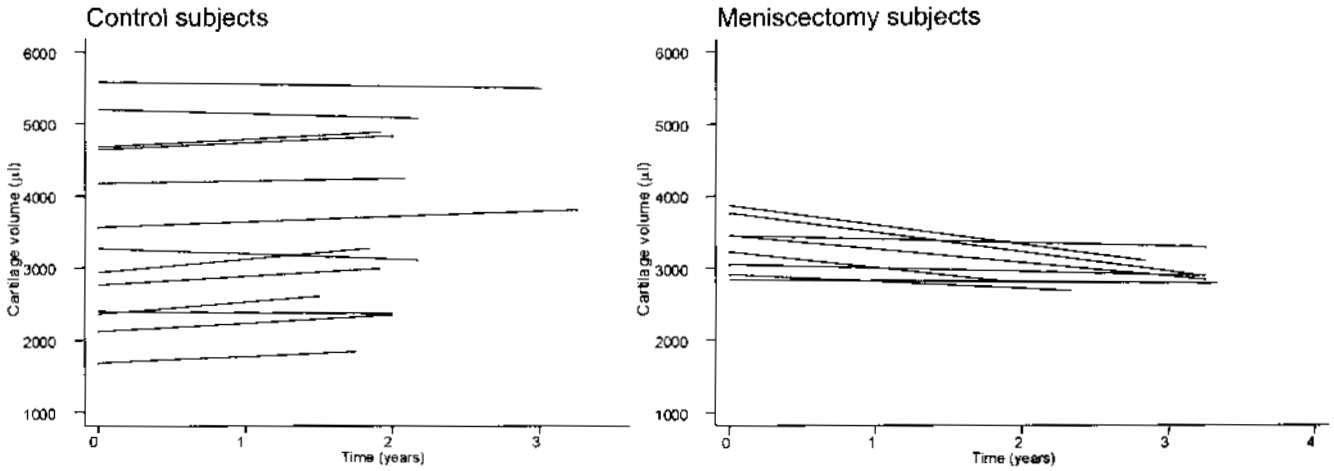

Figure 1. Baseline and followup cartilage volumes for each subject.

suggesting it is unlikely that the difference we found can be attributed to weight differences alone[11]. Further, when we adjusted for BMI, the difference in rates of tibial cartilage loss between the 2 groups persisted.

Not all the meniscectomy subjects in our study lost significant amounts of tibial cartilage. Our numbers were too small to be certain of the reason for this finding. However, it has been speculated that other factors may be important. For example, it has been shown that varus knee alignment at the followup evaluation is associated with a higher incidence of OA in subjects who undergo a meniscectomy[14]. It may be that other biomechanical factors such as associated joint instability or even continued moderate levels of physical activity contribute to the risk of developing OA in subjects who have a meniscectomy[14]. Identification of subgroups most at risk and in whom other interventions may reduce risk of OA would be important, as would determining whether meniscal repair reduces the risk of subsequent OA, as suggested[15].

Our study suggests that cartilage loss is increased in subjects after partial meniscectomy. This may be a useful model in which to examine therapies to prevent OA.

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REFERENCES

1. Appel H. Late results after meniscectomy in the knee joint: a clinical and roentgenological follow-up investigation. Acta Orthop Scand 1970;133 Suppl:1-11.
2. Allen PR, Denham RA, Swan AV. Late degenerative changes after meniscectomy: factors affecting the knee after operation. J Bone Joint Surg Br 1984;66:566-71.
3. Roos H, Lauren M, Adalberth T, Roos EM, Jonsson K, Lohmander LS. Knee osteoarthritis after meniscectomy: prevalence of radiographic changes after twenty-one years, compared with matched controls. Arthritis Rheum 1998;41:687-93.
4. Sommerlath KG. Results of meniscal repair and partial meniscectomy in stable knees. Int Orthop 1991;15:347-50.
5. Bolano LE, Grana WA. Isolated arthroscopic partial meniscectomy: functional radiological evaluation at 5 years. Am J Sports Med 1993:21:432-7.
6. Hede A, LarsenE, Sandberg H. Partial versus total meniscectomy: a prospective, randomized study with long-term follow-up. J Bone Joint Surg Br 1992;74:118-21.
7. Lequesne M, Brandt K, Bellamy N, Moskowitz R, Menkes C, Pelletier J-P. Guidelines for testing slow acting drugs in osteoarthritis. J Rheumatol 1994;21 Suppl 41:65-73.
8. Peterfy CG, White DL, Zhao J, van Dijke CF, Genant HK. Longitudinal measurement of knee articular cartilage volume in osteoarthritis [abstract]. Arthritis Rheum 1998;41 Suppl:S361.
9. Raynauld J-P, Kauffmann C, Godbout B, et al. Knee osteoarthritis progression evaluated by magnetic resonance imaging and a novel quantification software tool [abstract]. Arthritis Rheum 2000;43 Suppl:S399.
10. Peterfy CG, van Dijke CF, Janzen DL, et al. Quantification of articular cartilage in the knee with pulsed saturation transfer subtraction and fat-suppressed MR imaging: optimization and validation. Radiology 1994;192:485-91.
11. Cicuttini F, Forbes A, Morris K, Darling S, Bailey M, Stuckey S. Gender differences in knee cartilage volume as measured by magnetic resonance imaging. Osteoarthritis Cartilage 1999; 7:265-71.
12. Jones G, Glisson M, Kristen Hynes K, Cicuttini F. Gender and site differences in cartilage development: a possible explanation for variations in knee osteoarthritis in later life. Arthritis Rheum 2000;43:2543-9.
13. Maletius W, Messner K. The effect of partial meniscectomy on the long-term prognosis of knees with localized, severe chondral damage. A twelve- to fifteen-year followup. Am J Sports Med 1996;24:258-62.
14. Felson DT, Anderson JJ, Naimark A, Walker AM, Meenan RF. Obesity and knee osteoarthritis. The Framingham Study. Ann Intern Med 1988;109:18-24.
15. Jager A, Starker M, Herresthal J. Can meniscus refixation prevent early development of arthrosis in the knee joint? Long-term results. Zentralblatt fur Chirurgie 2000;125:532-5.