

# Arthroscopic Repair of Meniscus Tears Extending Into the Avascular Zone With or Without Anterior Cruciate Ligament Reconstruction in Patients 40 Years of Age and Older

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**Purpose:** The purpose of this study was to prospectively determine the outcome of meniscal repairs for tears that extended into the central one-third zone of the meniscus, or had a rim width of 4 mm or greater, in a case series of patients 40 years of age and older. **Type of Study:** Prospective case series. **Materials and Methods:** Thirty meniscal repairs in 29 patients were evaluated by a comprehensive examination (28 repairs) a mean of 34 months postoperatively, by follow-up arthroscopy (6 repairs) a mean of 24 months postoperatively, or both. **The mean age of the patients at the time of the meniscal repair was 45 years (range, 40 to 58 years).** Twenty-one patients (72%) also had ruptures of the anterior cruciate ligament, which were reconstructed at the time of the meniscal repair with bone–patellar tendon–bone autografts (16 patients) or allografts (5 patients). The Cincinnati Knee Rating System was used to rate symptoms, functional limitations with sports and daily activities, patient perception of the knee condition, and sports and occupational rating levels. **Results:** **At a mean of 33 months postoperatively, 26 meniscal repairs (87%) were asymptomatic for tibiofemoral joint symptoms and had not required subsequent surgery.** Three repairs failed to heal, requiring partial meniscectomy, and 1 knee with tibiofemoral symptoms related to the repair was treated conservatively. There was no significant effect of the side of the meniscal repair, chronicity of injury, or condition of the articular cartilage on the presence of tibiofemoral symptoms or meniscal resection. Concomitant anterior cruciate ligament reconstruction appeared to increase the rate of asymptomatic meniscal repairs. The patient rating of overall knee condition was normal/very good in 76%, good in 12%, and fair/poor in 12%. **Conclusions:** In athletically active patients, we recommend the preservation of meniscal tissue wherever possible regardless of age, basing indications for the procedure on current and future activity levels. **Key Words:** Avascular meniscus repair—Middle-aged—Anterior cruciate ligament.

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The importance of preserving meniscal function is well recognized and, in the last several years, multiple advocates have published reports of promising outcome of meniscal repairs for tears usually located in the periphery, or outer one-third region.<sup>1-4</sup>

Only a few investigators described attempts of repairing tears that extended into the avascular zone.<sup>5-10</sup> We recently reported results of the first study that followed a large group of patients (198 repairs) who had meniscus tears that extended into the central one-third avascular zone.<sup>11</sup> In that study, 91 repairs were evaluated arthroscopically a mean of 18 months postoperatively. Forty-four of the repairs had been performed in patients under the age of 25 years, and 47 were performed in patients 25 years or older. No statistically significant difference was found in the healing rates according to age, supporting findings from an earlier study<sup>5</sup> of a smaller group of knees that also had avascular meniscal repairs. These results encouraged us to conduct a study to determine the efficacy of meniscal repair in older patients. We found

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only 1 study reported in the recent literature that examined the outcome of meniscal repair in patients 40 years of age and older<sup>12</sup>; however, that report focused on peripheral meniscal repairs. **The purpose of our study was to prospectively determine the results of meniscal repairs for tears extending into the avascular zone in a consecutive group of patients 40 years of age and older.** This represents the first report we are aware of in the English language literature to report these findings.

## MATERIALS AND METHODS

### Subjects

Between May 1991 and October 1996, 31 consecutive meniscal tears in 30 patients 40 years of age and older that extended into the central one-third zone of the meniscus, or had a rim width of 4 mm or greater, were repaired by one of us (F.R.N.). To be included in the study, a patient had to have had either a clinical examination at least 2 years postoperatively, an arthroscopic examination after the initial repair, or both.

Thirty meniscal repairs (97%) in 29 patients met the criteria; 1 patient was lost to follow-up. Of these, 28 repairs (27 patients) were examined a mean of 34 months (range, 23 to 71 months) postoperatively. Six repairs (6 patients) were evaluated arthroscopically a mean of 24 months (range, 16 to 36 months) after the original repair.

Nineteen medial and 11 lateral menisci were repaired. A single meniscus was repaired in all but 1 knee in which both menisci were repaired. There were 23 men and 6 women whose mean age at the time of repair was 45 years (range, 40 to 58 years). Twenty chronic and 10 acute ( $\leq 10$  weeks from injury) meniscal tears were repaired, and 70% sustained the injury during sports activities.

Twenty-one patients (72%) also had ruptures of the anterior cruciate ligament (ACL) that were reconstructed at the time of the meniscal repair with bone-patellar tendon-bone autografts (16 patients) or allografts (5 patients).

Prior operations had been performed in 6 knees before referral to our center. One knee had previously had an ACL reconstruction and medial meniscal repair, both of which had failed due to a reinjury, and 1 knee had previously had a medial meniscal repair that had failed for unknown reasons. Four knees had arthroscopy and partial meniscectomies in the compartments opposite those that contained the menisci repaired in this study.

### Evaluation

All meniscal tears were classified during the initial arthroscopic procedure as previously described.<sup>11</sup> Single tears occurred in 1 plane and were classified as either longitudinal, radial, or horizontal. Tears with multiple components were classified as either double longitudinal, triple longitudinal, flap, or complex multiplanar.

In all knees that had follow-up arthroscopy, the repair site was probed to determine the stability of the remaining meniscus and estimate the percentage of healing.<sup>6</sup> Complete healing was assigned to those repairs when full-thickness apposition of the original tear occurred with no more than 10% of the original tear remaining. Partial healing was assigned if at least 50% of the original tear had healed and was stable when probed, and the meniscal body was in the normal position in the tibiofemoral joint. Repairs were considered failed if more than 50% of the original tear was present.

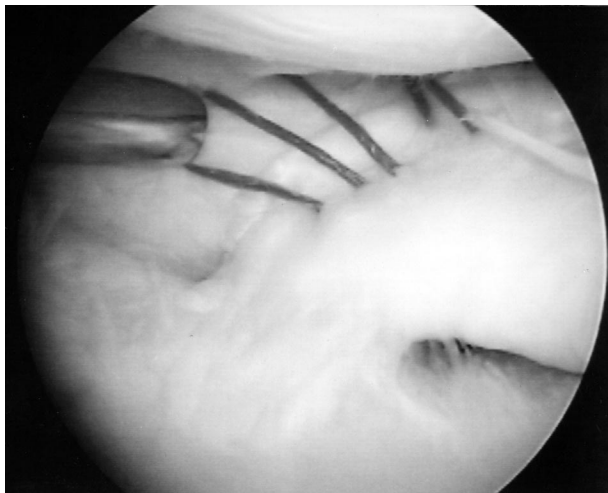
A comprehensive physical examination of the affected knee was performed to determine range of knee motion, joint crepitus, and tibiofemoral joint pain. A KT-2000 arthrometer test was performed at 134 N to determine total anterior-posterior displacement by 1 experienced examiner in 11 knees that had ACL reconstruction.<sup>13</sup> The other 10 patients who had ACL reconstruction also had ACL ruptures in the contralateral knee and were excluded from arthrometric testing. The difference in the measurements between the contralateral normal knee and the reconstructed knee were used for all analyses. Pivot shift testing was performed on both knees in all patients. The results of the arthrometric and pivot shift tests were used to classify all of the ACL reconstructions as either functional, partially functional, or failed.<sup>14</sup>

During both the initial meniscal repair procedure and follow-up arthroscopy, the articular cartilage surfaces were examined and graded according to our previously described system.<sup>15</sup> The cartilage was considered to be abnormal if fissuring and fragmentation of more than one half of the involved articular surfaces over an area of 15 mm<sup>2</sup> was present (grade 2B) or if any subchondral bone was exposed (grade 3).

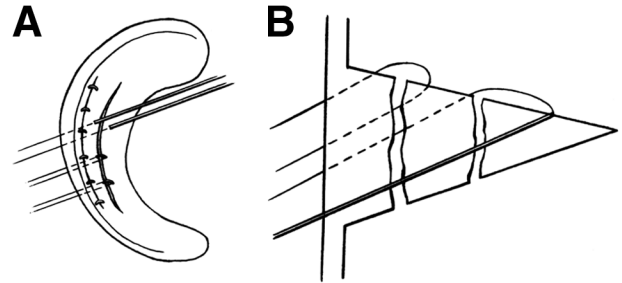
All patients completed questionnaires and were then interviewed for the subjective and return-to-activity evaluation. The Cincinnati Knee Rating System was used to rate symptoms, functional limitations with sports and daily activities, patient perception of the knee condition, and sports and occupational rating levels.<sup>16</sup>

## Surgical Procedures

The arthroscopically assisted, inside-out technique for the repair of meniscal tears extending into the avascular region has been previously described in detail.<sup>9,11,17</sup> The meniscus bed was routinely prepared before repair with a rasp or shaver. All repairs were performed with multiple 2-0 coated polyester nonabsorbable sutures (Ticron; Davis and Geck, Wayne, NJ; or Ethibond; Ethicon, Somerville, NJ) placed every 3 to 4 mm along the length of the tear (Fig 1). A single-barrel straight or curved arthroscopic cannula (Richard Wolf Medical, Vernon Hills, IL) was used to rigidly secure the meniscal tear. An accessory posteromedial or posterolateral incision was used for suture retrieval and knot tying, and a popliteal retractor (Stryker, Kalamazoo, MI) was used to protect the soft tissues during suture passage. The placement of the sutures depended on the tear pattern. Single longitudinal tears were repaired with vertical divergent sutures placed initially in the superior (femoral) surface of the meniscus and then into the inferior (tibial) surface. The superior sutures were placed first to restore the meniscus to its bed and ensure that the superior surface did not displace when the cannula was placed beneath the meniscus. The first pass of the suture was placed into the peripheral portion of the tear, and the second pass was placed through the central tissues. The sutures were brought out through the accessory incision and tied directly over the posterior meniscal



**FIGURE 1.** Arthroscopic photograph of a repair of a meniscus tear located in the central one-third avascular region. Note the sutures crossing the tear perpendicularly, spaced 3 to 4 mm apart. The single arthroscopic suture cannula is visible at the upper left. (Reprinted with permission.<sup>17</sup>)



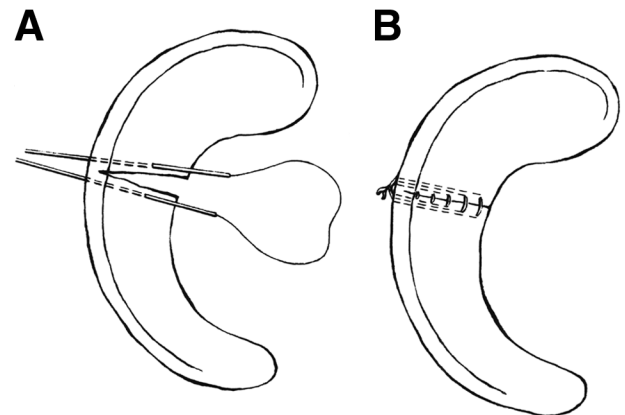
**FIGURE 2.** Double-stacked repair technique for double longitudinal tears. The peripheral tear is repaired first (A) with superior and inferior tacking sutures, followed by (B) repair of the inner tear in the same fashion. (Reprinted with permission.<sup>9</sup>)

attachment and capsule. The tension in the sutures was confirmed arthroscopically after the knot was tied. Double and triple longitudinal tears required additional sutures (Fig 2). Radial and flap tears were repaired with horizontal sutures placed perpendicular to the tear at 2- to 4-mm intervals (Fig 3).

The preferred technique for the arthroscopically assisted ACL reconstruction has been previously described in detail.<sup>18,19</sup> The reconstructions were carried out after completion of the meniscus repair.

## Postoperative Rehabilitation

The rehabilitation program allowed immediate knee motion and early weight-bearing, but delayed strenuous activities for at least 6 months.<sup>11</sup> We instituted 0° to 90° of knee motion immediately, with flexion advanced to 120° by 3 to 4 weeks and 135° by 5 to 6 weeks. Patients were restricted to partial weight-bearing for the first 4 postoperative weeks. Then, full



**FIGURE 3.** Repair technique for radial meniscus tears. (A) The inner sutures are placed first, followed by (B) the more peripheral sutures. (Reprinted with permission.<sup>9</sup>)

weight-bearing was allowed in patients who had single or multiple longitudinal repairs. Those that had horizontal, radial, or complex multiplanar repairs were kept partial weight-bearing for 2 additional postoperative weeks. Squatting or deep flexion past 125° was restricted for 4 months, and running, jumping, cutting, and twisting motions were restricted for 6 months in all patients.

**RESULTS**

**Evaluation and Follow-up Arthroscopy**

At follow-up, 28 meniscal repairs (93%) were asymptomatic for tibiofemoral joint symptoms. Two knees had tibiofemoral symptoms: 1 had repeat arthroscopy, and the other patient elected not to have further surgery (Table 1).

The indications for follow-up arthroscopy on the 6 meniscal repairs were reinjury without meniscal symptoms in 3; diagnostic, in conjunction with removal of hardware in 2; and continuing meniscal symptoms without reinjury in 1 patient. Three of the meniscal repairs were classified as failed, 2 as partially healed, and 1 as healed. One medial and 1 lateral meniscus required removal of tear fragments that had been reinjured in new trauma 16 and 21 months after the original repair even though neither patient had tibiofemoral symptoms (Table 1). Another medial repair that had failed to heal at the site of the initial horizontal tear required partial removal 26 months postoperatively for continuing medial tibiofemoral symptoms.

When the clinical and arthroscopic data were combined, 26 meniscal repairs (87%) were both asymptomatic for tibiofemoral joint symptoms and had not required removal at follow-up. There was no significant effect of the side of the meniscal repair, chronicity of injury, concomitant ACL reconstruction, or condition of

the articular cartilage on the presence of tibiofemoral symptoms or meniscal resection (Table 2).

**Articular Cartilage**

Abnormal articular cartilage surfaces were found during the index meniscal repair in 14 knees (48%). Ten of these had chronic meniscal tears and 4 had acute tears. There were abnormal surfaces in the patellofemoral compartment in 6 knees, in the medial tibiofemoral compartment in 8 knees, and in the lateral tibiofemoral compartment in 3 knees. Four knees had deterioration in the same compartment as the meniscal repair. Six other knees did not have significant deterioration but did have early articular cartilage damage in the involved tibiofemoral compartment. None of the 6 knees that had follow-up arthroscopy showed further deterioration in the articular cartilage compared with that recorded during the index meniscus repair procedure.

**Physical Examination**

Before the meniscal repair, 25 knees had no or only mild palpable patellofemoral crepitus, and 4 knees had moderate crepitus. At follow-up, 1 knee had moderate crepitus that was not present preoperatively. Before the meniscal repair, all knees had no or only mild palpable tibiofemoral crepitus. At follow-up, 1 knee had moderate crepitus that was not present preoperatively.

At follow-up, all knees had a full normal range of motion (0° to 135°) and no effusion. Moderate tibiofemoral joint-line pain was present in 1 patient in the same compartment as the meniscal repair, and in 2 patients in the compartment opposite that of the meniscal repair.

Preoperatively, all 21 knees with ACL ruptures had a grade 2 or 3 pivot shift. At follow-up, 17 knees had a grade 0 and 4 patients had a grade 1 pivot shift. The results of the arthrometric testing performed in 11

**TABLE 1.** Types of Meniscal Tears and Results of Repair According to Follow-Up Arthroscopy and Clinical Evaluation

Type of Meniscal Tear	Follow-Up Arthroscopy			Clinical Evaluation Tibiofemoral Pain	
	No.	Indications	Healing Classification	No. With Pain	Follow-Up Arthroscopy?
Single longitudinal (n = 10)	2	Reinjury*, remove hardware	Healed, partial healed	0	
Double longitudinal (n = 4)	1	Reinjury*	Failed	0	
Complex multiplanar (n = 4)	1	Remove hardware	Failed	1	No
Radial (n = 4)	1	Reinjury*	Partial healed	0	
Horizontal (n = 4)	1	Tibiofemoral symptoms	Failed	1	Yes
Flap (n = 4)	0			0	

\* No tibiofemoral joint symptoms at site of meniscus repair.

**TABLE 2.** *Effect of 4 Factors on Presence of Tibiofemoral Symptoms or Arthroscopic Second-Look Failure of Meniscal Repair*

	Asymptomatic	Tibiofemoral Symptoms or Arthroscopic Failure	P Value
Tibiofemoral compartment of meniscal repair			
Medial (n = 19)	17 (89%)	2 (11%)	.55
Lateral (n = 11)	9 (82%)	2 (8%)	
Time from injury to meniscal repair			
≤10 weeks (n = 10)	9 (90%)	1 (10%)	.70
>10 weeks (n = 20)	17 (85%)	3 (15%)	
Concomitant ACL reconstruction			
Yes (n = 22)	20 (91%)	2 (9%)	.26
No, ACL intact (n = 8)	6 (75%)	2 (25%)	
Articular cartilage			
Normal (n = 16)	13 (81%)	3 (19%)	.35
Abnormal (n = 14)	13 (93%)	1 (7%)	

knees showed that 9 knees had less than 3 mm of increased displacement and 2 knees had between 3 and 5.5 mm of increase. The classification of ligament function analysis determined that 17 knees had a functional reconstruction and 4 had partial function at follow-up.

### Subjective Evaluation

The subjective evaluation was completed at follow-up on 25 knees. Three knees with failed meniscal repairs that required removal at follow-up arthroscopy and 1 other knee that had follow-up arthroscopy but not a clinical evaluation 2 years postoperatively were not included. Of the 25 knees, 17 had chronic meniscal tears and 8 had acute tears before the index repair procedure. Nineteen had a concomitant ACL reconstruction with the meniscal repair.

The 17 knees with chronic symptoms had statistically significant improvements at follow-up for pain, swelling, and giving-way scores ( $P < .01$ ). The mean preoperative pain score of 4.4 improved to 7.1, and the mean preoperative giving-way score of 5.9 improved to 8.8 (scale, 0 to 10). These knees also had significant improvements in the mean scores for squatting ( $P < .05$ ), running, jumping, and cutting ( $P < .0001$ ). Before the meniscal repair, 12 patients had given up sports and 5 were participating with symptoms and functional limitations. At follow-up, 12 patients had returned to sports without problems, 1 was participating with symptoms, and 4 had not returned to sports due to the knee condition (Table 3). In the patient rating of the overall knee condition, 3 rated their knees as normal, 8 as very good, 3 as good, 2 as fair, and 1 as poor.

**TABLE 3.** *Sports Activities at Follow-Up*

Type of Sport	Chronic Meniscal Tears (n = 17)	Acute Meniscal Tears (n = 8)
Jumping, hard pivoting, cutting	1	1
Running, twisting, turning	5	2
Swimming, bicycling	7	3
None	4	2
Change in sports activities from preoperative to follow-up		
Increased level, no symptoms	10	4
Same level, no symptoms	1	1
Decreased level, no symptoms	1	1
Playing with symptoms	1	0
No sports, knee-related reasons	4	1
No sports, non-knee-related reasons	0	1

NOTE. Three knees with meniscal repairs that failed and required removal and 1 knee that had follow-up arthroscopy but not a clinical evaluation 2 years postoperatively were not included.



Seven of the 8 patients with acute symptoms were involved in athletics before their injury and 1 was a housewife not involved in athletics. The latter returned to normal activities of daily living without symptoms. Six patients returned to athletics without problems (Table 3). Only 1 patient reported difficulty with squatting, and 1 patient had problems with running, jumping, and cutting. All 8 patients rated their overall knee condition as normal or very good.

### Complications

There were no infections, knee motion problems, saphenous neuritis, or other major complications.

## DISCUSSION

To our knowledge, this report is the first in the English language literature to critically evaluate arthroscopic meniscal repairs in patients 40 years of age or older with exclusively single or complex tears that extended into the avascular zone. We found that 26 of the 30 meniscal repairs (87%) were asymptomatic for tibiofemoral joint symptoms and did not require removal at follow-up. This rate should not be interpreted as the rate of meniscal healing, but the incidence of tibiofemoral joint symptoms and follow-up arthroscopic resection. Whereas only 1 knee required follow-up arthroscopy for suspected meniscal symptoms, 2 other knees that had follow-up arthroscopy for other reasons had significant tearing at the original suture site and were considered “silent” failures. We considered these 2 as false-negative results and realize the limitations of using clinical examination only to determine the results of meniscal repairs. Therefore, we did not calculate an overall “success” or “failure” rate because of the possibility of other such cases.

The small patient population in this series precludes definitive conclusions regarding the outcome of the various types of meniscal tears encountered, and the effect of different factors such as side of repair, time from original knee injury to repair, and time from meniscal repair to follow-up arthroscopy on outcome. Two of the 19 (11%) medial menisci repaired and 2 of the 11 (8%) lateral menisci repaired had tibiofemoral joint symptoms or failure on follow-up arthroscopy. Others have reported higher rates of failure of medial repairs compared with lateral repairs.<sup>4,10,12,20</sup> No clear reason for this trend has been adequately shown. No definitive effect of the chronicity of the injury was found in the current study, as 3 of the 20 (15%) chronic meniscal tears and 1 of the 10 (10%) acute

meniscal tears failed. This finding was in contrast to those of other investigators who have found higher failure rates in chronic meniscal tears.<sup>5,11,12</sup>

The fact that 21 patients (72%) also had ACL reconstruction at the time of the meniscal repair may have contributed to the success of the operation, as others have shown an increased incidence of meniscal repair failures in ACL-deficient knees that are not reconstructed.<sup>21</sup> In this population, all but 1 patient had been athletically active before injury. Even though the patients were older, we felt it important to both stabilize the knee and save the meniscus because the desire to return to athletics was a consistent goal among the patients. This became even more evident when the initial arthroscopic examination found that nearly one half of the patients had severe articular cartilage deterioration in at least 1 compartment of the affected knee. Ten patients (34%) had articular cartilage deterioration on either the femoral condyle or tibial plateau in the compartment where the meniscus tear was found. Preserving meniscal function in these individuals is most important because the removal of these large meniscal tears with components in both the avascular and peripheral regions would have resulted in near total meniscectomy. Prior potential hesitation to perform both ACL reconstructions and meniscal repairs in these knees was based on anecdotal fears of increased stiffness, arthrofibrosis, arthrosis, and poor healing.<sup>22-24</sup> With the results of this study, advances in reconstructive technology, and progressive rehabilitation, these fears appear to be unfounded.

We found only 1 report in the English language literature that focused on the outcome of meniscal repairs in patients 40 years of age or older.<sup>12</sup> Thirty-seven patients (37 meniscal repairs) had meniscal repair for acute tears located mainly in the meniscal-capsular junction or outer one-third region. While 22 patients had associated ACL reconstruction, only 7 patients (18%) had significant articular cartilage deterioration. The results were similar to those found in the current study: at an average of 26.5 months postoperative, 32 knees (87%) were asymptomatic for tibiofemoral joint symptoms. Therefore, we can recommend repairing meniscal tears in both the periphery and central one-third regions in middle-aged patients, especially in those undergoing concomitant ACL reconstruction.

Although follow-up arthroscopy and magnetic resonance imaging provide valuable indications of meniscal function, we believe that a comprehensive clinical examination performed at a minimum of 2 years postoperatively will detect a failure in the majority of

knees. Cost-containment issues in today's health care environment preclude the use of noninvasive diagnostic procedures such as magnetic resonance imaging in asymptomatic knees. This leaves clinical evaluation as the only method for assessing meniscal healing after repair. In the current investigation, 2 of the 30 meniscal repairs had follow-up arthroscopy for reasons other than tibiofemoral symptoms and were found to have silently failed. We previously reported that, in a larger group of 159 patients who had avascular meniscal repairs, 9 patients also had silent failure.<sup>11</sup>

In this study, the small number of meniscus tears in the various categories (10 single longitudinal tears and 4 each of double longitudinal, complex multiplanar, radial, horizontal, and flap tears) precluded definitive conclusions regarding the outcome of specific types of avascular meniscal repairs. In our prior study, we reported reoperation rates for larger numbers of these types of tears.<sup>11</sup> The reoperation rates in that study were 12% (11 of 92) for single longitudinal tears, 28% (11 of 40) for double longitudinal tears, and 27% (7 of 26) for complex multiplanar tears. The question regarding the association between the pattern of meniscal tears and incidence of failure or reoperation has not been completely answered by our studies because of the limited numbers available in certain tear categories such as flap and triple longitudinal. It does appear that single longitudinal tears have the most reasonable chance for successful healing, as 0% in the current study and only 9% (8 of 92 repairs) in the prior study required subsequent surgery due to tibiofemoral symptoms.

There are several important principles that we believe are essential to obtain a successful outcome with avascular meniscal repairs. First, the meniscus must contain a tear that is reducible at arthroscopy and have good tissue integrity to ensure its position will be maintained in the joint once repaired. Chronic deformation or degenerative changes must be carefully assessed in regard to the ability of the tissue to hold sutures and maintain stable fixation. Second, multiple nonabsorbable sutures, vertically stacked in both the superior and inferior surfaces, are placed every 3 to 4 mm to ensure the repair will be held in place to allow healing to occur. These repairs will be subjected to higher stresses than those in the periphery and, therefore, sutures are required at close intervals. Third, our rehabilitation program protects against full weight-bearing for 4 to 6 weeks depending on the tear pattern. Importantly, patients are not allowed to squat or bring the knee into deep flexion past 125° for at least 4 months, nor are they allowed to run, jump, cut, or

twist for 6 months. We have seen in our clinical experience too many failures of meniscal repairs as the result of either too few sutures (placed over 4 mm apart) or aggressive activities permitted too soon postoperatively.

With more and more patients remaining active in middle age, the ability to retain native meniscal tissue following injury is an important goal. The treatment of tears that extend into the central one-third avascular zone represent a problem in these patients. Usually, these tears are not considered for repair but are removed to the extent to which the remainder of the meniscus is essentially nonfunctional. This study shows that meniscal repair for these types of tears in older adults is feasible and that the majority of patients are asymptomatic for tibiofemoral joint symptoms an average of 33 months postoperative. In athletically active patients, we recommend preserving meniscal tissue wherever possible regardless of age and to base indications for the procedure on current and future activity levels.

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