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Antegrade curettement, bone grafting and pinning of osteochondritis dissecans in the skeletally mature knee

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ABSTRACT

In the period between 1981 and 1983, we treated 40 patients who had osteochondritis dissecans of the knee. Seventeen patients were skeletally mature and had large lesions (2 to 3 cm in diameter) of the medial femoral condyle that required surgery. Each of these patients, who underwent antegrade curettement, bone grafting, and pinning, had either failed a conservative program or had a loose or separated fragment. The average age at the time of surgery was 17. Followup ranged from 5 to 7 years.

Postoperative evaluation included the criteria of the Hughston et al. rating scale, subjective assessment, clinical examination, and AP, lateral, and tunnel radio graphs. According to the osteochondritis dissecans rating scale described by Hughston et al., there were two exce!!ent, nine good, five fair, no poor results, and one failure. Additional evaluation, not included in the Hughston rating scale, consisted of Cybex II muscle strength testing, strict grading of preoperative and postoperative roentgenograms for degenerative changes, and magnetic resonance imaging.

Roentgenograms demonstrated that 16 of the 17 lesions healed. The average healing time was 8 months. Preoperative degenerative changes occurred fre quently; postoperatively, there was some progression of these changes in the majority of cases. Magnetic resonance imaging demonstrated that the articular sur face was smooth in 57% of the knees and in 43% there was some degree of irregularity. Although the integrity of the articular cartilage could be documented, mag netic resonance imaging is of questionable value in the postoperative evaluation of this condition, because the

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status of the articular cartilage could not be correlated with the degree of degenerative changes or results.

The results appear to be worse in those who had more preoperative degenerative changes, a larger le sion, or a loose fragment. This suggests that interven tion before these changes occur may improve results.

Osteochondritis dissecans has been the subject of many investigations, yet the etiology remains controversial and successful treatment is often an enigma. The condition was initially described as a "quiet necrosis" by Sir James Paget in 1870.[31] In 1888, Konig2[3] renamed it osteochondritis dis secans.

LITERATURE REVIEW

The most accepted theories regarding etiology of osteochon dritis dissecans are trauma and ischemia. Paget and Konig were the first to suggest trauma as a cause.[2] Fairbank's[13] theory, later advocated by Smillie,[39] was that impingement of the tibial spine against the medial femoral condyle results in a fracture through the subchondral bone. Although the articular cartilage remains intact, a nonunion develops and the articular cartilage subsequently breaks down. Rosen berg,[37] in 1964, concluded that nondisplaced osteochondral fractures that do not reunite become radiographically and microscopically indistinguishable from osteochondritis dis secans. Aichroth[2] demonstrated that the patella articulates with the classic site of osteochondritis dissecans on the medial femoral condyle when the knee is in full flexion. He suggested that the pathogenesis of this lesion is an osteo chondral or subchondral fracture that remains ununited and leads to separation of the fragment.

Experimental studies support the clinical impression that trauma is the etiology of osteochondritis dissecans. Reh-

bein,[33] in 1950, subjected dogs' knees to repeated minor trauma, producing lesions that were histologically and ra diographically similar to osteochondritis dissecans. Langenskiold[24] and later, Tallqvist,[43] excised portions of the epiphyseal cartilage in the knees of young rabbits. The fragments were left attached by a bridge of synovial tissue in the intercondylar notch. It was later determined that the fragments developed a bony nucleus resembling osteochon dritis. Langenskiold concluded that osteochondritis disse cans may be caused by a cartilage fracture in childhood. Aichroth' repeated this study in adult rabbits, demonstrat ing that nondisplaced but stable osteochondral fractures resembled osteochondritis dissecans in the human both ra diographically and histologically.

Others have postulated that osteochondritis dissecans re sults from an interruption of blood flow that causes ischemic necrosis, eventually leading to sequestration of the subchon dral bone and articular cartilage. In 1922, Axhausen[3] sug gested that an emboli of tubercle bacilli blocked the blood flow. Rieger[35] implicated fat emboli, whereas Watson Jones[45] suggested that emboli of red blood cells may be responsible for osteochondritis dissecans that occurs in mul tiple sites in adolescents. Enneking[12] noted that the sub chondral bone has a vascular arcade similar to that of the bowel mesentery, which has poor anastomosis with the surrounding arterioles. Infarction results in wedge-shaped necrosis and subsequent vascular ingrowth, producing gran ulation tissue between the viable bone and the fragment. Additional trauma causes the articular cartilage to fracture, leading to detachment of the lesion. However, Rogers and Gladstone[36] found that there is a rich blood supply to the distal femur, with numerous anastomoses in the cancellous bone. They concluded that ischemia was unlikely to be the etiology of osteochondritis dissecans.

Epiphyseal defects and osteochondral fractures may be confused with osteochondritis dissecans. Sontag and Pyle[40] and later Caffey et al.[5] noted that roughening or complete loss of the regular epiphyseal outline frequently occurred in the normal distal femoral epiphyses of children. Ribbing[34] compared epiphyseal defects to defects of osteochondritis dissecans and found similar locations. He suggested that an epiphyseal defect may result in an accessory nucleus that separates in childhood and detaches with trauma, resulting in osteochondritis dissecans.

It is generally agreed that treatment of osteochondritis dissecans depends on skeletal maturity and the stage of the lesion. The skeletaliy immature knee has a greater capacity for healing. Consequently, nondisplaced lesions may be suc cessfully treated with activity restriction or immobiliza tion.[8,16,32] Green and Banks[17] treated a series of children with nonweightbearing and immobilization. The lesions healed in 17 of 18 cases in an average of 4 months. Van Demark[44] and Edelsteinn reported satisfactory results with spontaneous healing. These cases were not documented by bone scan and some may represent irregular ossification, as in the 4-year-old child reported by Strange.[42] Smillie[39] was the first to suggest that immobilization should not exceed 16 weeks for nondisplaced lesions in patients who are younger than 15 years of age. Later, Hughston et ai.[20] demonstrated the deleterious effects of prolonged immobi lization, including stiffness, quadriceps atrophy, and possi ble cartilage degeneration. They recommended activity mod ification and quadriceps rehabilitation. In spite of a good prognosis in the skeletally immature knee, all of these le sions do not heal, as demonstrated by the series of Aichroth,[2] Hughston et al.,[20] Cahill and Berg,[6] Cahill et al.,[7] and Langer and Percy.[25] Smillie[39] suggested open drilling if healing in children is not adequate by 4 months. More recently, Guhl[18] and Gepstein et al.[14] have reported excellent results with arthroscopic drilling.

Older patients are more likely to develop loose or sepa rated fragments and secondary degenerative arthritis. In a long-term followup, Linden[26] concluded that children with osteochondritis dissecans did well with no secondary degen erative changes. However, osteoarthritis occurred in the majority of those who had the first manifestion of osteo chondritis dissecans after closure of the physis. Some au thors have advocated excision of all loose or partially sepa rated fragments,[2,10] in preference to pinning, since the pins would have to be removed and the fragment may yet remain ununited. In Aichroth's series,[2] however, the incidence of osteoarthritis was significantly higher in those who had excision of the fragments.

Smillie,[39] in 1957, was the first to advocate drilling and replacement and internal fixation of loose fragments. He successfully treated 10 patients with screw or pin fixation, although he alluded to the difficulty in accurate replacement of the fragment, which may sink below the surrounding articular surface as a result of bone loss. Bandi and Allgower[4] advocated drilling and securing the fragment with bone pegs in 1959. Lindholm et al.[27] reported good to excellent results in eight patients treated with this technique. However, they had a high incidence of osteoarthritis and residual pain. Gillespie and Day also used bone pegs to fix 18 lesions. They had healing in all cases and good results in 16 cases. Hughs ton et al.[20] fixed nine large fragments with bent K-wires, which could be removed percutaneously. It was their opinion that the results of replacement were superior to excision of the fragment. **In** 1978, Lipscomb et al.[28] used **K-wires** to reattach loose fragments in eight knees. They emphasized the need to remove the fibrous tissue from the base of the crater, drill the dense bone to improve vascularity, and restore joint continuity with cancellous bone graft before replacing and pinning the lesion.

The question arises as to why there is controversy regard ing the treatment of loose or separated fragments in adults. Several reasons are suggested in the literature. First, these lesions are uncommon; therefore, few surgeons have exten sive experience. Consequently, prospective randomized stud ies comparing different treatment modalities have not been performed. Second, most studies have included different methods of treatment, degrees of deterioration and patient ages, and lesions of different sizes and locations, all of which make it difficult to draw accurate conclusions from the

results. Finally, the results have not been uniformly good with any method of treatment.

The prevailing opinion now is that an attempt should be made to restore the articular surface, whenever possible, in large lesions of the weightbearing area.[2,10,22,28,38,39] Convery et al.[9] demonstrated in horses that lesions smaller than 3 mm heal, whereas larger lesions result in degenerative changes. Aichroth[1] devised an experimental model of osteo chondritis dissecans in rabbits and demonstrated that le sions attached only with articular cartilage went on to a poor result unless internally fixed. More recent clinical studies of Hughston et al.[20] and Outerbridge[30] have sup ported the experimental findings that the best results are obtained by replacement and pinning of large lesions on the weightbearing surface.

The purpose of this study was to review our experience with antegrade curettement, bone grafting, and pinning of loose fragments in end stage osteochondritis dissecans in the skeletally mature knee. To our knowledge, this is the largest series reported in the literature using this technique.

MATERIALS AND METHODS

Between 1981 and 1983, we saw 45 cases of osteochondritis dissecans in 40 patients. Forty-three lesions occurred in the medial femoral condyle and two in the lateral femoral con dyle. Eleven patients (14 lesions) were treated conserva tively. Conservative treatment consisted of nonweightbear ing crutch ambulation for 6 weeks and subsequent activity restriction. Eight of these patients were skeletally immature at the time of initial treatment, the average age being 13. Four lesions, two in skeletally mature and two in skeletally immature patients, did not heal. Of the four patients who failed to heal, one was subsequently lost to followup and the other three were successfully treated, one with arthroscopic drilling, one with replacement and pinning, and one with excision of the lesion.

Tt::11 vc1Lieuts (12 lesions) we;e treated with arthrotscopic drilling. The average age at the time of surgery was 12.4. The lesions healed in each case, with an average healing time of 4 months.

Two additional patients whose average age was 17 were treated with excision of the fragment and drilling of the crater. One of these patients was initially treated conserva tively in 1978 for bilateral lesions. The lesion in one knee healed and the articular cartilage of the other deteriorated to such a degree that excision was necessary.

Seventeen patients who were skeletally mature formed the basis of this study. They had large lesions (2 to 3 cm in diameter) of the medial femoral condyle (Table 1). Each of these patients failed a conservative program or had a loose or separated fragment. There were 14 males and three fe males. The average age was 17 (range, 13 to 30) and the physis was closed in every case at the time of surgery. There were eight left and nine right knees involved. None of the patients had a history of an acute injury with pain or hemarthrosis consistent with a true osteochondral fracture.

Rather, the pain was gradual in onset and all of these lesions were at the classic site for osteochondritis dissecans of the medial femoral condyle. The average duration of symptoms before surgery was 1½ years. Fifteen of the patients com plained of chronic pain, eight had catching, five had locking, and nine had effusions. The followup ranged from 5 to 7 years. The anatomical and radiographic criteria of Cahill and Berg[6] was used to classify the lesions, which were measured at the time of surgery (Table 1). The lesion was completely separated in seven cases, partially separated in three, and attached but soft and unsupported in seven cases.

Surgical technique

Under tourniquet control the lesion is visualized arthroscop ically and palpated with a probe. In the skeletally immature knee the fragment usually has good subchondral support, and in these cases antegrade drilling with a 0.012 K-wire may be performed. Retrograde drilling with simultaneous C arm visualization is a good alternative because it does not transgress the articular cartilage.

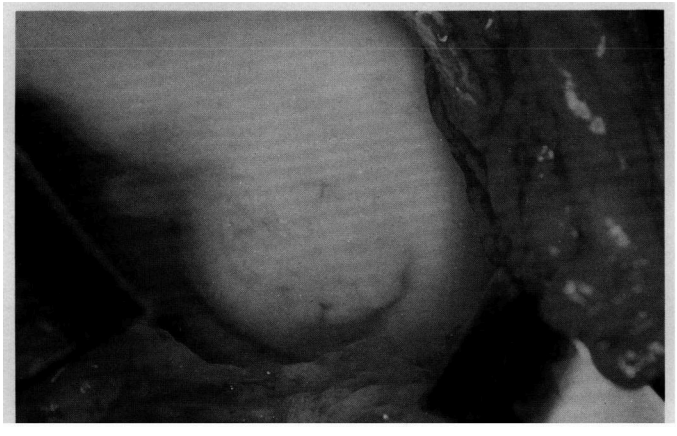
In the skeletally mature knee with relatively normal ar ticular cartilage and good subchondral support, retrograde drilling over a guide pin is performed along with iliac bone grafting. This technique is not attempted if the articular cartilage is partially detached or lacks subchondral support. This is because packing bone beneath the loose articular cartilage may result in displacement of the fragment.

In the skeletally mature knee, if the lesion is loose, par tially detached, or soft without subcondylar support, a me dial arthrotomy is performed. The knee is flexed to 90° and the lesion is identified (Fig. 1). If the fragment is loose, it is removed and preserved in lactated Ringer's solution **for** replacement. The partially detached or attached and soft fragment is outlined with a #15 blade and reflected to the middle of the knee, preserving the synovial cartilage pedicle (Fig. 2). The underlying fibrous tissue and avascular bone are 1e111ovt::d wiLli a curett.e or l1i◆li-:svt::t::<l Lun-. Muli,ivit:: small drill holes are then made at the base of the crater to increase its vascularity (Fig. 3). A bone graft is taken from the anterior distal femur through the same incision. Cancel lous bone is then carefully packed in the crater to support the fragment and to restore the contour of the condyle. With the fragment displaced, two 0.062 threaded K-wires are drilled through the crater and brought out through the skin over the medial aspect of the knee (Fig. 4). The drill is then placed on the opposite end of the K-wire, the fragment is reduced, and the K-wires are drilled into the fragment holding it in place (Fig. 5). Alternately, K-wire placement may be facilitated by use of a cannulated drill guide. The wires are cut subcutaneously. Postoperatively, the leg is immobilized for 6 weeks in 15° of flexion and crutch ambu lation with toe-touch weightbearing is permitted. Range of motion exercise is begun at 6 weeks. The pins are removed at 8 to 12 weeks, after radiographic evidence that the lesion is healing. Then progressive weightbearing and rehabilita tion are begun. Determination of healing is a clinical judg-

TABLE 1
Patient data

Age	Sex	Duration of symptoms	Status of lesion	Size (cm)				Cahill & Berg' Radiographic	Postop	Postop Hughston location	radiographs-healed	MRI	et al.[20]
				AP	Lat	AP	Lat						
13	F	4 years	Loose	2½	2½	2-3	B	Yes	Smooth	Good			
19	M	1 year	Partially detached	2	3	2	B&C	Yes	Irregular	Good			
15	F	6 years	Soft	2¾	2½	2&3	B&C	Yes	Smooth	Good			
17	**M**	3 years	Soft	2½	2½	2	B&C	Yes	Irregular	Excellent			
17	**M**	2 years	Partially detached	2	2½	2	C	Yes	Smooth	Good			
19	**M**	2½ years	Soft	3	4	2&3	B&C	No	**TKR•**	Failure			
16	**M**	4 years	Loose	2	1	2	B	Yes	Smooth	Good			
19	**M**	1 year	Soft	**1¾**	2	2	B&C	Yes	Smooth	Good			
19	**M**	6 months	Loose	2½	3	2&3	B&C	Yes	Irregular	Good			
16	**M**	8 months	Partially detached	2	2½	2&3	C	**Yes**	Smooth	Fair			
13	**M**	15 months	Soft	2	2	2	B	Yes	Irregular	Excellent			
17	F	7 months	Loose	2	3	2&3	C	Yes	Irregular	Fair			
14	**M**	2 months	Loose	2	2½	2	B&C	Yes	Smooth	Fair			
17	**M**	1 year	Loose	2½	3	2&3	B&C	Partially	Smooth	Fair			
14	**M**	1½ years	Soft	1½	2	2	C	Yes	Smooth	Fair			
15	**M**	2 years	Soft	2½	3½	2&3	B&C	Yes	Irregular	Good			
30	**M**	5 months	Loose	2½	2½	2&3	B&C	Yes	Irregular	Good			

• Total knee replacement.



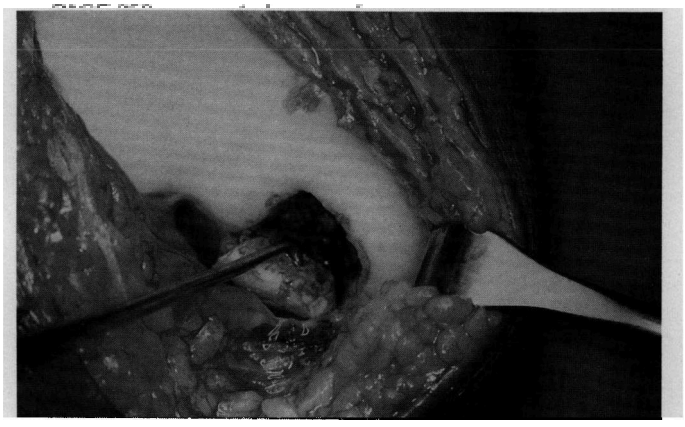


Figure 1. A medial arthrotomy is performed and the protruding lesion is visualized.

Figure 2. The lesion is outlined with a #15 blade and reflected to the middle of the knee preserving a synovial cartilage pedicle.

ment based on progressive obliteration of the lesion in serial radiographs.

RESULTS

Postoperative evaluation included subjective assessment, clinical examination, and AP, lateral, and tunnel radio graphs. The criteria for healing was complete amalgamation of the fragment in the three radiographic views and on the follow-up MRI. Sixteen of the 17 lesions healed and the average healing time was 8 months. Each case was evaluated according to the osteochondritis dissecans rating scale de scribed by Hughston et al.[20] (Table 2). There were two excellent, nine good, five fair, no poor results, and one failure.

Additional evaluation, not included in the Hughston et al.[20] rating scale, included Cybex II muscle strength testing (Cybex, Ronkonkoma, NY), strict grading of preoperative and postoperative degenerative changes, and MRI. Ham string and quadriceps strength was tested with the Cybex II dynamometer according to protocol. Flexion-extension was measured on the 180 foot-pound, 150° scale at 60 and 180 deg/sec. The average quadriceps strength of the involved lower limb compared to the normal limb was 90% at 60 deg/sec and 100% at 180 deg/sec. The average hamstring strength in flexion of the involved limb, compared to the uninvolved limb, was 92% at 60 deg/sec and 104% at 180 deg/sec. These values were within normal limits.

Preoperative and postoperative radiographs were strictly graded to determine progression of degenerative changes and to identify the factors associated with those changes. **AP** and tunnel radiographs were examined for flattening of the femoral condyle, narrowing of the joint space, irregular ity of the surfaces, and spurring. The medial joint space, intercondylar notch, and the lateral joint space were graded

Figure 3. The underlying fibrous tissue and avascular bone is removed with a high-speed burr. Multiple drill holes are made at the base of the crater.

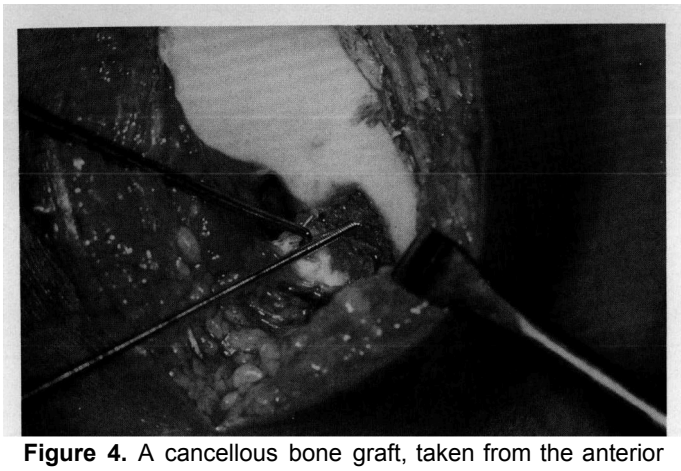


Figure 4. A cancellous bone graft, taken from the anterior distal femur, is carefully packed in the crater to support the fragment and restore the contour of the condyle. Threaded K-wires are drilled through the crater and brought out of the skin over the medi&I aspect of the knee.

on a scale of Oto 3 in each parameter, with zero being no degenerative changes, 1 being minimal changes; 2, moderate changes; and 3, severe changes. Preoperatively, 9 of the 17 patients had Grade I degenerative changes and three had Grade II degenerative changes. Postoperatively, 4 had Grade I degenerative changes and 12 had Grade II degenerative changes. Patients with the worst degenerative changes post operatively had the same changes preoperatively, although to a lesser degree. As an example of the grading system, in Case I there was a large lesion of the medial femoral condyle but no preoperative degenerative changes (Fig. 6A). At fol lowup, 6 years later, the lesion had healed. Degenerative changes were rated as Grade II spurring, Grade I flattening and irregularity of the medial femoral condyle, and Grade I spurring of the intercondylar notch (Fig. 6B).

Postoperatively, the articular cartilage was evaluated with **MRI** using a Phillips Co. 1.5 tesla machine (Phillips Medical Systems, Shelton, CT).[19,29,41] Five to 7 mm sagittal and

Figure 5. The drill is placed on the opposite end of the K wire, the fragment is reduced and the K-wires are drilled into the fragment holding it in place. Alternately, K-wire placement may be facilitated by using a cannulated drill guide.

coronal Tl images were made (Fig. 6C and D). The articular surface was smooth in 57% of the knees and in 43% there was some degree of irregularity. The bone marrow at the site of the lesion appeared to be normal in 44% and there was a dark spot in 56% of the cases. We felt the dark spot represented more dense bone or an accumulation of hemo siderin from red cells that were destroyed during or after the operation.

Those who had a loose fragment had a higher incidence of aching and swelling and, consequently, a poorer result. Increased size of the lesion also adversely affected the result. The larger lesions occupied Cahill and Berg[6] Zones 2 and 3 on the AP radiograph and B and C on the lateral radiograph.

DISCUSSION

Our experience in treating patients of different ages with lesions of various stages of deterioration has fostered a number of ob,;ervation,; regarding the pathophysiolog-y of osteochondritis dissecans. First, we agree with the consensus of the literature that the etiology of osteochondritis disse cans, in the classic location of the medial femoral condyle, is trauma. Smillie[39] concurred, although he stated that the subchondral fracture of osteochondritis dissecans is "never seen in the recent state." However, one of our skeletally mature patients sustained an acute subchondral fracture, with intact articular cartilage, which was classic for osteo chondritis dissecans in its shape and location on the medial femoral condyle. We believe that a subchondral fracture is the precursor to osteochondritis dissecans. It is usually asymptomatic until later, and consequently not diagnosed in the "recent state," although in this case, the early diag nosis was facilitated by a torn medial meniscus.

Second, osteochondritis dissecans has a spectrum of pres entations that depend on the patient's age and the interval from injury to diagnosis. Initially, there is a subchondral fracture with intact articular cartilage, as described above, or a stress fracture as hypothesized by Cahill et al.[7] The

TABLE 2
Hughston et al.[20] rating criteria

Rating	Score (Points)	Criteria
Excellent	4	No limitation of activity No symptoms Examination normal Radiographs normal
Good	3	Mild aching with strenuous activity Examination normal Radiographs show healed defect or residual sclerosis
Fair	**2**	Mild aching and swelling **with** strenuous activity Examination normal Radiographs show flattening of condyle but normal joint space
Poor	1	Pain and swelling with mild activity Tenderness Loss of 20' of motion 0-2.5 cm of thigh atrophy Radiographs show irregularity of condyle and narrowed joint space
Failure	0	Pain and swelling with no activity Tenderness Loss of motion of more than 20' More than 2.5 cm of thigh atrophy Radiographs show absent joint space

fragment undergoes avascular necrosis. If the injury fails to heal, there is bony reabsorption around the fracture. The articular cartilage subsequently loses subchondral support and is subjected to abnormal stress, which results in pro gressive deterioration of the fragment. The articular carti lage protrudes outward and eventually splits around the periphery of the lesion, displacing into the joint. The length of time it takes to progress from initial injury to complete detachment is unknown, although it may be several years. In this series, four cases were followed from 4 to 6 years before the lesion completely detached.

Third, treatment depends on where the lesion is in this spectrum at the time of diagnosis. In children with an early presentation, the articular cartilage is healthy, has subchon dral support, and there is a good chance of healing with conservative therapy. A bone scan must be performed to rule out epiphyseal defects that may have the appearance of osteochondritis dissecans. Although the literature docu ments that healing in children is a dependable occurrence with immobilization or activity restriction, our experience is similar to that of Hughston et ai.,[20] Guhl,[18] Cahill et al.,7 and Langer and Percy,[25] that is, activity restriction may not lead to healing, but to progressive deterioration. Four of our patients, ages 11 to 13, were treated with nonweightbearing and activity restriction 2 to 3 years before closure of the physis. In each case, the lesion progressed. In one case, the lesion partially separated, and in two the lesion completely separated after closure of the physis. Degenerative changes were identified in each of these cases at the time of surgery. Our experience is similar to that of Linden[26] in that we also found degenerative changes to be uncommon in patients who heal before skeletal maturity, but almost universal in patients who heal after maturity. Consequently, we believe that if an older child fails conservative therapy or ap proaches skeletal maturity, a more aggressive, surgical approach should be taken. Prolonged conservative treatment will only result in further deterioration of the fragment and irreversible degenerative changes.

In the skeletally mature patient, the pathophysiology is the same, although the lesion is less likely to heal with conservative treatment. Therefore, a more aggressive sur gical approach is indicated. There are differences of opinion on how the articular surface of the displaced lesion should be restored. Smillie[39] and Hughston et al.[20] advocated pin fixation. Smillie, however, found that subchondral bone loss made it difficult to accurately replace the fragment, and suggested the possibility of adding autogenous bone graft. Lipscomb et al.[28] were the first to routinely bone graft the crater to restore the contour of the condyle. In our experi ence, it was virtually impossible to remove the fibrous tissue and avascular bone from the crater and restore subchondral support and contour of the condyle without a bone graft. Our technique differed from that of Lipscomb et al.,[28] who removed the fibrous tissue on the undersurface of the frag ment and thinned any thick or rough subchondral bone. In this series, there was minimal fibrous tissue or bone on the inner surface of the fragments. Consequently, removal was unnecessary. We also used the anterior-distal femur as the donor site, in preference to the proximal tibia.

Lipscomb et al.[28] reported healing of the lesion and excel lent results in seven of eight patients. We agree that healing occurs with this technique, and although our results were not as good as theirs, most of our patients were better symptomatically. The discrepancy in results may be attrib uted to a difference in their rating scale and that of Hughs ton et al.,[20] which was used in this study. They did not allude to the preoperative degenerative changes that frequently occurred in this study, nor did they document postoperative progression of these changes. In this series, the results

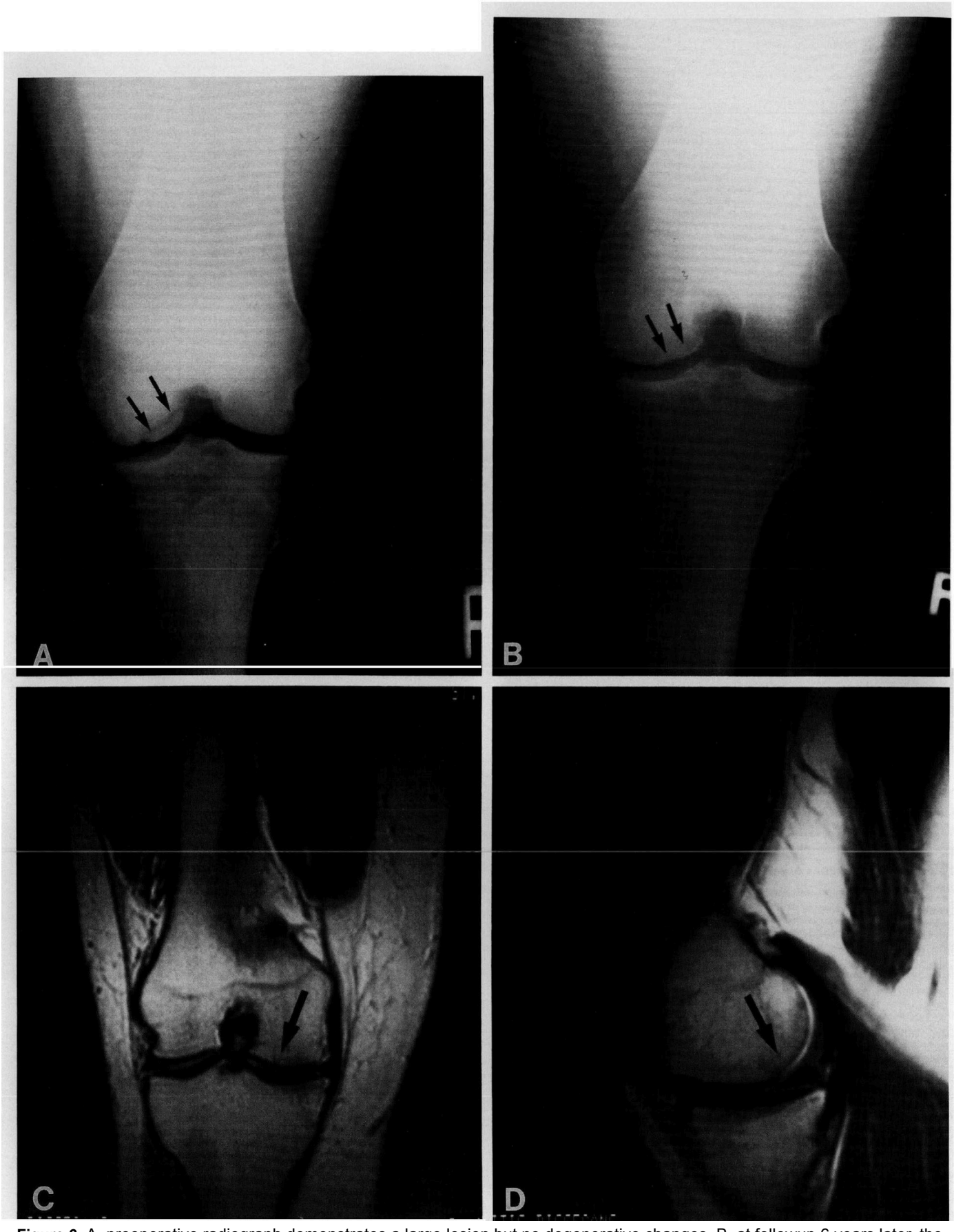


Figure 6. A, preoperative radiograph demonstrates a large lesion but no degenerative changes. B, at followup 6 years later, the lesion has healed. The degenerative changes were rated as Grade II medial femoral condyle spurring, Grade I flattening and

appear to be worse in those who had more preoperative degenerative changes, a larger lesion, or a loose fragment.

The subchondral bone and articular cartilage could be visualized with MRI. Although the integrity of the articular cartilage could be documented, MRI is of questionable value in the postoperative followup of this condition. The status of the articular cartilage, as demonstrated by **MRI,** could not be correlated with the degree of degenerative changes or the results.

Finally, this study supports the opinion that the best results occur in those who heal before maturity and confirms that degenerative changes frequently occur in adults. Al though the technique presented here is effective in healing the lesion, it does not prevent some progression of degener ative changes. Consequently, we believe that if a lesion in the immature knee is not responding to conservative ther apy, a more aggressive approach taken before closure of the physis may improve results.

CONCLUSIONS

1. Osteochondritis dissecans in the immature knee may progress in spite of conservative treatment.
2. If healing does not occur with conservative treatment, a more aggressive approach should be taken before closure of the physis occurs.
3. A delay in treatment frequently leads to preoperative degenerative changes or detachment of the fragment, which adversely affects the result.
4. Healing occurs in most cases with this technique; how ever, the incidence of degenerative changes indicates that it will not result in a normal knee.
5. Magnetic resonance imaging can determine the integ rity of the articular cartilage, although it is of questionable value in the followup of this condition because the status of the articular cartilage could not be correlated with the degree of degenerative changes or results.

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