

Review article

Unicompartmental knee replacement

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1. Introduction

Osteoarthritis can affect any or all of the three compartments of the knee joint. During the early stages of the disease a single compartment is frequently affected. Hemborg [1] has shown that the disease usually remains confined to the initially affected compartment and White [2] has suggested that medial component osteoarthritis does not progress while the ACL is intact. Symptoms may not be sufficiently severe to require invasive treatment but if they are it is an attractive option to merely address the damaged part of the joint leaving the 'normal' compartments alone. It therefore seems logical to merely treat the damaged part of the joint leaving good quality ligaments and articular cartilage in place. It also seems possible that replacing the damaged part of the joint where bone loss and collapse can be anticipated might slow down or even prevent the development of multicompartmental arthritis.

The concept of unicompartmental knee replacement is therefore very attractive and simple. To replace only the damaged part of the knee preserving as much normal tissue as possible and thereby not only relieving the patients symptoms but also preventing progression of the disease. Since the remainder of the joint is in good condition the object of the procedure should be to return the joint to 'normal'. Clearly this is somewhat unrealistic but it is the goal to which enthusiastic unicompartmental replacers aspire. How nearly this can be achieved will be considered later.

In 1954 MacIntosh [3] reported the use of his vitallium tibial plateau prosthesis which could give satisfactory pain relief but the lack of fixation

sometimes led to migration, a problem that was lessened by McKeever [4] who added a keel to his tibial plateau prosthesis. However, modern unicompartment replacement really started with Marmor who introduced his modular hemi arthroplasty in 1972 and in 1979 reported a high percentage of success in 56 patients followed for a minimum 4-year period [5].

At a similar time the St. Georg Sled was introduced in Germany and in 1976 Engelbrecht [6] was able to report on 294 patients with 85% achieving a good result after a 4-year follow-up. Other authors also produced good initial unicompartmental results with Scott et al. [7] reporting initial success with the Brigham prosthesis; and later both Larsson [8] and MacKinnon [9] confirming satisfactory results with the St. Georg Sled.

However, these reports were counterbalanced by others. In 1980 Insall reported on a series of 22 initially successful UKAs which had started to fail at the 6-year review [10]. Laskin noted poor results with the Marmor [11] prosthesis and Bucholz recorded a high failure rate for the St. Georg Sled [12]. However, a review of these articles suggested inappropriate patient selection was a major contributory factor since many of the Insall group had undergone prior patellectomy and in Germany the prosthesis had frequently been used for bicompartamental disease and often in association with rheumatoid arthritis and joint laxity. Those papers and later reports of mechanical failure of certain prosthesis such as Brigham, due to thin polyethylene and possible edge contact, and the PCA Uni due to poor quality heat-treated polyethylene [13,14] meant that there has been widespread scepticism about the wisdom of using a unicompartmental replacement; especially as the outcome of total knee replacement has become more acceptable.

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As a result in North America and the United Kingdom many surgeons feel that total knee replacement is an easier and more reliable procedure which should always be performed in knees where prosthetic replacement is indicated. However, in mainland Europe many surgeons take an opposite view and continue to perform unicompartmental replacement.

Two recent studies have perhaps produced evidence that unicompartmental replacement needs to be considered more seriously. The first study from Bristol [15] reports the 5-year results of a randomised study of unicompartmental or total knee replacements in cases deemed suitable for unicompartmental replacement. This demonstrated an advantage for the unicompartmental group in terms of rapidity of recovery, overall function and range of movement obtained. The second study from Oxford showed that with a congruent mobile bearing unicompartmental replacement (Fig. 1) a 10-year survivorship of 97% could be obtained [16]. This compares favourably with the best survivorship series of total knee replacements and thus modifies the argument that unicompartmental replacements fail more rapidly than total knee replacement. It therefore seems sensible to re-examine the position of unicompartmental knee replacement.

2. Indications

Since only one of the three compartments is to be replaced it is clearly necessary for the disease to be predominantly confined to that compartment. In early disease unicompartmental degeneration is frequently seen, especially if a previous meniscectomy has been performed. When the medial compartment is involved pain is usually significant but with primary lateral compartment arthritis pain is frequently minimal so that patients present late with instability and deformity, which is often too great to be corrected by unicompartmental replacement. Thus, lateral unicompartmental replacement is seldom indicated and the reported results have been less predictable than with medial unicompartmental replacement [17–19], though excellent long-term results can be achieved.

Even when the disease appears to be confined to one compartment the quality of the apparently normal articular cartilage in the opposite compartment is less good than in age-matched controls, so it is important not to overload the unreplaced compartment [20].

The importance of the patello femoral compartment is debated. Most feel it is unwise to perform unicompartmental replacement in the presence of significant patello femoral osteoarthritis or symptoms

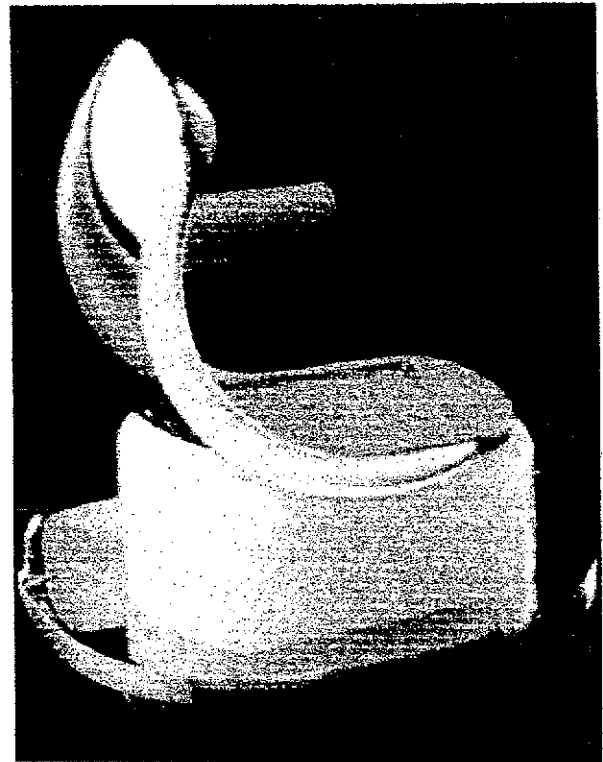


Fig. 1. An Oxford mobile bearing unicompartmental replacement with a completely congruent tibio femoral interface.

of patello femoral pain and cases of failure due to patello femoral disease have been reported. However, Goodfellow [21] takes a contrary view and argues that correction of the varus deformity will improve patella tracking so that the state of the patella becomes unimportant and unicompartmental replacement can be performed even in the presence of patello-femoral pathology.

Two contraindications to unicompartmental replacement are an absent anterior cruciate and a fixed flexion deformity of more than 10°. Moller et al. [22] suggested on theoretical grounds that an absent ACL would lead to early unicompartmental failure and this has been reported in practice by Goodfellow [21]. Similarly, major collateral laxity is not controlled by UKA and should be regarded as a contraindication. Fixed flexion deformity is rarely corrected by Unicompartmental Knee Replacement and since it compromises the result of any knee replacement its presence should be regarded as an indication for total rather than unicompartmental replacement.

Rheumatoid and other forms of inflammatory arthritis are contraindications and many regard the presence of chondrocalcinosis as unacceptable though this is not universally agreed.

3. Alternatives to Unicompartmental Knee Replacement

3.1. Upper tibia osteotomy

Although biological resurfacing methods are gaining in popularity no comparative studies with unicompartmental knee replacement exist as yet. The traditional alternative to unicompartmental knee replacement has been an HTO which can give acceptable results. No randomised studies exist in which a prospective study has been performed comparing the two surgical interventions. Karpman and Voltz [23] compared a group of patients treated by the two procedures and found a higher percentage of excellent cases in the unicompartmental knee replacement group and Scott and Santore [7] noted that in properly selected cases unicompartmental knee replacement had a higher initial success rate and less complications but both these studies had a short follow-up. In a retrospective review of similar cases treated by either HTO or unicompartmental knee replacement, Broughton et al. [24] demonstrated that at 7 years unicompartmental knee replacement gave a superior result in terms of both quality and longevity of the intervention. When this study was later extended so that at an average follow-up of 12.9 years the results of the unicompartmental knee replacements were still superior [25].

However, until good evidence exists that unicompartmental knee replacement can give good long-term results in younger people osteotomy should probably continue to be preferred for that group especially if there is some articular cartilage preservation. Once articular cartilage is completely lost UKA should be considered since acceptable results have recently shown in patients under 60 years of age [26].

3.2. Total Knee Replacement

In 1991 Laurencin et al. [27] published a series of 23 patients with a unicompartmental knee replacement in one knee and a unicompartmental knee replacement in the other. At an average of almost 7 years the unicompartmental knee replacement knee was performing better both in terms of pain relief and range of movement. A similar study showed that most patients who had a unicompartmental knee replacement in one knee and a total knee replacement in the other preferred the unicompartmental knee replacement side [28].

Recently a study from Bristol [15] has been published in which 102 knees all deemed suitable for unicompartmental were randomised to be treated by either a St. Georg Sled unicompartmental replace-

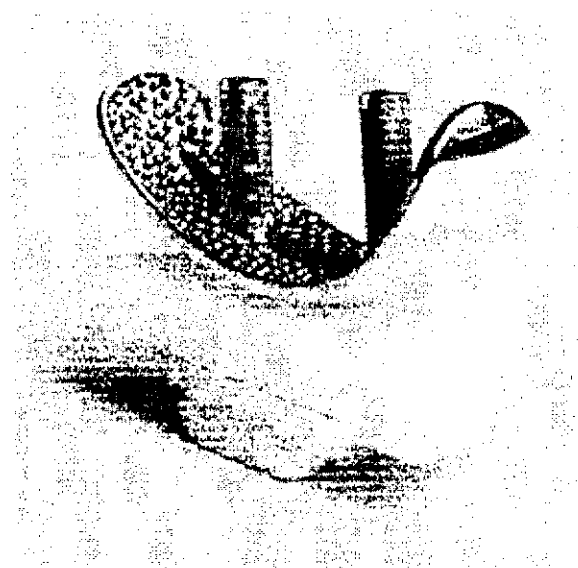


Fig. 2. St Georg Sled unicompartmental replacement with femoral component rounded in two planes to avoid edge contact and a completely flat all polyethylene tibia.

ment (Fig. 2) or a Kinematic modular Total Knee Replacement, with routine preservation of the posterior cruciate and patella resurfacing. Well matched groups were obtained with a predominance of females and a mean age of 69 years.

Patients in the Unicompartmental Knee Replacement group showed less perioperative morbidity, regained knee movement faster and were discharged from hospital 2 days sooner.

At 5 years review pain relief was good in both groups but significantly more UKRs achieved $>120^\circ$ of knee flexion (69% as opposed to 17%) and there were more excellent results on the Unicompartmental Knee Replacement group. There was no difference in the failure rate.

3.2.1. Advantages of Unicompartmental Knee Replacement over Total Knee Replacement

Unicompartmental Knee Replacement is a more minor procedure and as such offers a number of advantages when compared to total knee replacement.

- Rehabilitation is more rapid and hospital stay is shorter.
- The operation is usually quicker.
- The procedure can be performed through a limited incision without the need for dividing the quadriceps muscle or everting the patella. This can result in a spectacularly fast recovery and can be performed without compromising prosthetic alignment.

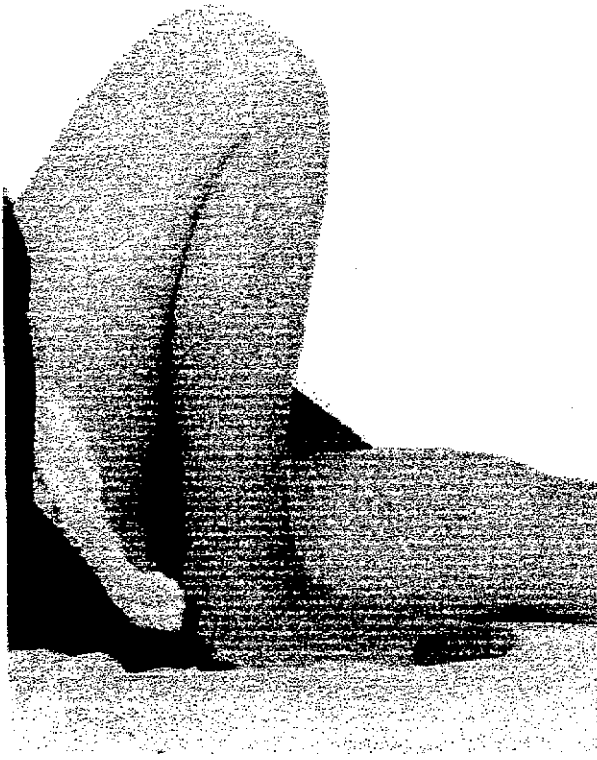


Fig. 3. Range of flexion achieved by a patient following unicompartmental replacement with a St Georg Sled prosthesis.

- The need for blood transfusion is substantially reduced with only 25% requiring transfusion as opposed to 68% of TKRs [29].
- Infection rates are lower as demonstrated by the Swedish multicentre study [30].
- More excellent as opposed to good results are obtained.
- A greater range of movement is usually obtained (Fig. 3) perhaps due to a lesser tendency for patella infera to develop [31].
- Death from pulmonary embolism is extremely rare. Ansari et al. [32] found an overall death from pulmonary embolus rate of 0.22% in a series of 1390 knee replacements but there was not a single death amongst the 532 patients having Unicompartmental Knee Replacement
- Knee function on gait analysis is more physiological [33].
- Revision is easier than revising a Total Knee Replacement and good results can be achieved [34], though when necessary revision should always be to a total knee replacement [35].

3.2.2. Disadvantages of Unicompartmental Knee Replacement

- Most surgeons are less familiar with the techniques than with total knee replacement and since even enthusiasts would probably only consider 20% of arthritic knees suitable for UKR some surgeons will not acquire many appropriate cases.
- Instrumentation systems are not as well developed.
- Disease can progress in the unreplaced compartments though with correct techniques this should be rare, and does not form a high percentage of the failures in most modern series (Fig. 4).

4. Choice of prosthesis

There are many unicompartmental prostheses on the market, particularly in Europe. There are advantages and disadvantages to most. Some of the longer

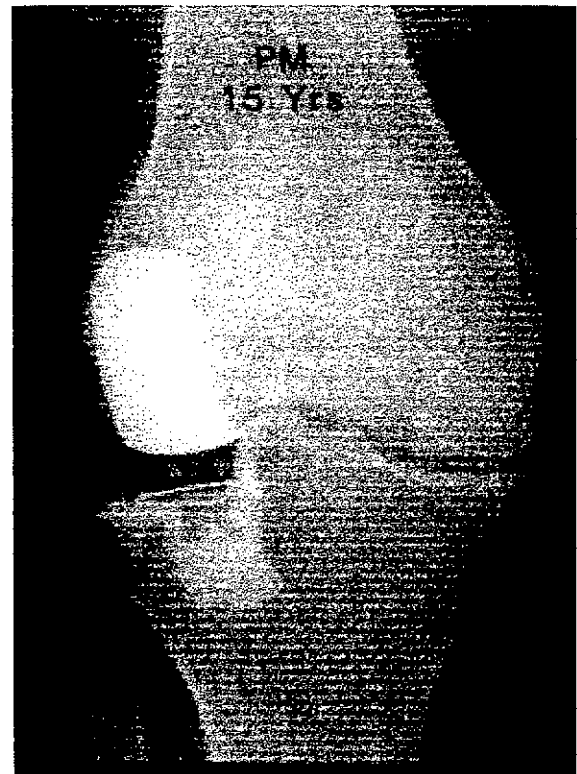


Fig. 4. Fifteen years after lateral unicompartmental replacement this patient is symptomatic despite some radiological medial compartment arthritis. Note there is no evidence of prosthetic wear or loosening.

established prostheses have poor instrumentation which has been much improved for the newer models which currently lack a proven track record. When selecting a prosthesis it is important to remember that in unicompartmental replacement the collateral and cruciate ligaments are left intact and will dictate the pattern of movement of the replaced femoral condyl on the tibia. Since this is fixed by the ligaments the prosthesis must be able to conform. It is therefore important that constraint is avoided by using either a mobile bearing or flat tibia component. Stability is provided entirely by the soft tissues.

Errors will inevitably be made so it is also desirable to choose a model in which minor surgical errors can be accommodated; in particular prostheses in which edge contact can occur should be used with caution. Polyethylene wear will occur so adequate thickness of polyethylene is essential. If a fixed bearing tibial component is to be used serious consideration should be given to using an all polyethylene tibia since there is no proven advantage to metal backing in unicompartmental replacement. Use of an all polyethylene tibia allows more bone preservation for a given thickness of component. Since mobile bearing components tend to wear less thinner polyethylene inserts are acceptable allowing good preservation of tibial bone stock.

5. Survivorship of Unicompartmental Knee Replacement

The most comprehensive study of survivorship is the Swedish arthroplasty register. It is interesting to note that in 1970 the rate of failure of unicompartmental replacement was almost identical to that of total knee replacement. However, in the two subsequent cohorts studied the survivorship of total knee replacement has improved markedly while that for the unicompartmental knee replacement has hardly changed [36]. This suggests that the same technical or design improvements have not been made with unicompartmental knee replacement as with total knee replacement and so room for further improvement probably exists.

Relatively few survivorship studies of unicompartmental knee replacement exist. In 1991 Rand and Ilstrup reported a 68% 10-year survivorship, but in the last few years several studies have reported 10-year survivorship of approximately 90% [37–39].

Although some authors have reported poor results with the Oxford mobile bearing unicompartmental replacement [40] the outstanding 97% 10-year survivorship reported by Murray [16] suggests that good long-term survival can be obtained, especially as the same prosthesis has been shown to have an extremely low polyethylene wear rate [41]. The LCS mobile

bearing unicompartmental replacement has also been shown to have a low complication rate after 6 years follow-up [42].

6. Modes of failure

The pattern of failure of the unicompartmental knee replacement will inevitably vary with the particular prosthesis used and the skill of the surgeon. Broadly, failures can be divided into those which occur early and will probably relate to inappropriate patient selection, infection or poor technique. While the second group which will usually occur later result from progression of the arthritis in other compartments or prosthetic failure. Clearly the mode of failure here will vary with the particular prosthesis — for example the PCA Uni failed early due to unacceptable polyethylene wear while the Brigham could fail early due to edge loading or later due to the thin polyethylene used with some metal backed prostheses. Tibial loosening was the major cause of failure of the Lotus prosthesis, frequently associated with ligamentous laxity [43].

Some failures in theory can be addressed by improvements in technique and prosthetic design, while patient selection will always be important.

However, polyethylene wear will always be of importance. In the St. Georg Sled prosthesis, which has a fixed flat polyethylene tibial bearing surface penetration occurs at a rate of 0.08 mm per year and creates a volumetric defect at a rate of 37.6 cu mm³ per year [44]. This is similar to the wear rate reported for Charnley hip replacement [45] and considerably less than the rate thought to cause osteolysis (Fig. 5). By contrast the totally congruous mobile bearing Oxford Unicompartmental Knee Replacement wears at a rate of 0.03 mm per year and generates less polyethylene wear debris which should substantially reduce the likelihood of long-term loosening and failure [41]. However, this low wear rate is achieved at the expense of occasional meniscal-dislocation.

The LCS uni with its captive mobile meniscus also has a reduced wear rate but does not achieve congruence throughout its range of movement and thus polyethylene wear remains an important factor.

The more fundamental question though is whether the arthritis in the uninvolved compartments will progress and whether the disease progression can be arrested by uni replacement of the arthritic compartment. Although the latter question has yet to be answered two recent studies have suggested that following medial unicompartmental replacement progression of arthritis in the other compartments is unusual [46,47]. In Bristol 43 unicompartmental replacements which have been carefully followed for

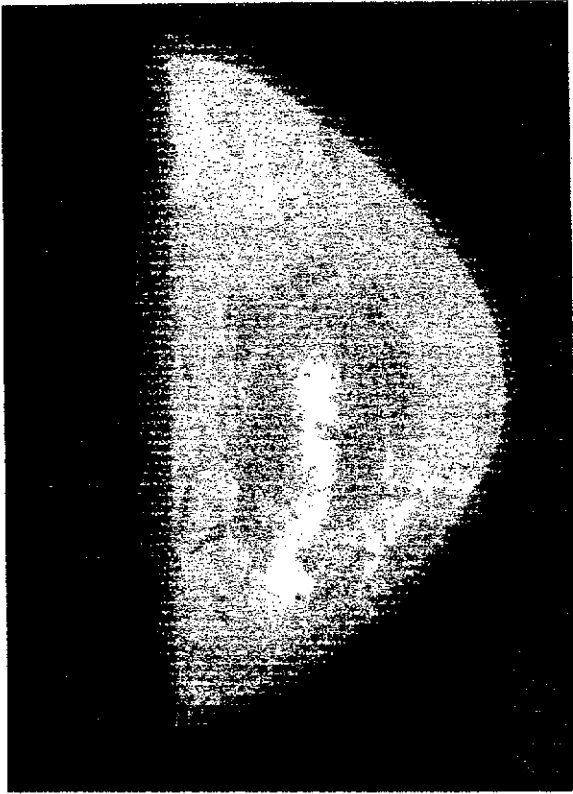


Fig. 5. A conforming groove has been created in the flat polyethylene component. Its exact position and direction is determined by individual component placement and ligament balance.

over 5 years showed that only one case had radiological progression of arthritis in the patello femoral joint and none in the tibio femoral joint. Similar findings after 10 years have been reported from Oxford though in this series weight bearing and skyline radiographs were not taken.

7. Revision of Unicompartamental Replacement

One traditional agreement against the use of unicompartamental replacement has been that should failure occur it is difficult to revise. There are few series addressing this problem. Several authors [34,48–50] feel good results can be achieved while Padgett et al. [51] note that the results are less satisfactory than primary knee replacement.

In Bristol 78 revisions of unicompartamental replacements have been carried out. These were carefully analysed for technical difficulties as well as for outcome. By taking care when removing the failing implant it was found that in 78% of cases there was either no bone loss or only a small contained defect after standard cuts for a primary knee replacement

had been made. In these cases no problem was posed. The remaining 22% had a significant bony defect that required either grafting or augmentation with a wedge or stem. However, with modern revision systems such defects can easily be managed.

Overall, the average thickness of the polyethylene insert used at revision was 11.4 mm. At a mean follow-up of 58 months the average Bristol Knee Score for the group was 80, with no repeat revisions. This figure is not as good as those reported for primary knee replacement but is considerably better than the results obtained by the same unit for total knee replacements after upper tibial osteotomy [52], or for revision of failed Total Knee Replacements.

8. How good are Unicompartamental Replacements?

In order to achieve a 'perfect' knee the following need to be achieved

- Total pain relief. This undoubtedly is achievable in some cases, at least in the short-term.
- Stability. Rarely a problem in appropriately selected cases
- Strength. No figures available for power after Unicompartamental Knee Replacement.
- Full movement. Several series report a proportion of knees with full movement.
- Normal proprioception and gait. Further studies are needed to assess this aspect though nearly normal mechanics have been noted [53].
- Correction of deformity. This can probably be achieved but many deliberately undercorrect
- A minimal access scar allowing rapid rehabilitation.
- A long lasting result. Several series report 10-year survivorship of approximately 90%, so clearly this is possible.

It therefore seems that many of these objectives are achievable but as yet consistency is lacking. Further improvements will undoubtedly occur as many areas still need addressing. The following are among the more important

1. Accurate patient selection so as to avoid cases in which the disease will progress.
2. Refined instrumentation so that the prosthesis can be inserted consistently through a minimal incision thus allowing rapid recovery, possibly following day case surgery.
3. A forgiving implant that tolerates minor surgical errors since these will inevitably occur.
4. Improved design in terms of fixation and bearing surfaces so that unicompartamental replacement

can be used with confidence in young people who are currently likely to suffer from premature implant failure.

5. Accurate audit of the procedures. Good results are currently obtainable so efforts must be made to ensure faulty designs or techniques are not allowed to persist.

9. Conclusion

After an encouraging start in the 1970s when Unicompartmental Knee Replacement gave much better results than other available treatments there has been a period of prolonged uncertainty about the place of the procedure. Total Knee Replacement has proved reliable and many surgeons abandoned Unicompartmental Knee Replacement. However, patients are demanding better and better outcomes from all surgical interventions and it seems likely that by preserving the satisfactory parts of the joint and merely replacing the damaged areas excellence should be achievable. Many series have reported short-term excellence but it now appears as though longer term survival with unicompartmental replacement is becoming possible. Thus, in the future it should be possible to intervene surgically at an earlier stage and return the patient to near normal mobility before severe generalised arthritis develops in the knee.

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