

# Surgical options for patients with osteoarthritis of the knee

Jörg Lützner, Philip Kasten, Klaus-Peter Günther and Stephan Kirschner

**Abstract** | Osteoarthritis (OA) of the knee is a progressive disease that ultimately damages the entire joint. Knee OA should initially be treated conservatively, but surgery should be considered if symptoms persist. Surgical treatments for knee OA include arthroscopy, osteotomy and knee arthroplasty; determining which of these procedures is most appropriate will depend on several factors, including the location and severity of OA damage, patient characteristics and risk factors. Arthroscopic lavage and debridement do not alter disease progression, and should not be used as a routine treatment for the osteoarthritic knee. Bone marrow stimulation techniques such as microfracture are primarily used to treat focal chondral defects; the evidence for the use of these techniques for knee OA remains unclear. The goal of osteotomy for unicompartmental knee OA is to transfer the weight load from the damaged compartment to undamaged areas, delaying the need for joint replacement. This procedure should be considered in young and active patients who are not suitable candidates for knee arthroplasty. For patients with severe OA, total knee arthroplasty can be a safe, rewarding and cost-effective treatment. In selected patients with isolated medial or patellofemoral OA, unicompartmental knee arthroplasty and patellofemoral replacement, respectively, can be successful.

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## Introduction

Osteoarthritis (OA) of the knee (Figure 1) is a progressive disease that ultimately damages the entire joint. Knee OA is a common disease that has an increased incidence and prevalence in people over the age of 40 years; around 10% of all people older than 60 years of age have radiological signs of knee OA, and about half of those complain of clinical symptoms.<sup>1</sup> Musculoskeletal diseases, and especially OA, are common causes of disability and limitations to activities of daily living and work. The direct cost of OA in the US is estimated at \$81 billion per year, with a further \$47 billion in indirect costs, including lost wages and productivity.<sup>1–5</sup> Initial treatment of knee OA is conservative, and includes educational information, physical therapy, regular exercise, weight reduction, the use of acetaminophen (paracetamol) and/or NSAIDs and intra-articular injections of corticosteroids or hyaluronate.<sup>6,7</sup> If symptoms persist after the appropriate use of nonsurgical treatment, however, surgery can be recommended.<sup>6</sup> This Review outlines the surgical procedures available to treat knee OA at various stages and in consideration of patient-related factors, such as age, level of physical activity and risk factors.

## Competing interests

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## Arthroscopic surgery

Arthroscopy is widely used in the treatment of OA, despite the lack of evidence showing it to have greater benefit than other treatments.<sup>8,9</sup> The different arthroscopic techniques include lavage, debridement, bone marrow stimulation of contained chondral lesions, osteochondral transplantation, and autologous chondrocyte transplantation. As autologous osteochondral<sup>10</sup> and chondrocyte transplantation<sup>11,12</sup> are not indicated for knee OA, we will not discuss them in this Review. Most published studies of arthroscopic procedures for knee OA (Table 1) are of limited quality, owing to lack of randomization, lack of a control group, short-term follow-up, or inconsistent assessment methods.<sup>13</sup> Only three randomized trials have compared arthroscopic surgery with a nonsurgical control procedure for knee OA.<sup>8,9,14</sup>

## Lavage and debridement

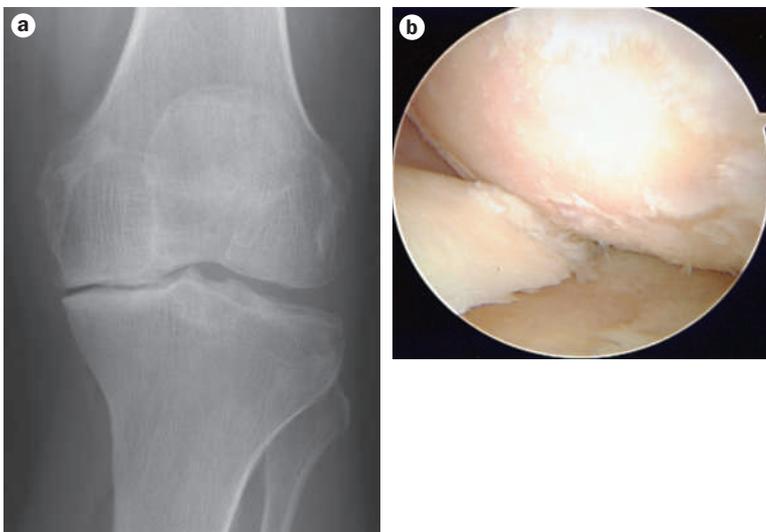
The rationale for arthroscopic lavage is to wash out debris and inflammatory enzymes, consequently reducing symptoms of synovitis and pain and improving function. Arden *et al.*<sup>14</sup> compared improvements in WOMAC score following tidal irrigation, performed with a 3.2 mm wrist arthroscope, and intra-articular corticosteroid injection. Both treatments provided short-term pain relief; however, the benefits lasted longer after irrigation. After 6 months, only 29% of patients who received corticosteroids reported continued improvement, compared with 64% of those who underwent tidal irrigation. In both groups, the best outcomes were reported in patients with effusion and radiographic signs of mild OA at baseline. Van Oosterhout *et al.*<sup>15</sup> compared arthroscopic lavage in

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**Key points**

- Osteoarthritis (OA) of the knee should first be treated nonsurgically; however, if this approach fails, several surgical options are available
- Arthroscopic lavage and debridement should not be used as a routine treatment in knee OA, as only selected patients might benefit; neither procedure alters disease progression
- Evidence for the use of bone marrow stimulation techniques for knee OA is unclear; the primary indication for this procedure remains focal cartilage defects
- Osteotomy is recommended for young, active patients with knee OA who are not suitable candidates for arthroplasty
- Total knee arthroplasty is a safe and cost-effective treatment for severe knee OA, although the relative risks and benefits should be thoroughly considered
- Unicompartamental knee arthroplasty or patellofemoral replacement can be an option for selected patients with isolated medial or patellofemoral OA, respectively



**Figure 1** | Characteristic appearance of advanced osteoarthritis of the knee, occurring mainly in the medial compartment. **a** | Radiograph revealing medial joint space narrowing and the presence of osteophytes. **b** | Arthroscopic view shows cartilage loss at the medial femoral condyle and tibia.

combination with corticosteroids, arthroscopic lavage alone, and joint aspiration in combination with corticosteroids. The results demonstrated superior outcomes following arthroscopic lavage combined with administration of corticosteroids. Only patients with inflammatory arthritis were included, and no validated outcome measurement scores were used; therefore, the results of this study are not directly applicable to knee OA.

Arthroscopic debridement includes not only lavage and washout of debris, but also the immediate treatment of other mechanical problems (that is, removal of loose bodies, hypertrophied synovium and torn meniscal fragments); many surgeons also shave fibrillated articular cartilage and remove detached cartilage flaps. These procedures are thought to provide benefit beyond that of lavage by improving the mechanical conditions of the knee joint. In a prospective randomized trial, however, Moseley *et al.*<sup>8</sup> did not find any significant difference in pain relief over 24 months following arthroscopic

debridement or a placebo procedure. The results of this study have been extensively debated, as several methodological issues were raised against the protocol employed, including the use of an unvalidated outcome measurement (namely the 'Knee-Specific Pain Scale'), a restrictive patient selection (favoring mainly male patients) and possible selection bias (44% of eligible patients declined to participate, and there was no stratification for OA severity). Most of these issues were addressed in a study by Kirkley *et al.*<sup>9</sup> that compared a combination of arthroscopic lavage and/or debridement and physical and medical therapy with physical and medical therapy alone. Again, no differences were observed between the two treatment groups in WOMAC score—a well-validated outcome measure—after 2 years. A recent Cochrane Review<sup>16</sup> of arthroscopic debridement for knee OA identified only three well-performed studies,<sup>8,17,18</sup> and concluded from these that the procedure has no benefit for OA arising from mechanical or inflammatory causes. However, a critical systematic review of all available publications<sup>13</sup> concluded that arthroscopic debridement offered benefit to patients with meniscal tears and knees with low-grade OA. The Osteoarthritis Research Society International (OARSI) views arthroscopic debridement for knee OA as controversial.<sup>7</sup>

On the basis of available evidence, arthroscopic lavage seems to provide only short-term benefit to selected patients with mild radiographic OA and effusion. In addition, arthroscopic debridement should not be used as a routine treatment for OA of the knee, although patients with symptomatic meniscal tears and loose bodies with locking symptoms could benefit. Neither procedure alters the progression of OA.

### Bone marrow stimulation

The aim of bone marrow stimulation techniques is to induce bleeding from the subchondral bone followed by the formation of a fibrin clot, the migration of undifferentiated mesenchymal stem cells and, consequently, the formation of fibrocartilaginous tissue that covers full-thickness chondral lesions. These techniques were developed mainly for the treatment of focal chondral defects, but are also used in osteoarthritic knees. Different techniques for penetrating subchondral bone include drilling,<sup>19</sup> microfracturing,<sup>20</sup> and abrasion arthroplasty.<sup>21</sup>

Microfracturing is used more often than drilling or abrasion because it is easy to perform and avoids heat damage. The microfracture technique<sup>20</sup> involves debridement of all unstable cartilage to bone level to form a stable rim of healthy cartilage around the defect; specially designed awls are then used to make multiple holes 2–4 mm deep and 3–4 mm apart (Figure 2). Rehabilitation includes continuous passive motion and partial weight bearing for 6–8 weeks, although this estimate of healing time is based on scant clinical data. In a nonhuman primate model of microfracture, the repair tissue was still immature after 6 weeks;<sup>22</sup> therefore, a longer period of partial weight bearing could be necessary.

Whatever technique is used, the fibrocartilaginous tissue produced by bone marrow stimulation does not have the biomechanical properties and durability of the original articular cartilage, and the treatment probably does not alter the progression of OA. Bone marrow stimulation is not, therefore, a curative treatment; however, many patients obtain relief from symptoms for several years.<sup>23</sup> The results are good for small and focal chondral lesions, which occur in patients with moderate OA; in advanced OA, which is usually associated with large chondral defects, the techniques are less effective.

Unfortunately, no randomized or controlled prospective studies have appropriately evaluated these techniques. Clinical trials have often used distinct indications and techniques, and only short-term follow-up. In summary, the evidence for the use of bone marrow stimulation techniques in patients with knee OA remains unclear. The primary indication for this surgical procedure remains focal cartilage defects.

### Osteotomy

Osteotomy is an established procedure for the treatment of unicompartmental knee OA that has been in use since the 1960s.<sup>24,25</sup> Osteotomy entails cutting through the bone and fixing it in another position in order to change the alignment and, consequently, redistribute the weight load. As a result of technical advances in unicompartmental and total knee arthroplasty, osteotomy has become less frequently performed. With the introduction of new techniques and more-stable fixation devices, however, this procedure is experiencing resurgence in some countries. In unicompartmental knee OA, the goal of osteotomy is to transfer the weight load from damaged areas to the unimpaired femorotibial compartment, and consequently reduce symptoms and delay the need for joint replacement. Medial compartment OA is most often associated with a varus deformity of the tibia; therefore, high tibial osteotomy is the technique most often performed around the knee. OA of the lateral compartment in combination with valgus malalignment of the distal femur is treated with supracondylar femoral osteotomy. Additional arthroscopic treatment is often performed at the same time as osteotomy, making it difficult to distinguish the effect of each operation.

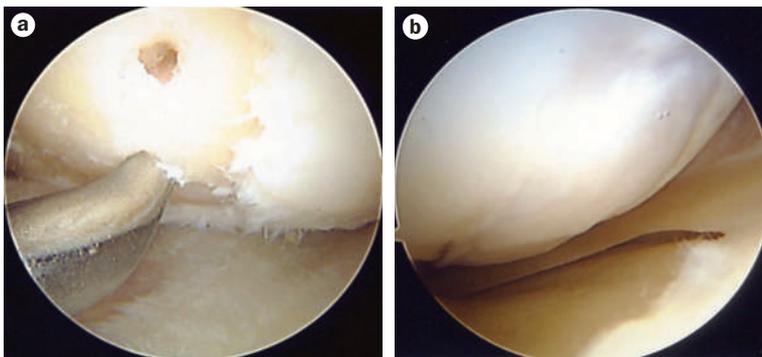
Early results from osteotomy are usually good, with deterioration over time owing to OA progression. The probability of 'osteotomy survival' (defined as non-conversion to total knee arthroplasty) after 10 years ranges from 50% to 90%.<sup>26–30</sup> A meta-analysis<sup>31</sup> of high tibial osteotomy demonstrated an overall 10-year failure rate of 25%, and an average of 72 months between high tibial osteotomy and conversion to total knee arthroplasty. The probability of a 'good' or 'excellent' result was 75% after 60 months and 60% after 100 months.<sup>31</sup>

Several studies have demonstrated that the degree of correction is the most important factor for the success of osteotomy.<sup>28,32</sup> Computer-assisted navigation improves the precision of correction, and possibly improves the

**Table 1** | Quantity of literature relating to various surgical procedures for knee OA

Search terms used	Number of articles retrieved <sup>a</sup>
Osteoarthritis and lavage	181
Osteoarthritis and debridement	365
Osteoarthritis and osteotomy and knee	874
Osteoarthritis and unicompartmental and knee	407
Osteoarthritis and patellofemoral and knee	490
Osteoarthritis and (arthroplasty or replacement) and knee	3,300

<sup>a</sup>Number of articles retrieved from a search of the PubMed database conducted in December 2008.

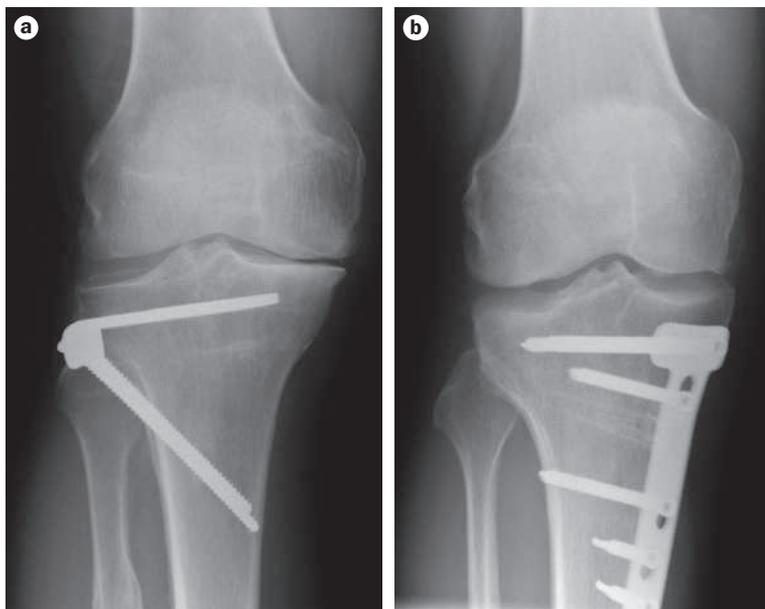


**Figure 2** | Microfracture is a bone marrow stimulation technique that creates small holes in the bone with the aim of stimulating growth of fibrocartilaginous tissue. **a** | To induce bleeding in a chondral defect at the medial femoral condyle, holes are made 3–4 mm apart. **b** | A defect of the medial femoral condyle is filled with newly generated fibrocartilaginous tissue.

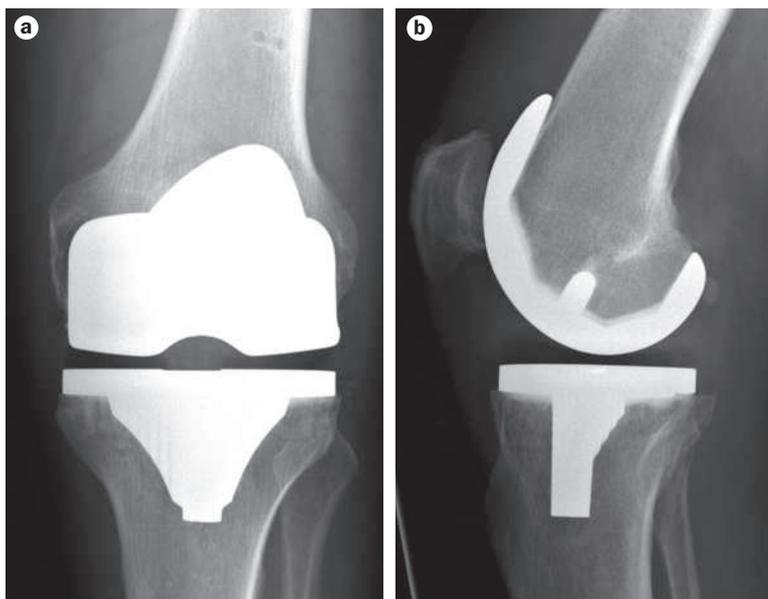
outcome.<sup>33–35</sup> Risk factors for osteotomy failure include female sex, obesity and severe OA.<sup>27,28</sup>

Two basic high tibial osteotomy techniques are used to treat a varus deformity of the tibia: lateral closing wedge and medial opening wedge osteotomy (Figure 3). Lateral closing wedge osteotomy generally requires a fibular osteotomy, which incurs the risk of peroneal nerve palsy; additional disadvantages include the need for two saw cuts and detachment of the extensor muscles. On the other hand, a large area of bone contact is produced, which supports reliable postsurgical bone healing. Medial opening wedge osteotomy has become increasingly popular since the development of angle-stable implants, owing to the simple medial approach involved and the possibility of precisely adjusting the degree of correction. Bone healing following an opening wedge procedure is reportedly reliable, even if the osteotomy gap is not treated by bone grafting.<sup>36</sup> To date, there is no evidence for a better outcome following either the opening or closing wedge technique.<sup>37</sup>

Given that unicompartmental and total knee arthroplasty are not ideal for patients who are young, active and have physically demanding jobs, osteotomy should be considered in these cases. The ideal candidate for osteotomy is active, younger than 50 years old, has a history of isolated medial compartment pain, a malalignment of less than 15°, a metaphyseal tibial varus, full range



**Figure 3** | High tibial osteotomy, often used to treat medial unicompartmental knee osteoarthritis. Osteotomy is carried out at the proximal end of the tibia to overcorrect a varus malalignment and transfer the weight load to the intact lateral compartment. **a** | The closing wedge technique involves the excision of a lateral-based bone wedge from the proximal tibia and part of the fibula. **b** | The opening wedge technique requires only one osteotomy and the medial-based opening of the resulting gap.



**Figure 4** | Total knee arthroplasty replaces the femoral and tibial contact areas. Additional patellar replacement can be done optionally. **a** | Anteroposterior and **b** | lateral views show the metal femoral and tibial prosthetic implants. A fixed polyethylene insert is placed between the two implants.

of motion of the knee, a BMI of less than 30 and radiographic evidence of moderate, isolated medial compartment OA.<sup>38</sup> However, the benefits of osteotomy are less immediate than those of knee arthroplasty, and the outcome is less predictable.

### Joint replacement

Replacement of the entire knee joint, or total knee arthroplasty, is a safe and cost-effective treatment for severe OA of the knee (Figure 4).<sup>39</sup> Durable alleviation of pain and improvement of physical function can be expected following the procedure.<sup>39,40</sup> In addition to physician-derived data, patient-centered outcome measurements have also become an essential component of any long-term analysis of the success of total knee replacement.<sup>41</sup> Owing to its irreversible nature, joint replacement is recommended only in patients for whom other treatment modalities have failed.<sup>6</sup> The procedure has a remarkably higher risk of failure 10 years after implantation in patients aged 50 years and younger<sup>43</sup> than in patients aged 70 years or older.<sup>39,42,43</sup> Complications of joint replacement surgery include prosthetic loosening, wearing of the polyethylene insert, infection and periprosthetic fractures. For patients younger than 50 years, therefore, the risks and benefits of less-invasive surgical alternatives should be thoroughly weighed against those of total knee arthroplasty.<sup>40,44</sup> Patients over 70 years of age are considered the best candidates for total knee replacement.<sup>39</sup> Increasingly, older patients with severe OA, as well as younger patients, are successfully treated with total knee arthroplasty.<sup>39,45</sup> Registers from all over the world, such as the Swedish Knee Arthroplasty Register,<sup>45</sup> demonstrate a constant increase in joint replacement rates. Joint replacement must be considered in patients with radiographic evidence of knee OA who have pain and disability refractory to conservative or joint-preserving therapy.<sup>44</sup> The indication criteria for joint replacement surgery, however, might vary between countries.<sup>46</sup>

The demand for musculoskeletal health care services is expected to increase substantially in aging populations as public expectations rise and diagnosis and treatment improve.<sup>47</sup> Using a structured method to score pain, function, movement and deformity, the New Zealand priority criteria ensure an impartial distribution of total joint replacement.<sup>48</sup> In Sweden, patients are categorized into three groups on the basis of pain level, serious functional impairment, and at least 50% reduction in radiographically visible joint space.<sup>49</sup> By contrast, the Ontario Hip and Knee Replacement Project team suggests a patient-oriented approach: the need for joint replacement surgery is indicated by both the patient's own perceptions of overall symptomatic burden and physician-derived information from clinical judgments and health status instrument scores.<sup>50</sup> Still, an evidence-based consensus on the appropriate indication for knee replacement needs to be developed.

The ideal timing of joint replacement surgery is controversial. Patients with more-severe OA gain more from the operation, but remain in worse health postoperatively, than patients with less-severe disease.<sup>51</sup> Surgery at an earlier disease stage could, therefore, be preferable. Age and comorbidities are substantial risk factors for adverse outcomes after joint replacement. The risks of major complications, including mortality, infection, and

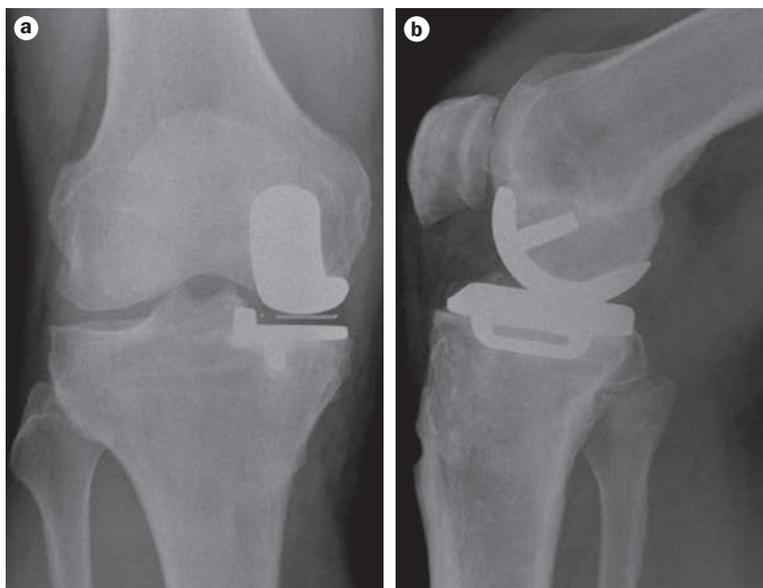
pulmonary embolism, are well known.<sup>52</sup> In addition to screening for these complications, preoperative assessment of mental status with standardized instruments, such as the Mini Mental State Exam, can help to identify older patients at risk for delirium.<sup>39</sup>

### Unicompartmental knee replacement

Unicompartmental knee arthroplasty could be indicated in cases where OA involves only one of the three compartments of the knee—the medial tibiofemoral, lateral tibiofemoral or patellofemoral compartment. The most common unicompartmental knee arthroplasty replaces the contact surfaces of only the medial tibiofemoral compartment with two metallic prosthetic devices and inserts a polyethylene inlay between them (Figure 5). For medial compartment knee arthroplasty to be indicated, the knee ligaments (anterior and posterior cruciate ligaments, medial and lateral collateral ligaments) should be intact, the varus deformity should be correctable, and the lateral compartment should have full-thickness cartilage.<sup>53</sup> Unicompartmental knee replacement should not be performed in knees that have previously undergone high tibial osteotomy.<sup>54</sup>

The use of modern implants and surgical techniques has improved clinical results and survival rates of medial unicompartmental knee arthroplasty.<sup>55</sup> Outcomes for the treatment of lateral unicompartmental knee OA are rarely reported.<sup>56</sup> These results are less predictable than those of medial unicompartmental OA, despite recent improvements in implant design. Scientific debate about the involvement of the patellofemoral joint in knee OA is ongoing. The experience of the surgeon has a considerable impact on the outcome of unicompartmental arthroplasty: a learning curve, with worse results for the surgeon's first 10 procedures, has been suggested.<sup>57</sup> Long-term survival depends on the rate of implant failure and/or progression of OA in the lateral or patellofemoral compartment of the knee. In general, the 10-year survival rate of medial unicompartmental knee replacement is slightly worse than that of total knee arthroplasty.<sup>45</sup> Specialized centers report equal survival rates for medial unicompartmental implant and established total knee arthroplasty implants.<sup>58</sup> In cases of conversion from medial unicompartmental knee replacement to total knee replacement, one-third of patients need bone grafting or wedges to augment the medial bone defect of the tibia.<sup>59</sup> The revision of a unicompartmental knee arthroplasty, in which damaged implants are replaced, is considered easier, and the results superior, to revision of a total knee replacement.<sup>60</sup>

Isolated patellofemoral OA occurs in 10% of patients with knee OA.<sup>61</sup> Underlying disorders often include prior trauma to the patella, malalignment of the patellofemoral joint, trochlea dysplasia and degeneration secondary to deep bending, overuse and/or age.<sup>62</sup> Few patients undergo isolated patellofemoral replacement,<sup>63,64</sup> although this number is increasing. Specialized centers report encouraging results.<sup>63</sup> On the other hand, these patients can also be treated with conventional total knee replacement, with



**Figure 5** | Unicompartmental knee arthroplasty in isolated medial osteoarthritis replaces only the medial femoral and tibial contact areas. **a** | Anteroposterior and **b** | lateral views show the metal femoral and tibial prosthetics. A mobile polyethylene meniscal insert is placed between the two implants.

reliable and favorable results.<sup>65–67</sup> One reason for failure of isolated patellofemoral arthroplasty is the progression of OA in the tibiofemoral joint. Indications for isolated patellofemoral replacement include diseases of the patellofemoral joint leading to isolated arthritis: trochlear dysplasia, post-traumatic arthritis and recurrent dislocations or subluxations.<sup>68</sup> OA of the tibiofemoral joint should be ruled out, as the treatment would be unsuitable for such cases.<sup>62</sup> If the suitability of patellofemoral replacement is uncertain, a conventional total knee replacement is recommended. Replacement of the patellofemoral joint is likely to have a substantial learning curve for the surgeon, and is best performed in specialized centers.<sup>40</sup>

### Total knee replacement

Total knee replacement is the gold standard for end-stage knee OA.<sup>39</sup> A large number of well-designed studies have reported preoperative and postoperative results and precisely described study populations; these data were pooled for a US government-commissioned health technology assessment of total knee replacement.<sup>69</sup> Most of the patients in the report were about 75 years of age, two thirds were female and one third were considered obese; 90% suffered from OA. Instruments used to report improvements included the Knee Society Knee Score (KSKS), the Hospital for Special Surgery (HSS) Knee Score, the WOMAC Score and the SF-36, a general-purpose 36-question health survey. Expressed as mean effect sizes, with a result greater than 0.8 considered a large treatment effect, increases in these scores varied with the scoring instrument used. With the HSS score, the observed mean effect size ranged from 3.91 (2-year follow-up) to 2.97 (>5 years' follow-up). Studies using the KSKS reported effect sizes between 2.35

(0–2 years) and 2.67 (>5 years). In WOMAC studies with a 2-year follow-up, the mean effect size was 1.62, and, finally, the mean effect size using the SF-36 was 1.27. The procedure, then, was generally reported to produce substantial improvements, although the use of more-joint-specific outcome measures was associated with the reporting of remarkably greater effects. In this report, pooling all the included studies resulted in a cumulative rate of adverse events of 5.4%. The most severe complication was perioperative mortality (0.5%).<sup>39</sup> Of note, 0.71% of infections and 0.41% of pulmonary embolism occurred within the first 90 days after surgery.<sup>52</sup>

The Swedish Knee Arthroplasty Registry<sup>45</sup> shows that revision rates of total knee arthroplasty have decreased over time. Improved surgical techniques and improved implant technology were both suggested as reasons for the improved outcomes. The rate of complications in some studies are inversely related to hospital and surgeon volumes of operations per year.<sup>39</sup>

A comparison of outcomes following either the retention or sacrifice of the posterior cruciate ligament (PCL) during total knee replacement is provided in a Cochrane report based on eight randomized studies; a total of 570 patients with OA or rheumatoid arthritis followed-up for 5 years were included.<sup>70</sup> No differences in pain or strength were found between patients whose PCL was sacrificed and those in whom it was retained. Patients whose PCL was sacrificed and in whom a posterior stabilized inlay was used showed an 8° greater increase in range of motion compared with those whose PCL was retained. The clinical scores (using the HSS score) demonstrated a statistically significant advantage of intraoperative PCL sacrifice over retention, although the clinical relevance of this advantage is questionable. A separate Cochrane report compared the clinical outcomes and postoperative range of motion following the use of either mobile or fixed tibial inserts in total knee arthroplasty: only two studies met the inclusion criteria, and the outcomes did not differ between the two treatment modalities.<sup>71</sup>

Two new technologies introduced into total knee arthroplasty surgery are minimally invasive surgery (MIS) and navigated total knee arthroplasty. A great number of reports deal with minimally invasive<sup>39</sup> total knee arthroplasty—although no accepted definition of MIS exists. In contrast to the numerous available descriptions of MIS techniques, only a few randomized controlled trials have investigated the potential benefits of MIS. Some trials show a beneficial short-term effect of MIS, whereas others do not. A meta-analysis of short-term outcomes showed

a small advantage for MIS over conventional surgery, but mainly in studies that combined MIS with the use of a navigation system.<sup>72</sup> Computer navigation improves the precision of postoperative alignment following total knee arthroplasty, as shown in long-leg radiographs.<sup>73</sup> No additional effect of computer navigation has been shown on component alignment or early clinical outcomes. Whether this improved precision will lead to better long-term results and lower revision rates is unknown. Computer navigation requires longer operating times than conventional surgery, and has a reported learning curve of about 30 procedures.<sup>74</sup> These facts might have influenced the majority of surgeons who do not navigate each total knee arthroplasty, even though the equipment is available.<sup>75</sup> In summary, no clear evidence exists to recommend the widespread use of either MIS or computer navigation in total knee arthroplasty.

## Conclusions

Initially, treatment of knee OA should be nonsurgical. If this therapy fails, however, surgical treatment can be recommended.<sup>6,7</sup> In advanced stages of knee OA with complete loss of articular cartilage, total knee arthroplasty reliably relieves pain and improves function. If OA is limited to the medial compartment, unicompartmental knee arthroplasty is equally effective as total knee replacement. Osteotomy should be considered for young, active patients with unicompartmental OA. Bone marrow stimulation techniques can be used to treat full-thickness chondral lesions; patients with moderate OA with small chondral defects benefit most from this approach. Arthroscopic lavage and debridement should not be used as routine treatments for knee OA; however, patients with symptomatic meniscal tears and loose bodies with locking symptoms might benefit from these procedures. In summary, all available surgical treatments should be considered, and the appropriate treatment selected on the basis of the patient's characteristics, as well as the presentation and severity of the disease.

## Review criteria

Articles published in English and German were identified by searching PubMed in December 2008 using the following search terms: "osteoarthritis and lavage", "osteoarthritis and debridement", "osteoarthritis and osteotomy and knee", "osteoarthritis and unicompartmental and knee", "osteoarthritis and patellofemoral and knee", and "osteoarthritis and (arthroplasty or replacement) and knee".

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