Knee replacement for osteoarthritis

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Abstract

Knee replacement is one of the commonest surgical procedures performed in older adults, and its incidence is increasing rapidly. It is the only curative procedure for knee osteoarthritis, and it has excellent outcomes overall in terms of reoperation, functional outcomes and cost-effectiveness. However, a significant proportion of patients are dissatisfied after knee replacement surgery and there is a growing body of research into predictors of poor outcome and dissatisfaction. In this review, we delineate the place of knee replacement in the management of osteoarthritis, we discuss the alternatives, and discuss the predictors of success or failure after knee replacement surgery.

1 Introduction

Osteoarthritis (OA) is the commonest cause of loss of mobility in older adults, and its incidence has increased markedly over recent years as a result of the aging population and the prevalence of risk factors, principally obesity [1]. Knee replacement, in its various forms, is the commonest surgical treatment for osteoarthritis, and the numbers of knee replacements performed each year has increased in parallel with the increasing incidence of OA [2]. The commonest form of knee replacement is Total Knee Replacement (TKR), where the entire knee joint is excised and replaced, but around 10% of knee replacements are partial, replacing only the affected part of the knee joint [3].Knee replacement is the second commonest surgical intervention in those over the age of 60 (after cataract surgery), and over 63,000 people over the age of 60 underwent knee replacement in the UK in the last year [4]. In terms of impact on quality of life, TKR (along with total hip replacement) is considered amongst the most effective of all surgical treatments, yet expectations of surgery are not met in up to 20% of patients undergoing TKR [5].

The aim of this review is to discuss the management of osteoarthritis in older adults, to illustrate the place of knee replacement in the management of knee OA, to summarise the available data relating to outcomes after knee replacement, and to highlight factors which may favour a successful result from knee replacement surgery.

2 Osteoarthritis and the knee

Osteoarthritis is a very common condition amongst older adults, but precise estimates are difficult to obtain due to differences in diagnostic criteria [6]. In the knee, evidence of osteoarthritis is apparent on radiographs in up to 50% of the population over the age of 75, whilst up to one third have symptomatic knee OA [1]. Use of more sensitive tests such as MRI demonstrates evidence of osteoarthritis in up to 89% of people over the age of 50, irrespective of the presence of symptoms [7].Whilst most people with osteoarthritis remain asymptomatic, end-stage osteoarthritis requiring knee replacement is increasingly common. In the USA, the incidence of TKR has increased from 402,100 in 2005 to 676,000 in 2009, and is projected to increase to 3.5 million per year by 2030 [8, 9].

The principal symptom of osteoarthritis is pain, with varying degrees of stiffness and (usually varus) deformity. Whilst osteoarthritis is a progressive disease, the level of pain associated with it often fluctuates and can be affected by factors such as weight, activity level, climate and time of day. The level of pain experienced by patients with osteoarthritis correlates with radiological measures of disease severity, but this is inconsistent: a proportion of patients with end-stage disease on knee radiographs will remain asymptomatic and never present to a doctor [10].

Osteoarthritis can be considered to be a disorder of cartilage homeostasis, in which the repair mechanism of cartilage (mediated by chondrocytes) fails, tipping the balance in favour of cartilage degradation. In response to inflammation and cartilage degeneration, significant remodelling occurs in subchondral bone leading to the characteristic radiological features of subchondral sclerosis and osteophyte formation [11].

Risk factors for knee OA include systemic factors such as obesity, increasing age, female gender and family history; joint-specific factors such as malalignment (leading to abnormal loading) and previous knee injury (particularly anterior cruciate ligament (ACL) and meniscal injury) also play an important role [1]. On a microscopic level, osteoarthritis is considered a disease of the entire joint, but in most cases, the macroscopic defect is primarily restricted to a single compartment of the knee, usually the medial tibiofemoral joint [12] (figure 1). Progression to the remainder of the joint is largely dependent on the status of the ACL, the attritional rupture of which is associated with progression to tricompartmental disease [13].

3 Non-arthroplasty treatment for knee osteoarthritis.

Even amongst patients referred to orthopaedic surgeons for consideration of knee replacement, up to two thirds are considered ineligible, often because symptoms have not reached the stage where joint replacement is indicated [14].Whilst knee replacement is the only treatment for osteoarthritis that is considered curative, it is only indicated for end-stage disease and several treatments are indicated for disease which has not yet reached this stage [15, 16]. Strong evidence exists that regular exercise, physiotherapy, weight loss (if overweight), orthotics and walking aids are helpful for patients with osteoarthritis, alone or in combination with pharmacological therapies such as simple analgesics and non-steroidal anti-inflammatory drugs [15].There is weak evidence for the use of glucosamine [17] or chondroitin [11, 18], and these are not currently recommended for use in the UK by the National Institute of Health and Clinical Excellence (NICE) [16]. Injected corticosteroids appear to provide only short-term relief from symptoms, and injection of hyaluronic acid derivatives may produce a longer-lasting effect, although they take longer to act [15].

Non-arthroplasty surgical treatments, such as arthroscopic debridement and lavage, have little evidence of effectiveness and are reserved for patients with mechanical symptoms or radiographic evidence of loose bodies [11, 16]. Focal cartilage deficits can be treated by techniques that stimulate the production of fibrocartilage (such as microfracture), or by those which attempt to cover defects with cartilage transfers. These can be either from non-weight-bearing parts of the knee (mosaicplasty), or using sheets of chondrocytes which have been grown in culture after being harvested during an earlier arthroscopic procedure (ACI). These procedures are reserved for smaller, focal defects and are usually reserved for younger patients. Similarly, the use of high tibial osteotomy, which aims to off-load the degenerative (normally medial) compartment by altering the mechanical axis of the limb, is considered an arthroplasty-delaying procedure in active young people, and is therefore beyond the scope of this article [19].

4 Total Knee replacement

Whilst attempts were made at forms of knee replacement since the mid nineteenth century, knee replacement was first popularised in the 1970s. The Total Condylar Replacement was first implanted in 1974, and most knee replacements in use today work on similar principles.

In TKR, the knee joint is accessed through a midline incision and the patella and extensor mechanism are everted to allow access to the joint surfaces. The ACL is excised and the tibial plateaux are resected using horizontal saw cut. The distal femoral joint surfaces are resected in their entirety using a transverse cut and anterior and posterior chamfers. Depending on the severity of disease and surgeon preference, the posterior cruciate ligament (PCL) and the patellar joint surface may also be resected. Soft tissue deformity is corrected with sequential ligamentous and capsular releases until the knee is seen to be in equal tension medially and laterally, and in flexion and extension. The tibial joint surface is replaced by a polyethylene bearing, normally attached to a metal base-pate, whilst the distal femur is resurfaced using a metal component (figure 2b). If there is patellofemoral osteoarthritis, the patella may be resurfaced using a polyethylene 'button'. In most cases, the implants are cemented into place, but in around 5% of cases, the implants are coated to encourage bone ingrowth and fixation without cement [3]. The excision of the menisci and cruciate ligament(s) necessitates the imposition of a degree of constraint between the tibia and femur, which is normally achieved by dishing of the tibial component with or without a cam-post mechanism to replicate PCL function.

In revision knee replacement, stems are used to achieve more stability at the bone-implant interface, and implants are more highly-constrained. If there is significant bone and soft tissue disruption, a hinged implant may be used. Occasionally, primary disease is so severe that it necessitates the use of 'revision' implants.

5 Other types of Knee Replacement

TKR is the gold-standard treatment for knee OA, but it may not be the best treatment for all patients [5]. Resection of the cruciate ligaments (which are often normal) has implications for knee kinematics and proprioception [20], and the large amount of bone and joint which is resected (much of which is functionally normal) renders revision surgery challenging [21].

Around 10% of patients undergo partial joint replacement, either of one of the tibiofemoral compartments (known as Unicompartmental Knee Replacement, UKR (figure 2a) or of the patellofemoral joint (PFJR, figure 2c) [3]. In both cases, normal joint surfaces and cruciate ligaments are preserved, significantly less bone is resected, and surgery is often significantly less invasive than in TKR (figure 4). As a result of this, studies have demonstrated a lower morbidity and mortality for UKR than TKR [22], higher postoperative activity levels [23], better proprioception [20], more straightforward revision surgery (if indicated) [24] and more normal knee

kinematics [25]. However, in spite of good published results [26, 27], UKR and PFJR remain controversial as they have a significantly higher revision rate overall when compared to TKR [3, 28]. This is likely to be multifactorial: amongst other causes, patients undergoing partial replacement are likely to be younger, and with higher functional demands, than those undergoing TKR [3]. Additional failure mechanisms (principally progression of arthritis to un-replaced parts of the knee) exist in partial replacement [27], and the ease of revision in partial replacement lowers the threshold for revision in poorly functioning implants [29].

6 Outcomes of knee replacement

Knee replacement is a well-established procedure which is considered to be successful, reproducible and cost-effective [30]. The most commonly used outcome metric in joint replacement is revision-free implant survival, and in these terms, knee replacement is very successful, with joint registries demonstrating that between 94% and 97% of TKRs are still in situ at 8-10 years following implantation [3, 28]; a figure that has improved markedly as a result of refinements in technique since the introduction of knee replacement in the 1970s and early 1980s [31]. However, whilst implant revision has the advantage of being a solid end-point, it is insensitive to those implants that remain *in situ* but function poorly. Much progress has been made in determining more sophisticated end-points and our understanding of outcomes after knee replacement has developed markedly in recent years.

Knee replacement delivers significant improvements in health-related quality of life (HRQL), as measured using standardised HRQL questionnaires such as the EQ5D [32, 33]. Joint-specific functional outcome can be assessed using physician- or patient-completed outcome questionnaires; the Oxford Knee Score (OKS) is the questionnaire in most widespread use in knee outcome research in the UK (figure 5), and it is now collected by the UK Department of Health for every knee replacement undertaken within the NHS [34]. The OKS is a patient-completed questionnaire consisting of twelve questions, each with five domains, ranging from 0 (the worst outcome) to 4 (the best), on a range of pain-related and functional outcomes such as stair climbing, walking and kneeling. Outcomes are reported as an overall score ranging from 0-48 [35]. In studies of knee replacement patients, the mean preoperative score is around 19, rising to 34-35 after TKR [36-38] – this is remarkably consistent both amongst published studies and with nationally-collected data [39], and represents both a clinically and statistically significant improvement.

However, a significant proportion of patients report an unsatisfactory outcome following TKR (figure 6). In national data, the OKS remains the same or deteriorates in around 9-12% of patients following knee replacement [39], whilst around 15% [40], and up to 20% of patients [41] are dissatisfied with their knee replacement and a similar number report on-going pain [42]. Knee replacement compares unfavourably with hip replacement by all of these measures [4, 33, 41, 42].

Whilst modifications to surgical practice can make small differences, the most important determinants of outcome after knee replacement are adequate patient selection and the establishment of realistic patient expectations [43-45]. Whilst there is a growing body of research identifying factors predictive of positive outcomes following knee replacement, identification of specific patients most likely to benefit remains difficult. Attempts to define objective predictors of success for the purposes of healthcare resource management are fraught with difficulty [30].

Patient factors predicting dissatisfaction may differ from those predicting a poorer functional outcome (and predictors of postoperative pain may differ again [45]). The strongest predictor of poor postoperative outcome (as measured by functional scores) is poor preoperative function [45], but those with advanced preoperative disease demonstrate high levels of satisfaction [46]. Likewise, older patients (who also generally have lower preoperative functional scores [47]) demonstrate poorer functional outcomes, but exhibit high levels of satisfaction [48], perhaps due to lower preoperative expectations [44]. Satisfaction is strongly correlated with the fulfilment of preoperative expectations, with the expectations of kneeling, squatting and ease of climbing stairs amongst the least frequently-met expectations [44]. Achievement of pain relief is the most important predictor of satisfaction, and this expectation is very frequently met [41, 44].Markers of depravation [45] and psychological issues such as depression and a tendency to catastrophise [49, 50], have a negative effect on both outcomes and satisfaction.

7 Conclusions

For end-stage osteoarthritis of the knee, knee replacement (in its various forms) is a proven and cost-effective treatment. Advances in patient selection, design and technique have increased the reliability and survival of knee replacements over the last 30 years and a focus on functional outcome and patient satisfaction should lead to improvements in those outcome measures going forward. More than any aspect of surgical technique,

outcomes from knee replacement are affected by improved patient selection and realistic patient expectations.

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Figures

Figure 1. Anteroposterior and lateral radiographs demonstrating anteromedial osteoarthritis (a) AP (b) lateral.

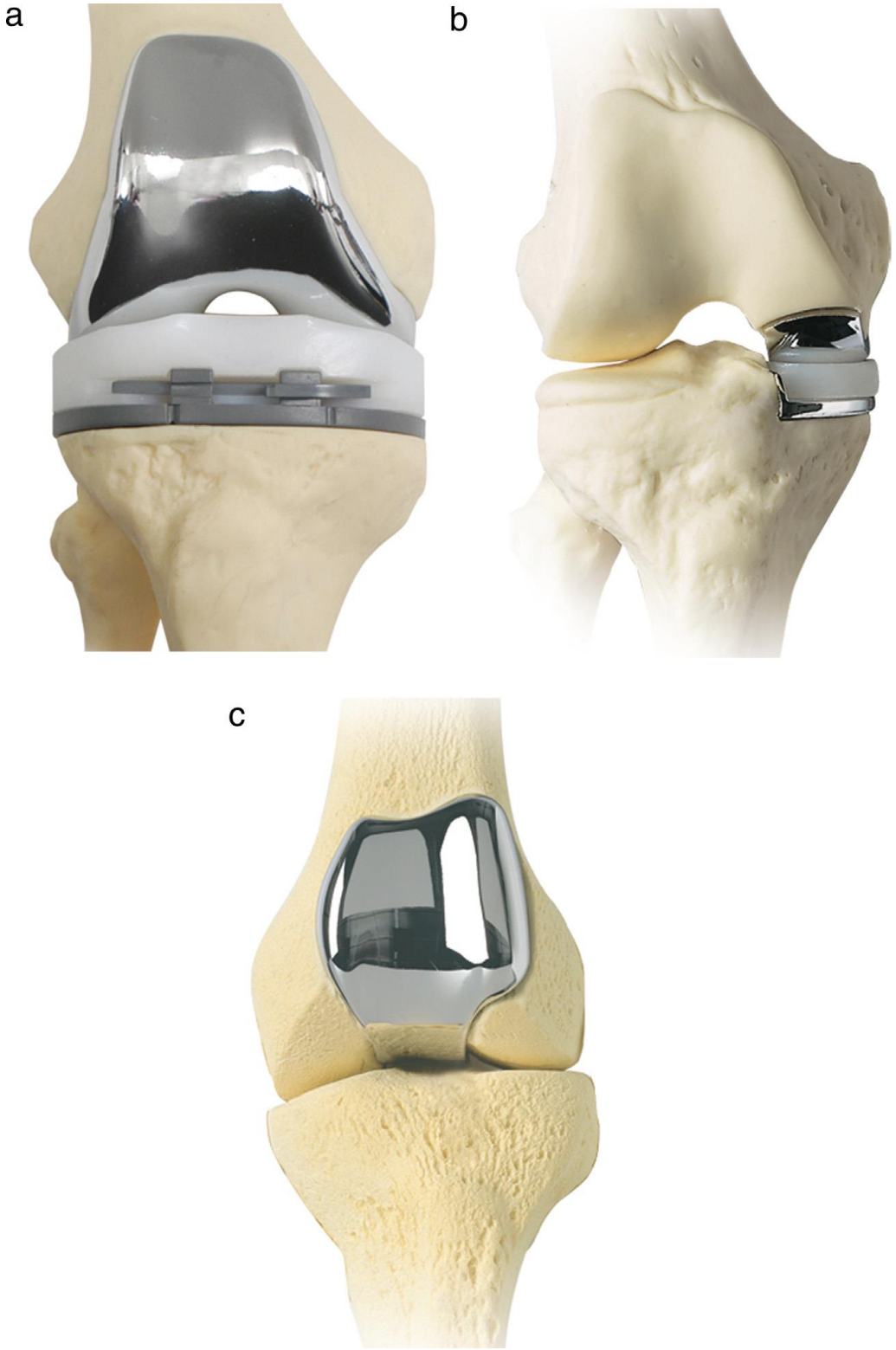

Figure 2. Different types of knee replacement: (a) total knee replacement (b) unicompartmental knee replacement (c) patellofemoral replacement.

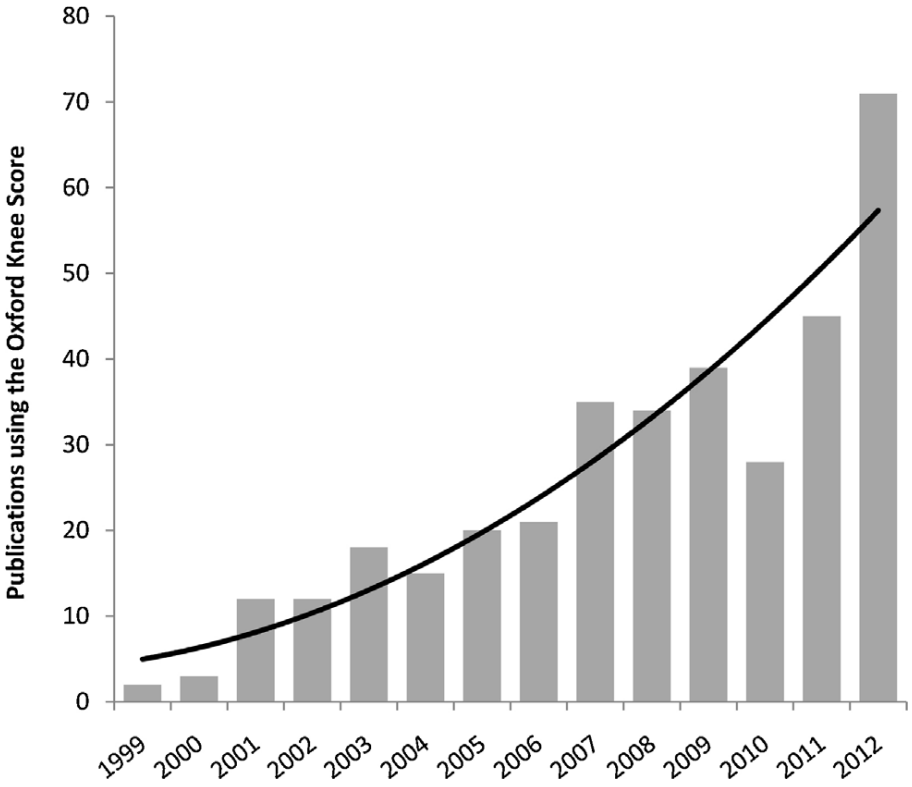

Figure 3. Growth in publications referencing the Oxford Knee Score.

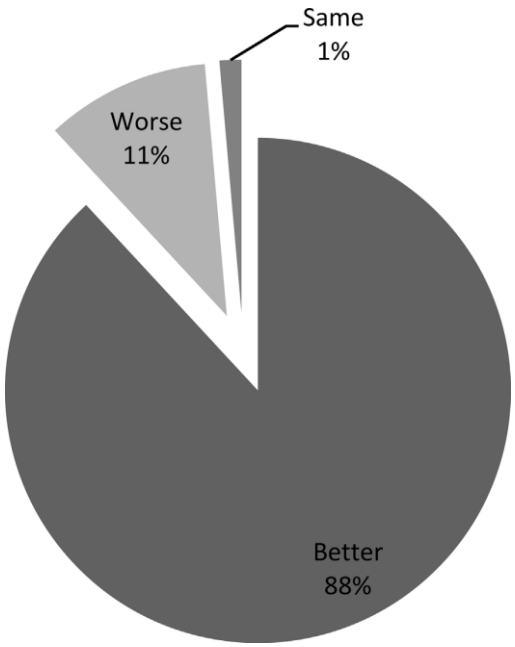

Figure 4. Proportion of patients achieving optimal and suboptimal outcomes (figures from the NHS PROMS database).