

The Twin Peg Oxford Knee – Medium Term Survivorship and Surgical Principles

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Abstract

Background: A multicentre study of single peg Oxford knees reported failure associated with osteoarthritis progression, femoral component loosening, unexplained pain and meniscal bearing dislocation. Suboptimally positioned femoral components and intraoperative MCL damage could explain these problems. We hypothesised that modifying implantation technique to optimise femoral component positioning and MCL preservation, and introducing the twin peg Oxford knee would address these problems and improve longer term survival. Moreover, its better congruency in high flexion could reduce wear. This study aims to investigate this hypothesis by asking 1) Is the 98% survivorship up to nine years found in an earlier study sustained at longer term (up to 13 years)? 2) What are the remaining causes of failure?

Methods: We described our modified implantation technique. A cohort of all patients treated by the senior author using this modified technique and the Oxford twin peg cemented knee replacement between September 2003 and August 2013 was investigated. A survival analysis was performed and the causes of failure were analysed.

Results: The cohort consisted of 468 patients with 554 medial cemented implants. In all, 16 implants were revised and the 12-year survivorship was 95%. Patients with extended indications had a lower survivorship than those with anteromedial osteoarthritis (10-year survival rate 78% vs 97%, $p < 0.001$). There were no failures due to femoral loosening.

Conclusions: Using our surgical principles the cemented twin peg Oxford knee can result in good medium to long-term implant survival, comparable to those obtained by the originating centre for the single peg Oxford knee.

Keywords: Oxford twin peg cemented knee replacement; Unicompartmental knee replacement; Anteromedial osteoarthritis; Survival analysis; Survivorship; Surgical technique

Introduction

The most commonly used design of unicompartmental knee replacement (UKR) is the Oxford knee, which has two cemented (single peg and twin peg) and one cementless

(twin peg) version of the femoral component. The cemented Oxford twin peg design evolved from the Oxford phase III single peg design. Besides incorporating an extra femoral peg, it also has an increased arc which allows the component to be inserted in greater flexion, thereby adding more contact and avoid edge contact in deep flexion, reducing the risk of wear. In a multicentre study to which we contributed, the four commonest indications for revision of the single peg Oxford design were progression of osteoarthritis to the lateral compartment, femoral loosening, dislocation of the bearing and unexplained pain [1]. Although the femoral loosening problem might be addressed by using the potentially more stable twin peg design, inadequate surgical technique could also explain these failure modes. Medial collateral ligament damage during insertion could lead to subluxation or dislocation of the meniscal bearing and to valgus malalignment [1,2]. Valgus malalignment would overload the outer compartment and predispose to progression of osteoarthritis to the lateral compartment. Malposition of the components could also explain these failure modes [2]. For example, overhanging of components could lead to soft tissue irritation [3], and impingement could lead to pain, wear and loosening [4,5,6]. Our multicentre study was published more than 10 years ago but the NJR still shows a high failure rate of 12% at 10 years for the Oxford knee [7] although the same implant has been used both inside and outside Oxford with excellent results [8,9].

In an attempt to address the four commonest causes of failure we encountered [1] we decided to adapt our surgical technique to reduce the risk of medial collateral ligament damage and malpositioning, the most likely causes of osteoarthritis progression, dislocation and pain. We also decided to use a more securely fixed version of the Oxford implant to reduce the risk of femoral loosening. With the approval of our New Procedure Committee and our patients' informed consent, we decided to discontinue the phase III single peg Oxford partial knee in 2003 in favour of the twin peg version. Our first 100 patients showed satisfactory clinical outcomes and radiological appearance when measured at 2 years [10] and our survivorship of a larger cohort of 249 patients with 288 implants showed a satisfactory cumulative implant survival of 98% at 9 years with no cases of femoral loosening [11].

We hypothesised that the good survivorship obtained with the twin peg femoral component that we reported earlier would be maintained up to and beyond 10 years.

We also hypothesised that using the twin peg femoral component combined with the adapted technique would reduce the frequency of revision attributable to the four commonest causes found in our multicentre study. The purpose of this paper was to report this longer-term survivorship of the Oxford twin peg knee and to describe the surgical principles which we have used in this group of patients.

Patients and methods

The study comprised all patients operated on between September 2003 and August 2013 by the senior author or under his direct supervision using the cemented twin peg Oxford partial knee system (Zimmer Biomet UK Limited, Bridgend, UK). They were treated in two centres. The Information Department of each centre provided up-to-date lists of all operations according to codes which were checked against the surgeon's records. Patients were registered with the UK National Joint Registry during this period. Patients were selected for treatment if they had medial compartment osteoarthritis, which in most cases meant anteromedial osteoarthritis (AMOA) [12]. We also included patients who had extended indications, in particular AMOA patients with more extensive erosion of the lateral femoral condyle or with limited anterior cruciate ligament damage which still preserved some function. In addition, we considered patients with previous localised trauma, such as tibial plateau fracture, or tibial or femoral shaft fractures. We also considered patients with avascular necrosis regardless of aetiology. All these extended indications were recorded at the time of surgery.

Surgical technique

The manufacturer's published surgical technique [13] contains some but not all of the steps we have taken to reduce the risk of progression of arthritis, unexplained pain, dislocation of the bearing and femoral loosening. Our extra steps were based on our experience and course faculty discussions. The published technique has 11 steps, and we refer to these steps while highlighting where our technique extends beyond the published one. We emphasize the vulnerability of the MCL during capsular release, meniscectomy and especially the need to avoid accidental section by the saw.

Preservation of the medial collateral ligament

Preserving the medial collateral ligament will reduce the risk of progression of osteoarthritis and dislocation of the bearing. There are four moments during the operation when the medial collateral ligament (MCL) is at risk of being damaged, not all of which are emphasized in the published technique.

1. *At the start of the operation (before Step 1).* If a standard periosteal elevator is used to free the capsule from the tibial plateau the MCL will be damaged. This pitfall can be avoided through the use of a narrow elevator to release the capsule, thus avoiding release of the posteromedial fibers of the MCL, which are attached within 1cm of the joint line.
2. *When removing posteromedial osteophytes from the medial femoral condyle (Step 1).* We believe that, unlike the published technique, these osteophytes should only be removed once the tibial plateau has been excised because only then is there sufficient slackness of the MCL to allow its safe retraction.
3. *During the horizontal tibial saw cut (Step 2).* As the published technique emphasizes, this risk can be reduced by protecting the MCL during the saw cut by a suitable metal retractor.
4. *During excision of the remnants of the medial meniscus (Step 4).* As the meniscus is pulled anteriorly and laterally and a scalpel is used, it is easy to accidentally cut a V-shaped gap in the posteromedial fibres of the MCL, which are attached to the meniscus. The risk of this pitfall can be reduced by gently pushing the knee into valgus, which tenses the ligament and allows the meniscus to be safely excised.

Central positioning of the femoral jig (Step 3)

Central positioning of the femoral component will drive the medial meniscal bearing in its intended course and thereby reduce the risk of dislocation and pain. It is therefore important to position the femoral jig correctly in the centre of the medial femoral condyle. If it is the correct width, mark the centre of the femur with a pen or a diathermy (Fig. 1). The femoral jig can be adjusted more medially or laterally to correspond to the centre line.

If the trial femoral component is placed too medially, the final femoral component will catch on the soft tissues of the capsule during movement (Fig 2). In addition, the medial meniscal bearing will be driven anteromedially over the edge of the tibial component which also irritates the capsule and synovial lining. Finally, medial placement of the femoral component will lead to eccentric loading of the tibia. Eccentric loading of the tibia will increase tibial strains, which has been hypothesised to cause medial joint pain [14].

Lateral malposition creates a gap (Fig. 3), which would make a cementless component stand off, but can be filled with cement using the twin peg component. Lateral malposition would also drive the meniscal bearing beyond the lateral limit of the tibial component, putting excessive pressure of the bearing against the upright border of the tibial component.

Maintaining Congruity of the Femoral Drill Hole (Steps 3, 5 and 6)

To avoid a loose femoral peg care needs to be taken with repeated use of the mill. The weight of the drill (Step 3) or mill (Step 5/6) and the lever arm can cause inaccuracies, especially in softer bone (Fig 4). For instance, overcompensation by the surgeon against gravity could toggle the spigot in the opposite direction. The weight of the tools must be balanced otherwise the fixation of the larger peg could be compromised from the outset.

Osteochondral Clearance to Prevent Impingement (Step 11, before closing the wound)

Impingement can cause pain and loosening. Careful checks at the end of the operation are required to ensure that the position of the front end of the bearing will not lead to impingement. Especially important is the clearance space between the front of the bearing and the femoral bone and cartilage in extension. If this is inadequate, chisels can be used to remove more cartilage and bone (Fig. 5).

Data Analysis

Revision cases were identified from our own records and from the 2015 National Joint Registry Clinician Feedback Report in case the revision procedure might have been performed outside our hospitals. Implant failure was defined as revision for any

reason. Implant survival was determined using the life-table method and Greenwood estimates of the 95% confidence intervals [15]. Log-rank tests were used to investigate the influence of nominal variables (indication, gender) on survival, and a Cox regression analysis to investigate the influence of continuous variables (age, baseline clinical score). All statistical analyses were performed using R vs 3.2.2 using the packages “survival” and “rms”. All statistical tests were performed as 2-tailed tests, and a p-value below 0.05 was assumed to denote statistical significance.

Results

There were 554 medial cemented implants, inserted into 468 patients (49% females and 51% males; mean age 67 years; Table 1). There were 382 unilateral and 86 bilateral procedures. Only 2 bilateral cases were simultaneous, the rest were staged. Most implants were inserted because the patient had AMOA (93% of patients with an indication known at the time of this study; Table 1).

The mean follow-up period was 6.6 years with a minimum of 0.1 years (excluding patients who died or whose implant failed) and a maximum of 12.5 years. For 73% of the knees, the follow-up period was at least 5 years and for 9% it was at least 10 years.

Revision and Survival

Sixteen patients (16 cases) required a revision: 8 patients who had AMOA indications and 8 patients who had another indication (Table 2). The revision was attributed to progressive arthritis (n=6), instability (n=4), unexplained pain (n=3), and aseptic loosening of the tibia, infection and peri prosthetic fracture (each n=1). Overall, the probability of survival at 12 years was 95.2% (95%CI 92.3 to 98.4; Table 3, Fig. 6). The only factor predicting implant survival was an indication of AMOA (log-rank test, $p < 0.001$; Table 4). Ten year implant survival for patients with AMOA was 97% (95% CI 94-100%) and for those with other indications was 78% (95% CI 63-96%). Patient age, gender, and pre-operative OKS did not predict survival ($p > 0.5$ for each; Table 4).

Discussion

This is the first study reporting survivorship beyond 10 years of the twin peg Oxford medial unicompartmental knee replacement. We found a survivorship of 95.2% at 12 years, which supports our first hypothesis that the good survivorship obtained with the twin peg femoral component that we reported earlier would be maintained up to and beyond 10 years. To our knowledge, this rate is comparable with the best results using the single peg cemented implant, such as those reported by the originating centre [8,16], elsewhere in the United Kingdom [17] and by an independent Swedish centre [9,18]. The commonest causes of failure in our study were progressive arthritis, instability and unexplained pain. No cases of femoral loosening were found. In line with our second hypothesis, the frequency of femoral loosening and meniscal dislocation was reduced. It would therefore seem that the problems with femoral loosening and meniscal dislocation we encountered previously have been largely solved by using the more secure twin peg femoral prosthesis, and the surgical principles described here. However, contrary to our hypothesis progressive arthritis and unexplained pain still occurred. The most important factor predicting revision was having an indication of extended AMOA, suggesting that changing the surgical technique and implant design are by themselves not sufficient to prevent these causes of failure. Patient selection is also an important issue.

We recognise that the relative importance of the two factors implant design and surgical technique on femoral loosening is difficult to determine, and they may even be synergistic. A cadaveric study found no difference in micromotion or subsidence between a perfectly implanted single or twin peg implant [19], which suggests that introducing the second peg alone does not explain our improved results. The surgical technique is bound to be important as well, because the above reports on good results were all based on the single peg [8,9,16,17,18]. With regards to loosening but also other causes of failure, at least four aspects of surgical technique have been mentioned: malposition of the implants [2], overhanging of components leading to soft tissue irritation [3], impingement leading to pain, and medial collateral ligament damage leading to subluxation or dislocation of the meniscal bearing or to valgus malalignment [1,2]. Studies trying to detect the influence of single surgical factors, such as implant positioning, have not been conclusive [20,21]. We therefore recommend to address all factors simultaneously by preserving the medial collateral

ligament, positioning the femoral jig centrally, maintaining congruity of the femoral drill hole and ensuring osteochondral clearance to accommodate hyperextension.

Our outcome is comparable to that of the more recent cementless Oxford Microplasty [22]. Its femoral component also has two pegs and apart from the hydroxyapatite coating, both components are virtually identical to the cemented twin peg that we used. Cementless implants have the benefit of an improved radiological appearance thus avoiding misinterpretation of physiological radiolucencies as signs of loosening, a problem identified with cemented Oxford knees [23]. By omitting the cementing stage, implanting the cementless version is also quicker and avoids any problems associated with the use of bone cement. Why then use the cemented twin peg at all? One advantage of the cemented version is that the cement can be used to fill any voids or incongruity between the components and the prepared bone, such as extensive osteochondritis dissecans, osteonecrosis or subchondral cysts. Other reasons to cement the femur may include intraoperative complications, such as an inadvertent expansion of the drill hole for the central peg or a gap laterally due to inappropriate lateral placement of the femoral component (figs 3 and 4). Whilst the cementless version is now the first author's preferred choice it is helpful to have the cemented twin peg components available in theatre for any of the above concerns.

We found that the best results were obtained for patients with classical anteromedial osteoarthritis, with a 10-year survival rate of 97%. Some patients that present with anteromedial osteoarthritis may have underlying problems that are difficult to identify. Examples are patients with a suboptimal condition of the anterior cruciate ligament who are more liable to develop stability problems with the freely mobile bearing, or patients with medial joint space loss and bone on bone contact medially that later turns out to be the first joint affected by rheumatoid arthritis, as we observed in one of our patients. The latter diagnosis may only become obvious some years later with multiple joint involvement. To avoid this problem, we now recommend a high index of suspicion of inflammatory arthropathy when considering a patient for unicompartmental knee replacement.

The failure rate in patients with extended indications was much higher, a 10-year survival rate of 78%. A Japanese study using the single peg phase 3 implant also

found a higher failure rate for patients with extended indications, with a 5-year survival rate of 94% for these patients [24]. Clearly, more needs to be learned about subgroups among these patients because these results show that many of them can do well.

Since the diagnosis of anteromedial osteoarthritis is such an important factor determining success it is important to have a good understanding of the disease. More is now known about anteromedial arthritis, including the major role of genetic factors in its development [25]. Another significant discovery is that anteromedial osteoarthritis is the most common form of osteoarthritis of the knee, accounting for 60% of subjects presenting with knee osteoarthritis in a specialist secondary care clinic [26]. The rate of progression of structural arthritis is however slower than may have been thought. In a longitudinal radiographic study of subjects with early anteromedial osteoarthritis only 11% progressed to advanced bone on bone disease within 10 years, and 37% within 20 years [27]. This implies that many patients at initial presentation could be managed without surgery. Our approach is to treat conservatively when appropriate and this philosophy is supported by evidence in our institution. In our cohort the mean age at surgery was 67 years, the same as that for total knee replacements for all consultants at our institution.

We included patients who had patellofemoral osteoarthritis and this is supported by evidence from Beard et al who found that in the absence of bone loss and grooving of the lateral facet, damage to the articular cartilage of the patellofemoral joint to the extent of full-thickness cartilage loss is not a contraindication to the Oxford mobile-bearing unicompartmental knee replacement [27]. Berend and colleagues also found no evidence for a difference in survival between knees with and without patellofemoral joint disease and concluded preoperative radiographic changes in the patellofemoral joint can be safely ignored when considering patients for medial UKA without compromising survivorship [28]. However, this subject remains controversial, and when looking more precisely at the location of the patellar lesions there is some evidence of decreased satisfaction with lateral patellar lesions [29], and stair descent is slightly more difficult at 10 years with severe lateral patellofemoral osteoarthritis [30].

In conclusion, we have described our surgical technique and shown that this technique combined with the twin peg cemented Oxford knee can provide secure femoral fixation and sustained clinical benefit beyond 10 years.

Acknowledgement

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Figure captions

Figure 1 Mark the center of the femoral condyle which should correspond to the centre of an appropriate feeler gauge.

Figure 2 Avoid drilling the holes too medially as the bearing will load eccentrically on the tibia.

Figure 3 The consequences of drilling the femoral condyle holes too laterally.

Figure 4 Avoid toggling the mill.

Figure 5 The dotted line indicates extra cartilage and bone to be removed to avoid impingement if in extension the bearing touches the bone (arrow).

Figure 6 Survival curve for Oxford twin peg unicompartmental knee. Greyed area represents 95% confidence interval.

Figure 7 Survival curves of Oxford twin peg unicompartmental knee for AMOA and extended indication cases treated. Greyed areas represent 95% confidence interval.

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Table 1 Demographic details

Characteristic	n or mean (SD)	Range
Number of patients	468	
Female	229	
Male	239	
Number of implants	554	
Unilateral	382	
Bilateral	86	
Staged	84	
Simultaneous	2	
Age at operation	67.0 (9.7)	34 to 94
Indication		
AMOA	513	
AMOA Extended	19	
Trauma	8	
AVN/OCD	8	
Others	6	

Table 2 Overview of revision cases

Revision case	Time to revision	Indication	Main reason for revision (any secondary reason)
1	0.1	AMOA	Periprosthetic fracture
2	1.4	Trauma	Instability (unexplained pain)
3	1.7	AMOA Extended	Instability
4	1.8	RA	Suspected infection
5	1.9	AMOA	Lateral and PF OA
6	2.2	Trauma	Unexplained pain
7	2.5	AMOA	Aseptic loosening tibial component
8	3.5	RA	Arthritis progression
9	3.7	AMOA extended	Lateral OA
10	4.2	AMOA	Unexplained pain
11	4.4	AMOA extended	Unexplained pain
12	4.7	AMOA	Lateral OA
13	5.4	AMOA	Instability (pain)
14	6.7	AMOA	Lateral OA (instability)
15	7.0	Trauma	Instability
16	9.4	AMOA	Lateral and PF OA

Table 3 Life table for all 554 implants

Year	N at start	N withdrawn			N at risk	N revised	Chance of failure	Chance of survival	Cumulative survival at end of interval (95% CI)
		Alive	Dead	Lost to follow-up					
0-1	554	0	0	1	553.5	1	0.002	0.998	0.998 (0.995-1)
1-2	552	0	6	0	549	4	0.007	0.993	0.991 (0.983-0.999)
2-3	542	13	2	0	534.5	2	0.004	0.996	0.987 (0.978-0.997)
3-4	525	41	4	0	502.5	2	0.004	0.996	0.983 (0.973-0.994)
4-5	478	63	2	0	445.5	3	0.007	0.993	0.977 (0.964-0.99)
5-6	410	101	4	0	357.5	1	0.003	0.997	0.974 (0.96-0.988)
6-7	304	79	4	0	262.5	1	0.004	0.996	0.97 (0.954-0.986)
7-8	220	58	1	0	190.5	1	0.005	0.995	0.965 (0.948-0.984)
8-9	160	59	0	0	130.5	0	0.0	1.0	0.965 (0.948-0.984)
9-10	101	51	0	0	75.5	1	0.013	0.987	0.952 (0.923-0.984)
10-11	49	27	0	0	35.5	0	0.0	1.0	0.952 (0.923-0.984)
11-12	22	13	0	0	15.5	0	0.0	1.0	0.952 (0.923-0.984)
12-13	9	9	0	0	4.5	0	0.0	1.0	0.952 (0.923-0.984)

Table 4 Predictors of revision

Factor	HR (95% CI)	p-value
Indication (AMOA vs others)	0.09 (0.03 – 0.25)	<0.001
Gender (Male)	1.3 (0.5 – 3.5)	0.60
Age at operation	0.99 (0.94 – 1.04)	0.58
Preop Oxford Knee Score	0.96 (0.83 – 1.11)	0.60

Figure 1

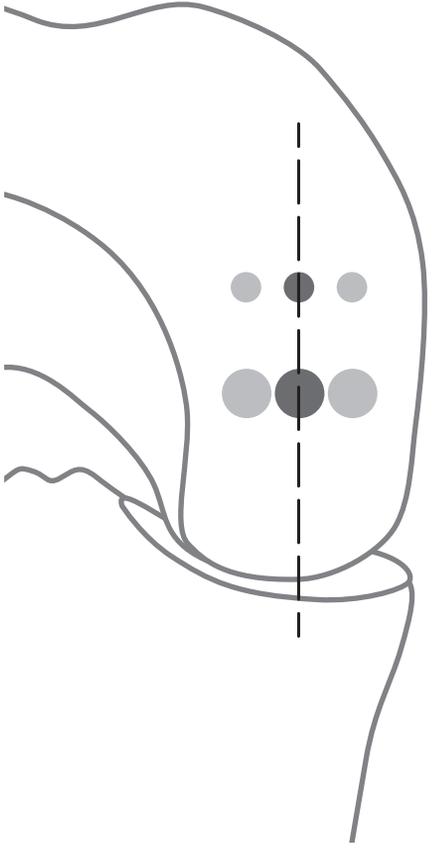
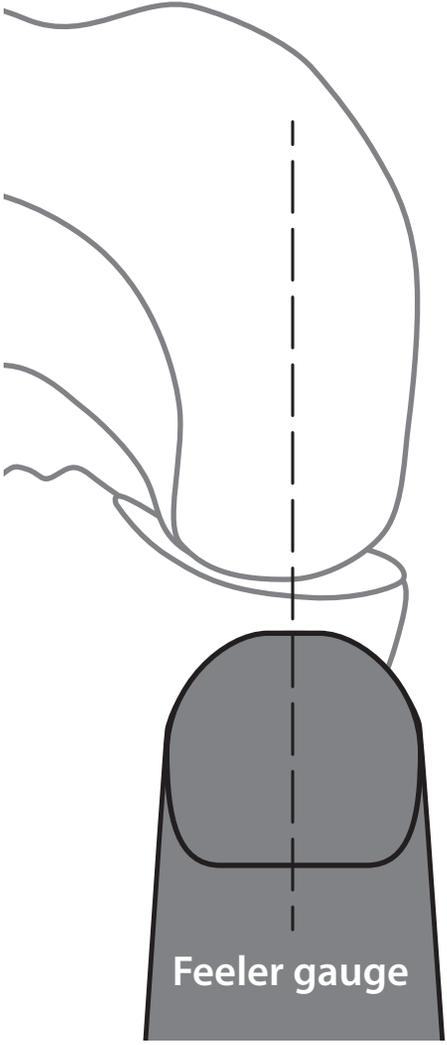


Figure 2

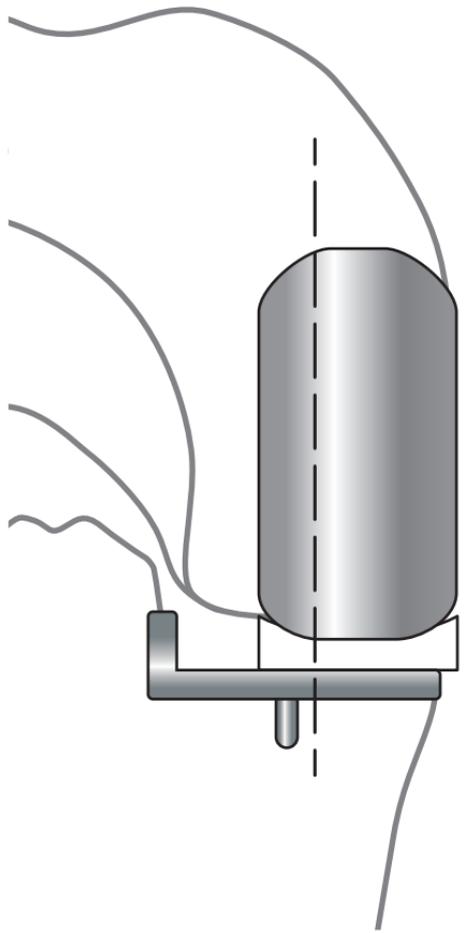
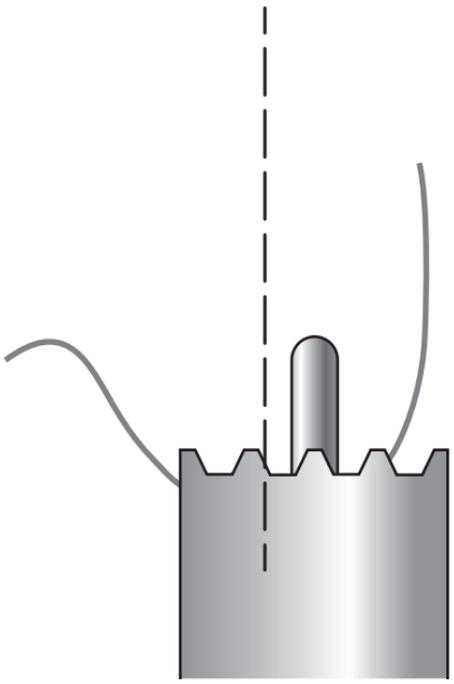


Figure 3

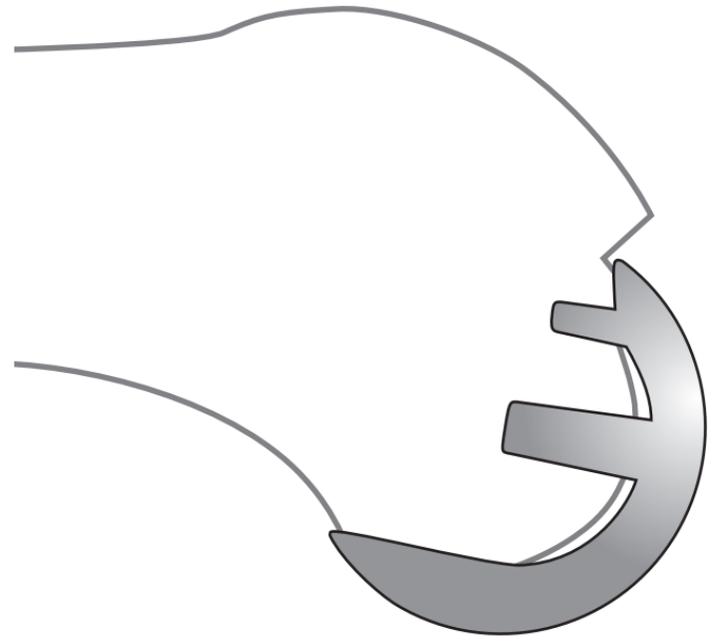
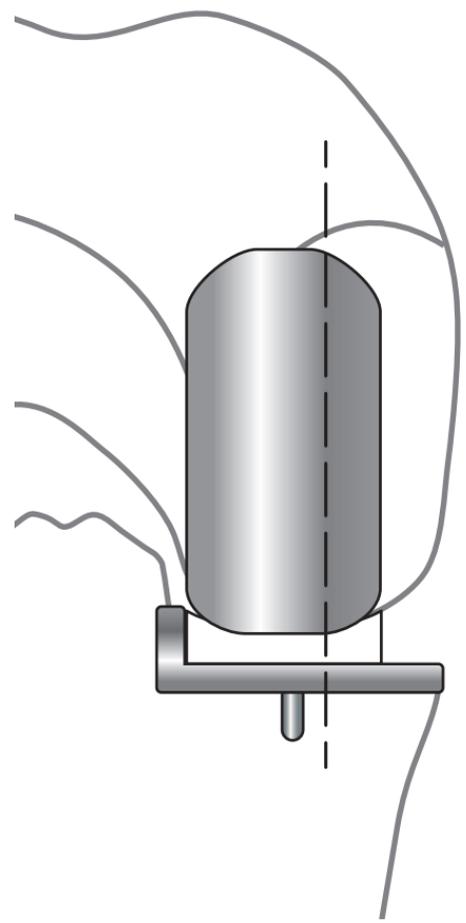
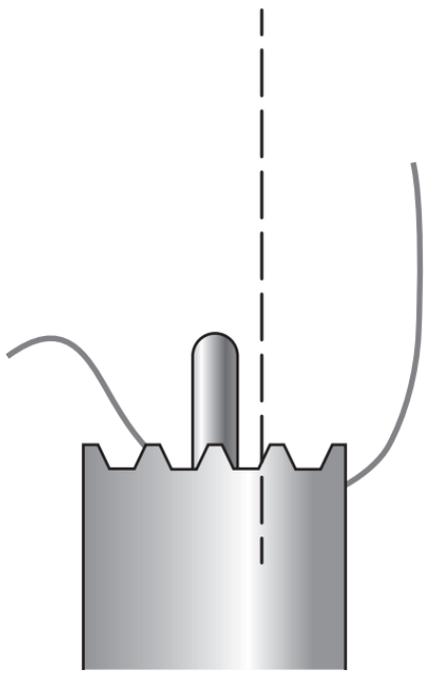


Figure 4

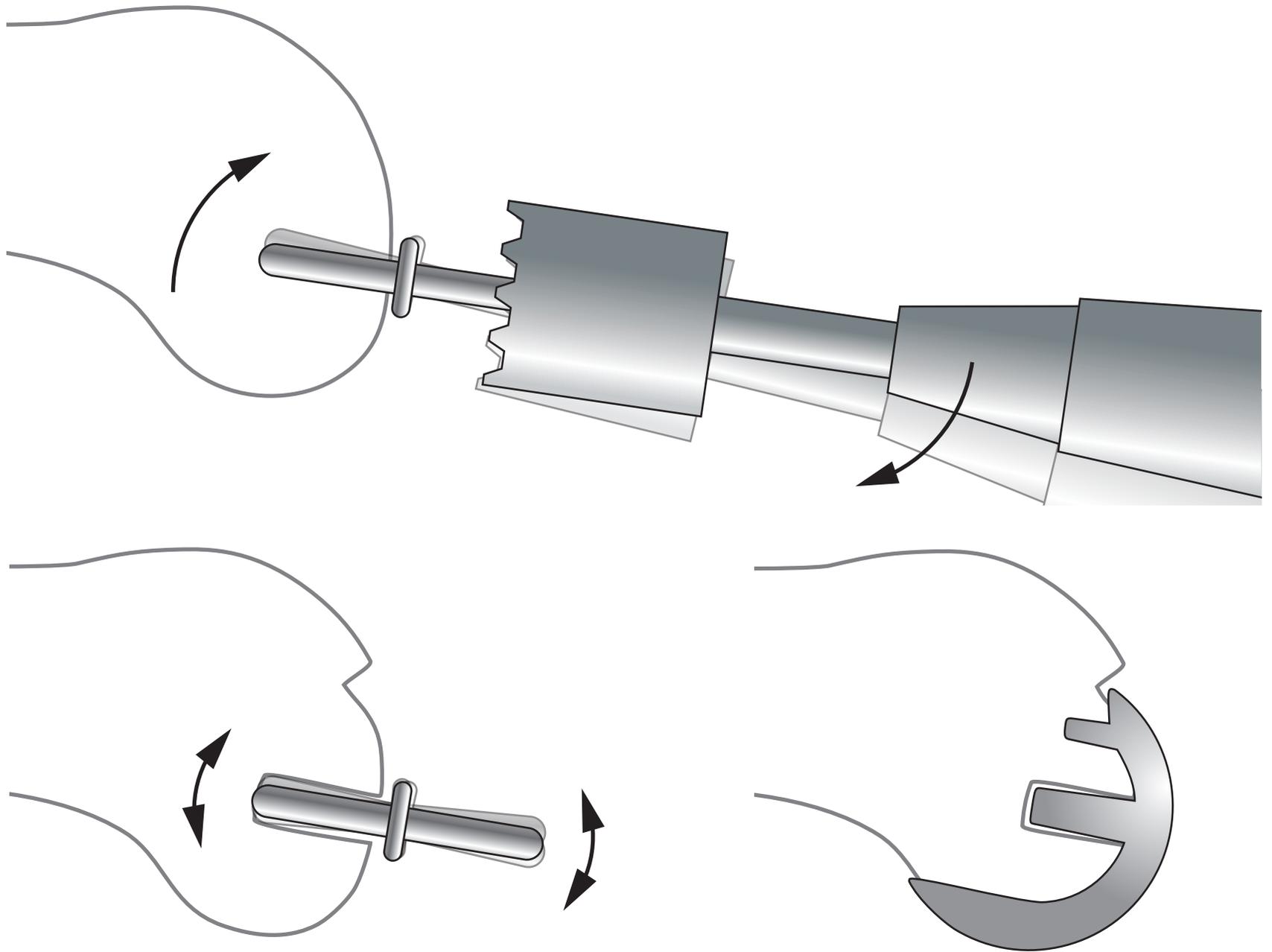


Figure 5

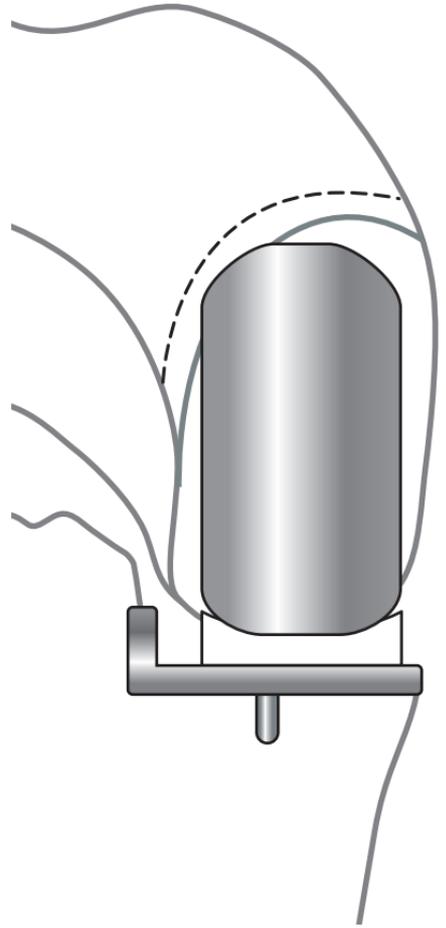
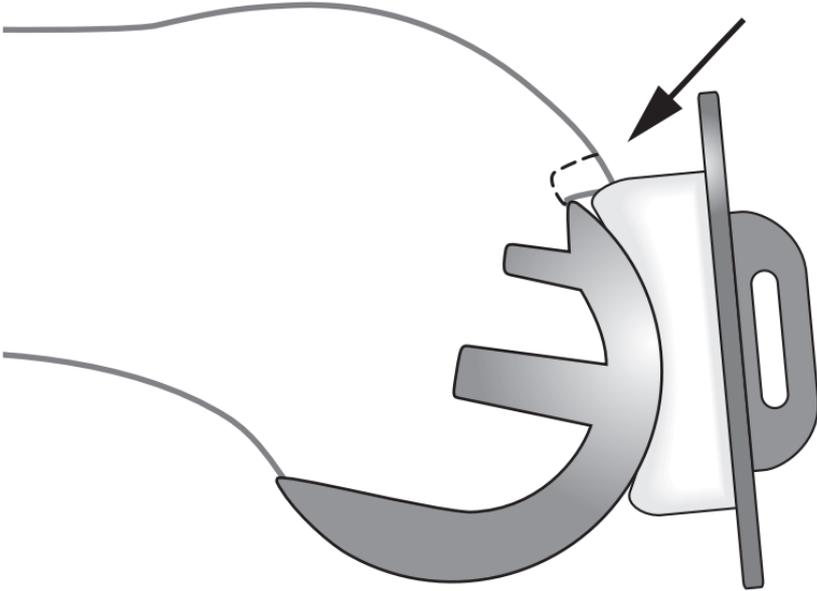


Figure 6

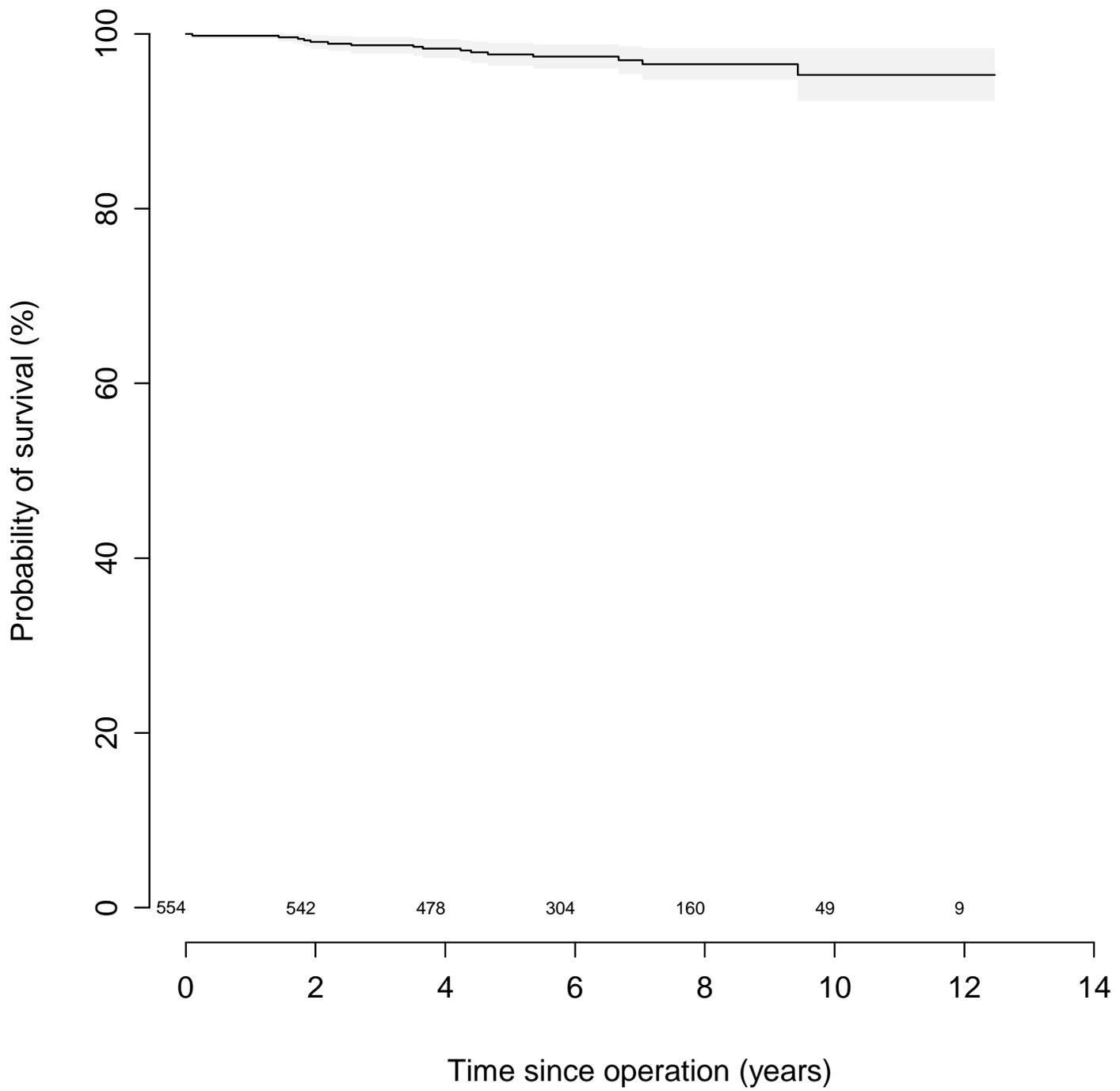


Figure 7

