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Review article

Patellofemoral arthroplasty

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ABSTRACT

Patellofemoral arthroplasty remains controversial, primarily due to the high failure rates reported with early implants. Several case series have been published over the years, which describe the results with various first- and second-generation implants. The purpose of this work was to summarize results published up to now and identify common themes for implants, surgical techniques, and indications. First-generation resurfacing implants had relatively high failure rates in the medium term. Second-generation implants, with femoral cuts based on TKA designs, have yielded more promising medium-term results. The surgical indications are quite specific and must be chosen carefully to minimize poor results. Short-term complications are generally related to patellar maltracking, while long-term complications are generally related to progression of osteoarthritis in the tibiofemoral joint. Implant loosening and polyethylene wear are rare. Overall, recent improvements in implant design and surgical techniques have resulted in better short- and medium-term results. But more work is required to assess the long-term outcomes of modern implant designs.

1. Introduction

Isolated patellofemoral arthritis is relatively rare [1] and the best surgical treatment is highly debated. Patellofemoral arthroplasty (PFA) is an increasingly popular option [2,3], but it is controversial because of inconsistent results [4,5] and the relatively high failure rate found in some studies [6–8].

This article will provide detailed information on the various types of patellofemoral (PF) implants available along with indications and surgical techniques. Clinical results and complications reported with different implant designs will also be reviewed. Finally, the outcome of revising these patellofemoral implants will be discussed.

2. History and design considerations [9]

2.1. History

MacKeever first proposed a vitallium patellar resurfacing implant in 1955, which, despite good initial results [10,11], was quickly abandoned because of excessive wear in the trochlear groove. Patellofemoral arthroplasty had a rebirth in the 1970s when the Richards prosthesis (Smith-Nephew-Richards™) was introduced [12].

2.2. Implant design

Patellofemoral implants attempt to reproduce the complex kinetics of patellofemoral joint during knee flexion, allowing patellar movements in the sagittal, axial, and coronal planes. More highly constrained trochlea designs produce less natural patellar motion; this may contribute to increased loads on the PF joint and premature polyethylene wear. Conversely, a less constrained implant design allows more degrees of freedom but may increase the risk of patellar subluxation and dislocation.

2.2.1. Implant types

The two main types of patellofemoral implants are based on the trochlea preparation method: resurfacing implants and anterior cut implants:

- resurfacing (first-generation) implants (Fig. 1) simply replace worn cartilage without significantly changing the shape of the subchondral bone (inlay technique). Since they are embedded in subchondral bone, their positioning depends on the anatomy of the native trochlea (Fig. 2). Some implants are asymmetric, such as the Spherocentric [13], LCS [14] and Autocentric. Others are symmetric, such as the Richards III [12] and Lubinus [15];
- anterior cut (second-generation) implants (Fig. 3) use the same anterior femoral cuts as total knee arthroplasty (TKA); these implants are often designed based on the femoral trochlear groove of TKA implants. Instead of replacing only the cartilage lost due to wear, they completely replace the anterior compartment of the knee (Figs. 4–6).

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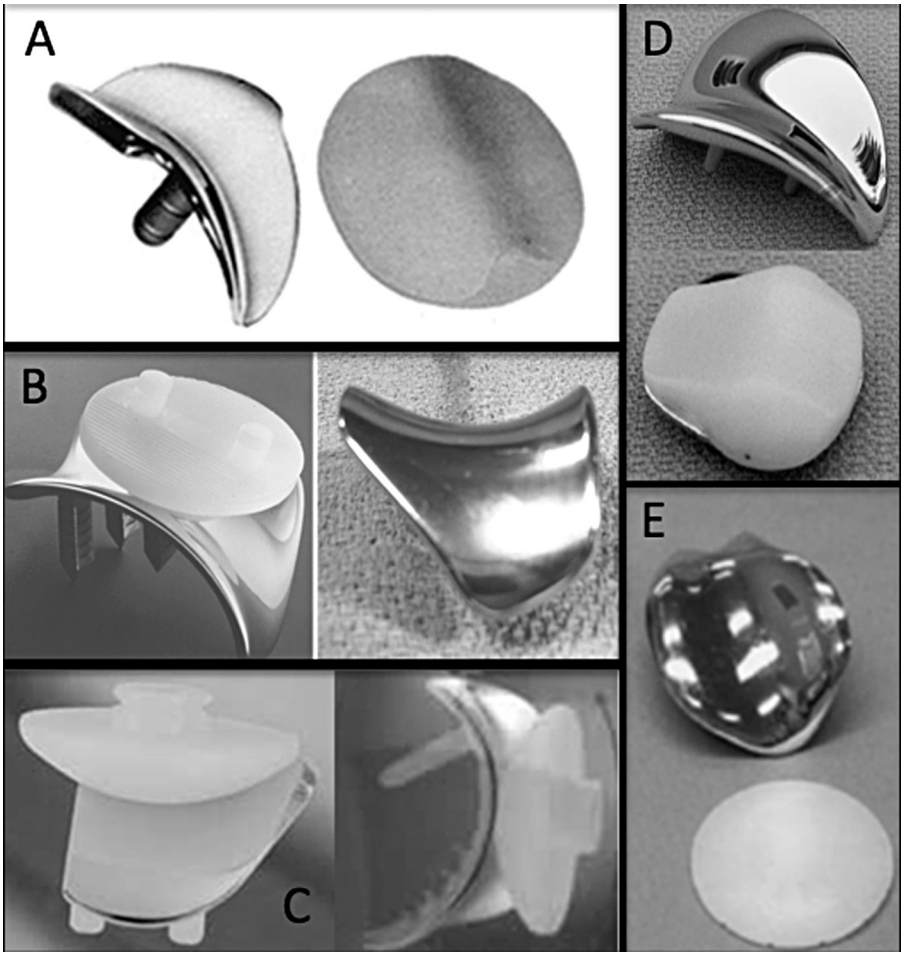

Fig. 1. Resurfacing type implants: Richards III™ (A), Spherocentric™ (B), Autocentric™ (C), LCS™ (D), Lubinus™ (E).

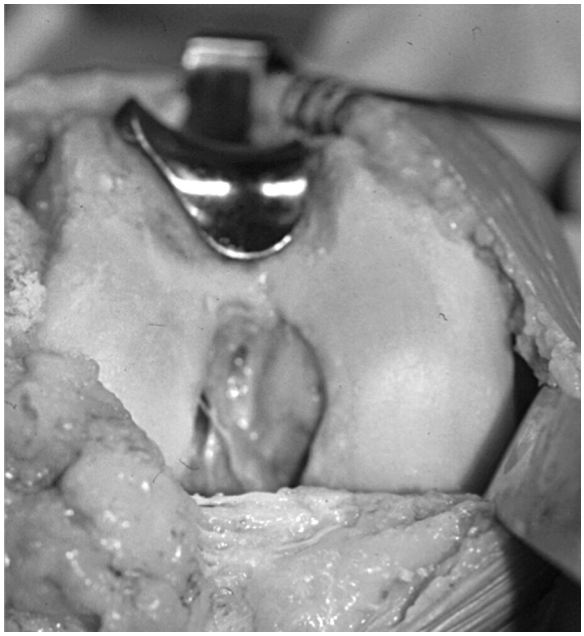

Fig. 2. Intraoperative view of a resurfacing patellofemoral implant; the shape of the subchondral bone is not altered since the implant only replaces worn cartilage.

Some of these implants have an asymmetric trochlea such as the Hermes™, Vanguard™, JourneyCompetitor™, Leicester™ or Gender™. Others are symmetric such as the Avon™ [16]. The femoral implant must be aligned in valgus to match the mechanical axis of the lower limb instead of the axis of the native trochlea.

2.3. Implant geometry

Patellofemoral implants can also be classified using specific geometry features that determine joint biomechanics.

2.3.1. Trochlear component

When the trochlear component is asymmetric, an elevated lateral flange is used to resist lateral forces exerted by the quadriceps [17].

The point at which the patellar button engages the trochlea is determined by the sagittal radius of curvature of the trochlea and the amount of anterior femoral coverage [18]. In implants with less trochlear coverage, the amount of flexion or extension in which the implant is placed can significantly affect patellar tracking. But in some models, femoral coverage extends proximally beyond the native trochlea, ensuring contact with the patellar button even in full extension.

Similarly, implants with extended distal coverage can prevent contact between the native articular cartilage of the femoral condyles and the patellar button in deep flexion.

The shape of the trochlear groove also varies greatly between models [19], ranging from deep, highly constrained trochlea such

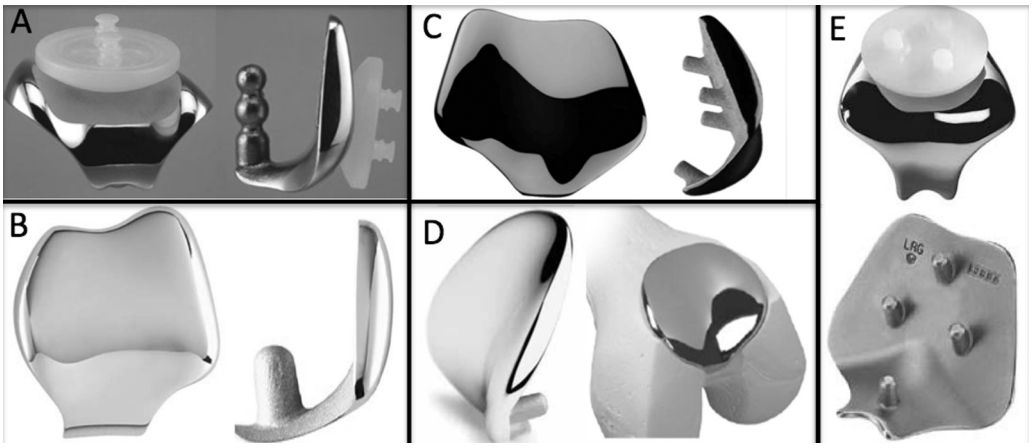

Fig. 3. Anterior cut type implants: Hermes™ (A), Vanguard™ (B), JourneyCompetitor™ (C), Gender™ (D), Avon™ (E).

Fig. 4. Intraoperative view of an anterior cut type implant. The anterior cut here is the same one performed during total knee arthroplasty.

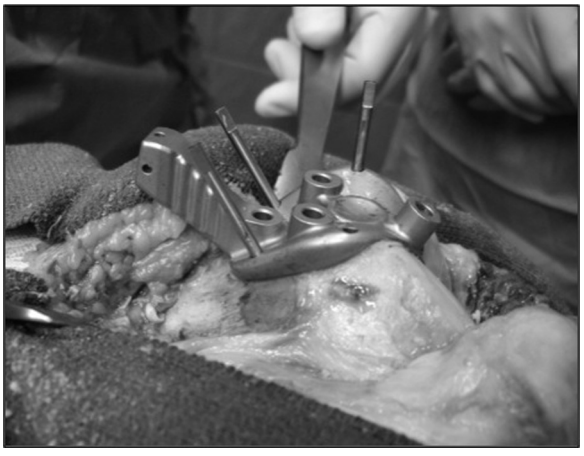

Fig. 5. Instrumentation for preparing the pegs used to fix the femoral component (Avon™).

as the Richards III™ to more open, unconstrained designs such as the Avon™.

2.3.2. Patellar component

The patellar button can be shaped as a dome, have facets and be either symmetric or asymmetric. Spherical dome designs theoretically allow automatic self-centring of the patella on the trochlea, absorbing any residual tilt. If revision is required, these models

Fig. 6. Intraoperative view of an anterior cut patellofemoral implant (Avon™); the trochlear component completely replaces the native trochlea.

can also generally match the trochlear shape of a subsequent TKA, eliminating the need to change the patellar button [20].

3. Indications

As with any unicompartmental knee replacement, the success of patellofemoral arthroplasty is highly dependent on patient selection [3,12,21,22]. This procedure can be indicated in patients with isolated primary or post-traumatic patellofemoral osteoarthritis or in patients with patellofemoral arthritis associated with trochlear dysplasia [23] and patellar subluxation [24] (Fig. 7).

There are several contraindications to PF arthroplasty: chondrocalcinosis, evidence of significant osteoarthritis or pain in the medial or lateral tibiofemoral compartments [3], obvious tibiofemoral alignment defect. Inflammatory joint disease is an absolute contraindication because several joints are affected, not only the patellofemoral one.

Radiology evaluation must consist at least of weight-bearing AP and lateral views of the involved knee and skyline view with knee flexed at 45 degrees. Weight-bearing measurements are used to determine relative femur and tibia alignment on X-rays. CT arthrography is sometimes used to determine the condition of the cartilage. Bone scintigraphy or even SPECT/CT imaging [25] can also be performed during the preoperative evaluation to help determine where the pain is coming from.

There is insufficient information to determine whether chronic anterior laxity is deleterious to the function and longevity of the PF arthroplasty. Patient age should also be considered. Some authors advocate using this procedure only in patients under 60 years of age

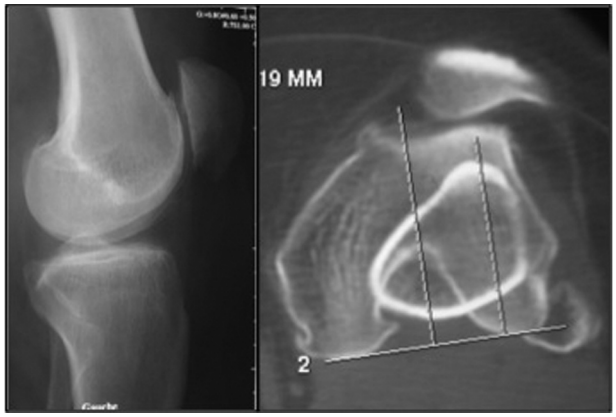

Fig. 7. Patellofemoral arthroplasty performed for patellofemoral OA secondary to dysplasia seems to lead to better results than arthroplasty performed for primary OA, as long as the malalignment of the extensor mechanism is corrected.

[26], but there is currently no evidence demonstrating any impact of patient age on outcomes.

Better clinical outcomes have been reported in patients with osteoarthritis secondary to trochlear dysplasia rather than other causes [2,27–29]. These studies concluded that trochlear dysplasia was the ideal PFA indication. Conversely, a recent report on the 13-year results of a series of 185 consecutive Richards II implants found no relationship between the initial diagnosis, gender or age at surgery on the revision rate. Obesity with a BMI > 30 kg/m^2 leads to a poor prognosis.

In theory, preoperative patella infera, often found in osteoarthritis secondary to patella fracture, should have a negative effect on PFA outcomes. Some consider patella infera to be a contraindication for PFA [30], although there is no objective data available on this topic.

4. Surgical technique

The surgical technique differs between a resurfacing implant versus and an anterior cut implant [9].

The first step in the implantation of a resurfacing implant consists of using trial components to determine the size of the femoral component. The goal is to provide coverage from the superior edge of the trochlea to the anterior edge of the intercondylar notch, and to cover most of the lateral border of the native trochlea. It can only adapt to the orientation of the native trochlea, while avoiding any internal rotation. The trochlear recess is prepared without any true instrumentation. The superior edge of the trochlea is embedded into the anterior cortex, while making sure the transition between the trochlea and condyles is smooth. The patella is prepared using standard techniques.

We prefer working with anterior cut implants because the implantation technique is more reproducible and specific instrumentation is available. These implants now dominate the global market. The incision must be long enough to correctly positioning the cutting blocks and guides; in most cases the patella is dislocated laterally.

As a general rule, the femur is prepared using anterior cutting guides placed on an intramedullary guide (Fig. 8), while making sure not to damage the anterior cortex. At this point, the surgeon can either:

- perform an "anatomical" anterior cut, parallel to the chosen reference plane (posterior condylar axis, etc.) and then recentre the patella by freeing up the lateral retinaculum; tibial tubercle osteotomy can also be performed if needed;

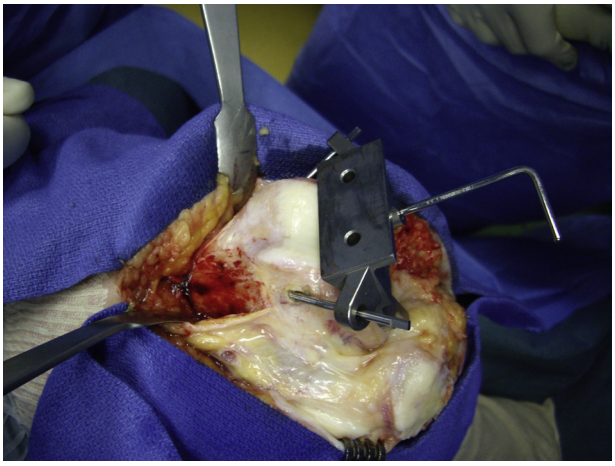

Fig. 8. Intraoperative view of an anterior cutting guide placed on an intramedullary guide.

- perform a "functional" anterior cut, with more external rotation relative to the patellar plane; this can be combined with lateral translation of the femoral component to avoid having to touch the extensor mechanism to recentre the patella.

With newer implants, the anterior cut and condyles are joined by reaming (Fig. 9). Then holes are drilled for the anchoring pegs. The trial implant is then impacted to ensure no ACL impingement and no step-off with the condylar cartilage. The patella itself is prepared as it would be for any total knee arthroplasty. The patellar button can be medialized to prevent initial subluxation.

In cases of subluxation or significant patellar tilt, medialization of the tibial tubercle (with or without release of the lateral retinaculum and/or lateral facetectomy) is a viable option because the PF implant itself will not be able to stabilize the patella if a severe alignment defect exists. In this case, a lateral approach in combination with tibial tubercle osteotomy may be better since the extensor mechanism alignment can be corrected at the end of the procedure. In cases of severe patella alta, the tibial tubercle could also be moved distally, especially if the patella does not articulate with the trochlea in full extension.

These procedures can be planned based on the preoperative evaluation (even if the lateral position of the tibial tubercle is often difficult to measure using the Tibial Tuberosity–Trochlear Groove distance because of the arthritic changes in the trochlea) but in some cases are only finalized at the end of the procedure when the patella is still not tracking normally.

Fig. 9. Reaming guide used to prepare the junction between the anterior cut and condyles (Gender^{TM}).

5. Results

The outcomes for PF implants are quite variable, likely because of the evolution in implant design, patient selection and surgical techniques [3].

5.1. Scoring systems

Published studies use a variety of different scoring systems, making comparisons between studies difficult. While scores such as the Knee Society [31] or Oxford Group are very useful for evaluating knee osteoarthritis treatments, specific tools are needed to evaluate the outcomes of PFA treatments.

Several score systems have been proposed including the Bristol score [3], Bartlett score [32], Fulkerson score [33], and Lonner score [5]. However, none of these are currently validated. After comparing various clinical scoring systems, Fithian and Paxton [34] determined that the Short-Form 36 (SF 36) and Knee Injury and Osteoarthritis Outcome Score (KOOS) are the most suitable for postoperative evaluation of PF implants.

5.2. Results of different implants

5.2.1. Richards™ (Smith & Nephew)

A key feature of this implant is its highly constrained (deep) trochlea. The first publication in 1979 by Blazina et al. [12] included 57 Richards I and II implants and reported a 16% revision rate after two years of follow-up. Several studies looking into the short- or medium-term results of this implant [21,35,36], found a high number of early reoperations for instability or impingement because of poor positioning. Case series with longer follow-up have also been published. The survival was 75% at 11 years [37]; satisfactory results were achieved in 86% of cases after 15–21 years of follow-up [38]; 69% survival has been reported after 20 years [24].

In every series, the main reason for revision was progression of the tibiofemoral arthritis. However, reoperation of soft tissues was also required early on in a large number of patients due to patellofemoral complications such as patellar catching, subluxation and persistent pain. These results were consistent with Lonner's analysis [20], who found that designs where the patella is highly-constrained due to a deep trochlear groove are less able to mitigate poor patellar tracking. These implants require the patient to have good alignment a priori or require an additional realignment procedure during implantation.

5.2.2. Lubinus™ (Waldemar Link)

The follow-up is fairly short in all the published series. Tauro et al. [15] reported implant survival of 65% at 8-year follow-up, but only 45% had good or excellent results. The most common cause of revision was poor patellar tracking (75%). Smith et al. [39] reviewed 45 patients with a mean age of 72 years with a follow-up of four years. The reoperation rate was 42%, while 11% of patients were converted to TKA. Board et al. [40] also reported mixed results after a 19-month follow-up of 17 patients. Only 53% of patients had good to very good results and the reoperation rate was 35% (including 24% revised to TKA). They concluded that the implant was very poorly tolerated and advised against using it. Also, several studies have noted the Lubinus™ implant to be prone to revision for patellar tracking problems [6,20].

In summary, results with the Lubinus™ implant have been disappointing, with high complication rates and early revisions reported in all published studies with this implant.

5.2.3. Autocentric™ (Depuy)

Published results with the Autocentric™ implant are also inconsistent. Some studies have found satisfactory medium-term results (84% patient satisfaction, 66 cases, 2-10 year follow-up) [28]. When reviewed after an average of 16.2 years (range 12–20 years), 14 knees had been revised to TKA for progression of tibiofemoral osteoarthritis. Patients treated for primary patellofemoral osteoarthritis were more likely to have undergone revision than those treated for trochlear dysplasia. The survival rate at 16 years was 58%.

Disappointing results have been reported after an average of 4.8-years follow-up (range 2–11 years) in 24 patients having primary patellofemoral osteoarthritis [41]. The reoperation rate was 87.5%, while 29% had been converted to TKA because of tibiofemoral osteoarthritis progression or patellar maltracking. In another study, the survival rate was 62% at 10 years [27]. Overall, the reoperation rate is relatively high, although the main outcome predictor is the aetiology of the PF osteoarthritis. Arthritis secondary to trochlear dysplasia seems to be better indicated for the Autocentric™ implant than primary or post-traumatic osteoarthritis [28].

5.2.4. LCS™ (Depuy)

This metal-backed, mobile-bearing patellar component is compatible with both the trochlear component in PFA and the femoral component of the TKA in the same product line. The drawback of this design is that the patellar button must be changed if a TKA implant from another product line is used. Also, some authors have reported dislocation [42] and polyethylene separation [7] with this implant.

The first published results with this implant found 93% good and excellent results reported after 4.5 years of follow-up in 16 cases [14]. But other studies subsequently reported results that were not as good. Arumilli et al. [43] reported failure with the cemented, metal-backed patellar component due to excessive polyethylene wear, metal–metal contact, and fracture/dislocation of the polyethylene in the first two years after implantation. Charalambous et al. found 17 revisions (33.3%), consisting of 16 TKA and one patellar button, with a relatively short follow-up of two years [44]. They also described three cases of extensive metallosis and several cases where polyethylene patella had been rendered immobile because of fibrosis around the implant. Because of the high complication rate and early failures, marketing of the LCS™ implant was discontinued in 2009.

5.2.5. Avon™ (Stryker)

This "second-generation" implant uses an anterior cut similar to most TKA systems. Lonner et al. [20] were the first to report on their experience with this implant. The early complication rate was less than with the Lubinus™ implant.

Since then, medium-term (average of seven years follow-up in published studies) outcomes have been reported by several groups. Starks et al. [45] also reported 100% good and excellent results after two years but 22% of patients had radiological signs of tibiofemoral osteoarthritis. Leadbetter et al. [46] completed a multicentre study of 79 knees followed for three years. They noted 84% good and excellent results. Ninety percent of patients reported not having any knee pain during activities of daily living. In the Ackroyd et al. study [47], the survival rate at five years was 95.8% with satisfactory results in 80% of cases. The main complication was the progression of tibiofemoral osteoarthritis (28% of cases). In the Odumenya et al. study [18], 100% of implants were still in place five years following implantation. However, patellar tilt was found in 16% of cases, lateral patellar subluxation in 14% and progression of tibiofemoral osteoarthritis in 22%. Nicol et al. [29] noted a revision rate of 14% after an average follow-up of 7.1 years, primarily due to progression of tibiofemoral osteoarthritis. They noted excellent results in patients treated for arthritis secondary to trochlear dysplasia. Finally, seven-year survival was 82% in the Mont et al. study [48]; there were three cases of aseptic loosening and two cases of

progression of tibiofemoral osteoarthritis less than one year after implantation.

In general, published results with the Avon™ are encouraging, but longer follow-up is needed to determine whether these results hold up over time.

6. Complications

6.1. Early postoperative complications

The rate of early postoperative complications is higher for patellofemoral arthroplasty than total knee arthroplasty [49]. Early postoperative complications include persistent anterior knee pain, patellar catching or snapping, and extensor mechanism rupture.

Poor positioning of the femoral component can be further complicated by patellar maltracking or even patellar instability [47]. Gadeyne et al. [27] showed that placing the femoral component in internal rotation was associated with higher reoperation rates. Misalignment of the extensor mechanism and an over-sized femoral component can also result in anterior knee pain (Figs. 8 and 9). Both of these complications bring about high rates of early revision.

Peripatellar pain may be an early consequence of "overstuffing" the patellofemoral joint (Fig. 10), which occurs when the implant used is thicker than the amount of bone and cartilage resected. A recent study found that patients with the worst functional results had greater increase in patellar thickness following surgery [50].

Lonner et al. [3] also reported that postoperative instability often results from inadequate soft tissue release. Similarly, failing to address significant patella alta by moving the tibial tubercle distally also increases the risk of postoperative patellar instability.

The incidence of many early complications has decreased with the introduction of newer patellofemoral arthroplasty designs [2,30]. For example, Ackroyd et al. [47] in a series of 306 patients treated with the Avon™ noted only a 4% incidence of anterior pain, 5% incidence of complications related to the extensor mechanism and 1.6% rate of arthrofibrosis.

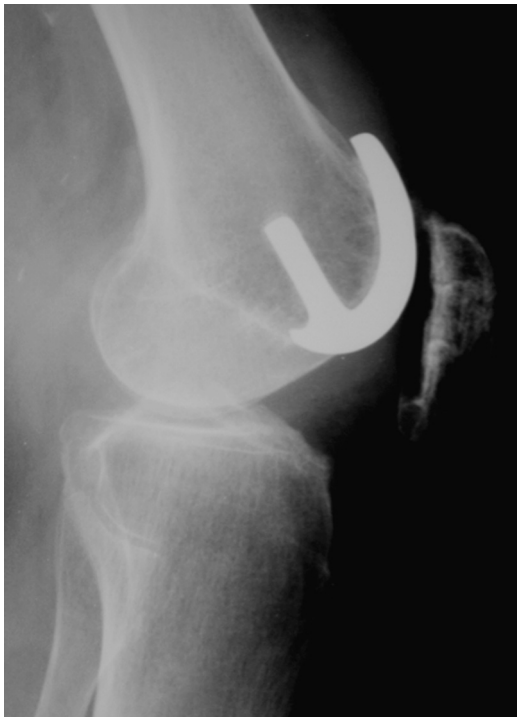

Fig. 10. Malpositioning of the trochlear component must be avoided at all costs. The lateral X-rays showing a trochlear implant placed too far forward in flexion, leading to anterior impingement and early post-operative pain.

6.2. Late complications

6.2.1. Progression of tibiofemoral osteoarthritis

Because newer implant designs have reduced the number of complications due to patellar maltracking, the main cause of revision surgery is now progression of tibiofemoral osteoarthritis. The reported revision rate for tibiofemoral osteoarthritis is up to 22% after 5 to 15 years of follow-up [36,38].

In a study with 306 Avon™ implants, Ackroyd et al. [47] found that progression of tibiofemoral osteoarthritis was the most common late complication. This complication could not be predicted by the functional results or pain control achieved by the PF implant in the first two years after surgery.

Progression of tibiofemoral osteoarthritis is more common in patients operated for primary patellofemoral osteoarthritis. Nicol et al. [29] in a prospective study of 103 Avon™ implants reported a 12% revision rate due to progression of tibiofemoral osteoarthritis after 7.1 years. The average time to revision was 55 months. The rate among patients treated for primary osteoarthritis was 17%, while it was 0% in patients treated for osteoarthritis secondary to trochlear dysplasia. The progression of tibiofemoral osteoarthritis after PFA for primary osteoarthritis is even more prevalent if there is a pre-existing tibiofemoral alignment defect when the PFA is performed.

6.2.2. Loosening

Loosening is a relatively rare complication. Lonner et al. [26] reported that fewer than 0.5% of revisions were due to loosening after a seven-year follow-up. Most of the reported cases involved cementless implants [51]. Gadeyne et al. [27] found a 24% failure rate in a study of 43 Autocentric™ implants after 74 months. While 2 of the 11 revisions were for loosening, each was associated with improper femoral component positioning. Kooijman et al. found only a 2% loosening rate after a follow-up of 15.6 years [38].

7. PFA revision

Few studies have looked specifically at PFA revisions. In 2006, Lonner et al. [52] described 12 PFA revisions in 10 patients. Ten knees had been operated for osteoarthritis secondary to trochlear dysplasia and two for post-traumatic osteoarthritis. The PFA and TKA procedures were separated by four years on average. The indication for revision was tibiofemoral OA in six cases, patellar instability in three cases and a combination of both in three cases. In all cases, a posterior-stabilized TKA was used. The implanted patellar buttons were dome-shaped polyethylene implants that were well-positioned, well-fixed, showed little wear; the trochlear congruence and tracking in the femoral component were deemed satisfactory at the end of the procedure. In all cases, these patellar implants could have been preserved. A femoral stem was not needed and the bone defect created when the femoral component was removed was mostly negated through the anterior and distal femoral TKA cuts. With a follow-up of 3.1 years after TKA, the knee scores and function had clearly improved. Flexion range of motion was satisfactory, but required mobilization under general anaesthesia in one case and arthroscopy in another.

Van Jonbergen et al. [53] compared the outcomes of 14 PFA to TKA conversions with those of a control group of 14 primary TKA cases. The knee and function scores and WOMAC were comparable, but mobilization was required in three cases of PFA to TKA conversion. The authors concluded that PFA has a negative effect on the results of a future TKA.

In a 2008 study, the Lubinus™ PFA was replaced by the Avon™ PFA in 14 cases [6]. The average time between the initial PFA

and revision was 67 months (range 7–128). The reasons for revision were patellar maltracking (8 cases), polyethylene wear with synovitis (9 cases), wrong position of the trochlea (3 cases) or patella (2 cases) and excessively large implant (1 case). In 11 cases, the two components were changed. With an average follow-up of 60 months, the results were satisfactory, but tibiofemoral OA was present in five patients, with two of them needing TKA. This series raises the possibility of revising a PFA implant with a different PFA implant instead of performing TKA, although the indications are limited (no tibiofemoral OA, more suitable PFA revision implant design, sufficient bone in the trochlea, patient too young for TKA).

8. Future directions

Published studies have revealed that outcomes of PFA are highly dependent on implant design, surgical technique and indications. Since greatly improved implants and instrumentation sets are now available, we can only hope that future developments will further improve the outcomes of PFA.

8.1. Surgical navigation

It is easy to imagine that computer assisted surgery could improve the reproducibility of positioning in PFA. Cossey et al. [54]

Table 1
Published clinical results of patellofemoral arthroplasty.

Study	Year	Implant	*n*	Age (years)	Follow-up (years)	Revision rate (%)	Good & excellent results
Blazina et al. [12]	1979	Richards I/II	57	39	2	35	N/A
Arciero and Toomey [21]	1988	Richards II CFS-Wright	25	62	5.3	28	72
Cartier et al. [35]	1990	Richards II/III	72	65	4	7	85
Argenson et al. [51]	1995	Autocentric	66	57	5.5	15	84
Krajca-Radcliffe and Coker [36]	1996	Richards I/II	16	64	5.8	6	88
Mertl et al. [13]	1997	Spherocentric	51	60.5	3	6	82
Arnbjörnsson and Ryd [61]	1998	Blazina Lubinus Richards II Other	113	56	7	22	75
de Cloedt et al. [62]	1999	Autocentric	45	51	6	18	63
de Winter et al. [63]	2001	Richards II	26	59	11	19	76
Tauro et al. [15]	2001	Lubinus	62	66	7.5	28	45
Smith et al. [39]	2002	Lubinus	45	72	4	19	64
Kooijman et al. [38]	2003	Richards II	45	50	17	22	86
Board et al. [40]	2004	Lubinus	17	66	1.5	35	53
Merchant [14]	2005	LCS	16	47	4.5	0	94
Lonner [20]	2004	Lubinus	30	38	4	33	84
Lonner [20]	2004	Avon	25	44	0.5	0	96
Argenson et al. [28]	2005	Autocentric	66	57	16.2	42	N/A
Ackroyd and Chir [16]	2005	Avon	306	62	N/A	3.6	N/A
Cartier et al. [37]	2005	Richards III	79	60	10	25	77
Sisto and Sarin [57]	2006	Kinamatch	25	45	6	0	100
Cossey and Spriggins [54]	2006	Avon (navigation)	4	52	1	0	100
Nicol et al. [29]	2006	Avon	103	68	7.1	14	N/A
Ackroyd et al. [47]	2007	Avon	109	68	5.2	15	80
Gadeyne et al. [27]	2008	Autocentric	43	67	6	24	72
Mohammed et al. [64]	2008	Avon Lubinus Femoro Patella Vialla	101	57	4	4	72
Butler and Shannon [59]	2009	Performa	22	48.6	5	14	N/A
Leadbetter et al. [2]	2009	Avon	79	58	3	16	84
Starks et al. [45]	2009	Avon	37	66	2	0	86
Van Wagenberg et al. [41]	2009	Autocentric	24	64	4.8	29	30
Van Jonbergen et al. [24]	2010	Richard II	185	52	13.3	25	N/A
Odumenya et al. [18]	2010	Avon	50	66	5.3	4	N/A
Charalambous et al. [44]	2011	LCS	51	64	2	33	33
Sarda et al. [65]	2011	Avon	44	61.7	4.5	5	85
Mont et al. [48]	2012	Avon	43	49	7	12	N/A
Beitzel et al. [66]	2013	Journey	22	46.4	2	0	N/A

described one-year results of Avon™ implants implanted with a navigation system without imaging. All patients had good or excellent results with no early failures or post-operative instability.

Robot-assisted surgery also holds promise for improving the reproducibility of implant positioning [55,56]. These systems require preoperative CT scanning to plan the ideal implant position. A robotic arm then guides the bone cuts and helps the surgeon place the implant in the predefined position.

8.2. Custom-made implants

New technology has enabled the development of custom implants, which reproduce the radius of curvature of the patellofemoral joint based on three-dimensional reconstructions. These optimize bone coverage without placing excessive loads on the patella. Encouraging results have been reported in a series of 25 custom-made implants (Kinamed Custom Implants™). With an average follow-up of 73 months, all patients had good or excellent results and there were no revisions [57,58]. Butler et al. [59] also reported good results in 22 patients with custom implants (Biomet® Performa Prosthesis) after five years, but two cases of stiffness had to be treated arthroscopic.

8.3. Bicompartmental arthroplasty

The combination of medial unicompartmental arthroplasty and patellofemoral arthroplasty is an option that has recently garnered renewed interest because of good long-term results [56,60]. This option extends PFA indications to young, active patients with bicompartmental OA or raises the possibility of adding a unicompartmental knee arthroplasty in cases where the OA progresses after PFA.

Results of the implants featured in the greatest number of publications worldwide are summarized in Table 1.

9. Conclusion

Recent series demonstrate that better and more modern patellofemoral implant designs and surgical techniques have produced satisfactory results in the short and medium term [18,29,47,48]. However, indications are limited and past failures must not be forgotten. Long-term studies are needed to determine if these positive results are sustainable.

Disclosure of interest

The author declares that he has no conflicts of interest concerning this article.

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