MENTORS IN ORTHOPEDICS

FROM RESECTION ARTHROPLASTY TO PARTIAL KNEE REPLACEMENTS – A HISTORICAL REVIEW

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SUMMARY

Background: Unicompartmental knee arthroplasty (UKA) originated from 18th-century surgical philosophies focused on motion preservation and minimal invasiveness. Historically, the procedure faced significant challenges regarding surgical risk, implant fixation, and clinical competition with realignment osteotomy or total knee arthroplasty.

Objective: This review delineates the chronological evolution of UKA, examining the transition from resection arthroplasty and soft tissue interposition to modern prosthetic designs and refined clinical indications.

Key Points: Early resection techniques by Park and Filkin preceded the scientific subperiosteal approach developed by Ollier. Subsequent developments in the 19th and early 20th centuries focused on realignment osteotomies and interpositional arthroplasty using fascia lata, adipose tissue, or Vitallium plates. The introduction of cemented polycentric implants by Gunston in the 1960s marked the transition to modern prosthetic UKA. Despite initial skepticism from Insall, who prioritized total knee arthroplasty, the development of specific selection criteria by Kozinn and Scott provided a standardized framework for patient selection. The resurgence of UKA was further driven by Marmor's modular designs and Cartier's technical refinements. A significant shift occurred with the introduction of the Oxford mobile-bearing prosthesis, which utilized a meniscal bearing to increase contact area and reduce polyethylene wear. Long-term data for mobile-bearing designs demonstrate implant survival rates of approximately 92% at 20 years.

Conclusion: The historical progression of UKA reflects a shift toward conservative, biomechanically informed surgical interventions. Current evidence supports UKA as a safe, reproducible, and effective treatment for isolated single-compartment gonarthrosis when strict selection criteria and precise surgical techniques are employed.

KEYWORDS

Arthroplasty, Replacement, Knee; Knee Prosthesis; Osteoarthritis, Knee; Osteotomy

Unicompartmental knee arthroplasty did not begin its story in the twentieth century, but in fact dates back to the end of the 18th century where we find many overlapping historical references to surgical techniques. To understand how the concept of a partial knee replacement came about, let us consider the history of other surgical techniques. Some may question what resection arthroplasty, bone osteotomy, soft tissue interposition and synthetic implants have to do with the birth of unicompartmental replacements. However, this is a logical approach because all these surgical techniques abide by the same philosophy of preserving movement whilst remaining minimally invasive.

All citations have been checked and primary articles read, unless stated otherwise. Reading the primary articles made it possible to identify any errors or misinterpretations that filtered down in subsequent articles.

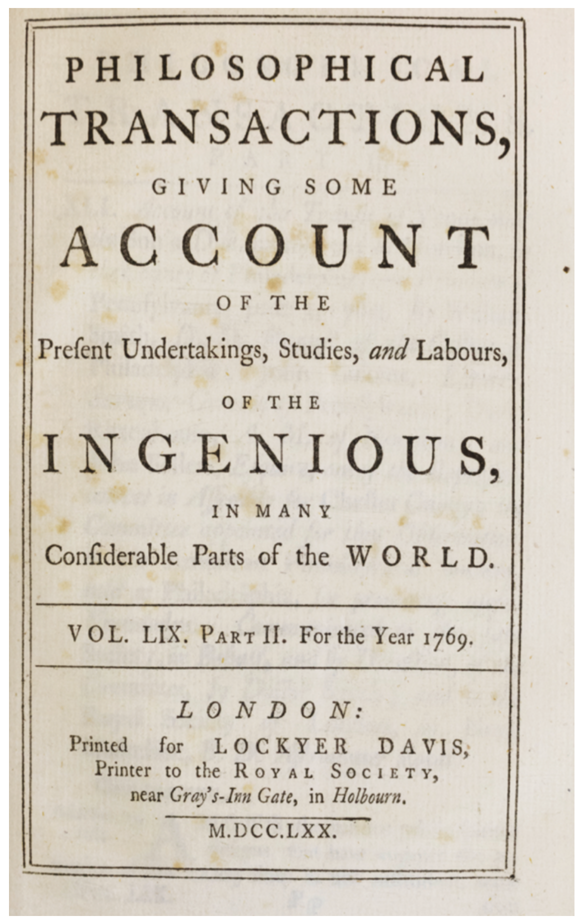
RESECTION ARTHROPLASTY IN THE 18TH–19TH CENTURY

It's not until the 18th century that we find the first written evidence of resection arthroplasty being described and taught. The procedure was not without risk to the patient, and there are two historical discussions of this topic, one by Hippocrates (460–377 BCE) and the other by Paul of Aegina (17th c.). Whilst the Hippocratic Corpus is vague and cautious, the work by Paul of Aegina mentions and recommends the procedure albeit without describing the indications or technique:

- 'The following are the indications for resection of a protruding bone: if it cannot be reduced, but only some small portion seems to come in the way, and it is possible to remove it...'[1]

- 'In like manner, the extremity of a bone near a joint, if diseased, is to be sawn off'[2]

The first surgical description of resection arthroplasty dates back to 1768. It is credited to Anthony White (1782–1849), who operated on a boy of just 16 years with infectious necrosis of the left shoulder.[3],[4] However, it is unclear whether he can claim the title, because one year earlier Prof. Barthelemi Vigarous from Montpellier performed the same procedure on a 17-year-old boy. It is described in a posthumous work published in 1820 by his son, Prof. Joseph-Marie Vigarous.[5],[6] Nevertheless, there is an even older record (Fig. 1).


PHILOSOPHICAL
TRANSACTIONS,
GIVING SOME
ACCOUNT
OF THE
Prefent Undertakings, Studies, *and* Labours,
OF THE
INGENIOUS,
IN MANY
Confiderable Parts of the WORLD.

VOL. LIX. PART II. For the Year 1769.

LONDON:
Printed for LOCKYER DAVIS,
Printer to the ROYAL SOCIETY,
near *Gray's-Inn Gate*, in *Holbourn*.
M.DCC.LXX.

Figure 1: Cover of Philosophical Transactions. Royal Society of London.

It comprises a clinical case study published by John Daniel Schlichting. The surgeon extracted the carious head of the femur in a girl, aged 14, by dilating a fistulous opening over the hip (Fig. 2).

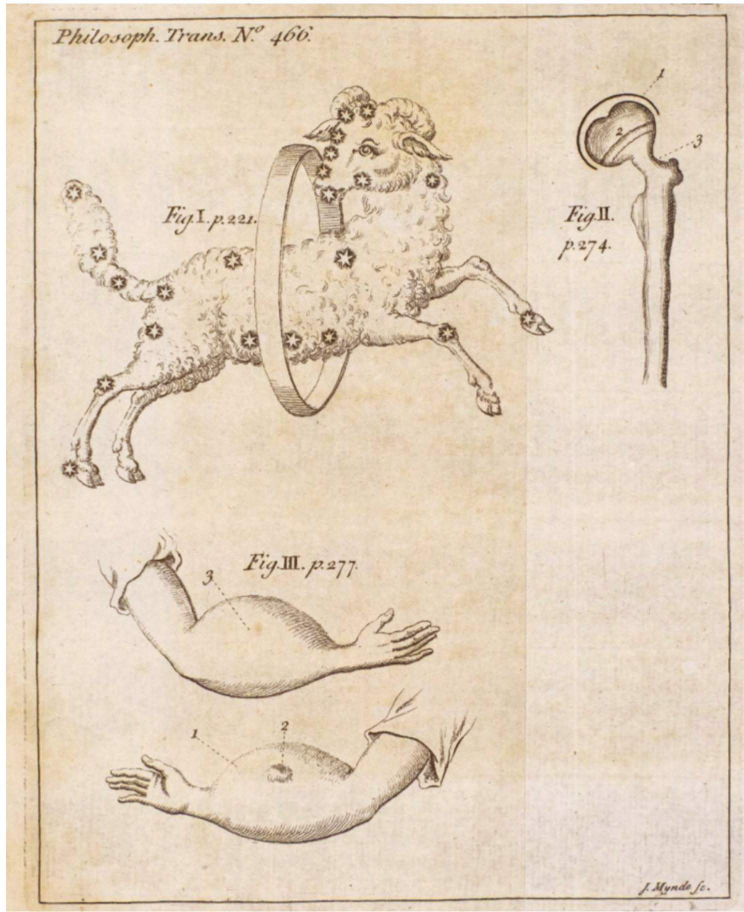


Figure 2: Carious head of femur in a 14-year-old girl..

Schlichting said the patient recovered in six weeks:[7]

- 'Anno 1730. Puella rustica 14 annorum coxae articulus tumecit, dolet, suppuratur, perrumpitur. Chirurgus dilatat foramen natura factum: extrahit totum ossis femoris caput: subjicit posthac in ulceris cavitatem 'Myrrhae tincturam, porro suscum umg...'

The first resection arthroplasty of the knee was performed in 1781 by Dr Henry Park from Liverpool: 'Suffice it to remark, that the case gave him a great deal of trouble, and that it was attended with many embarrassing circumstances, arising chiefly from the difficulty of keeping the limb in a fixed position...'[8] This operation was published twenty years later by Samuel Cooper, prompting Dr Filkin (Northwich, Cheshire) to claim priority based on a letter he had written to Park describing the technique two decades before (1762):[9]

- 'Filkin operated on a subject who had for many years had a tumour on the knee and who, after falling from a horse, fractured his patella. The joint began to discharge pus and amputation was proposed. Despite the fragile health of the subject, Filkin suggested removing the carious parts. Having practised on a cadaver, he performed the resection on 23 August 1762. Three months later, the limb was very solid and the patient had got so well as to require no further attention. He was still living in 1782. 'The person is now living', wrote Filkin junior in his letter to Binns (of Liverpool), 'and sometimes goes to Liverpool, where, if you will give me leave, I will desire him to call upon you'.[10]

The procedure became very popular, and in 1862 Dr O. Heyfelder counted over 176 cases of resection arthroplasty of the knee worldwide (Fig. 3).

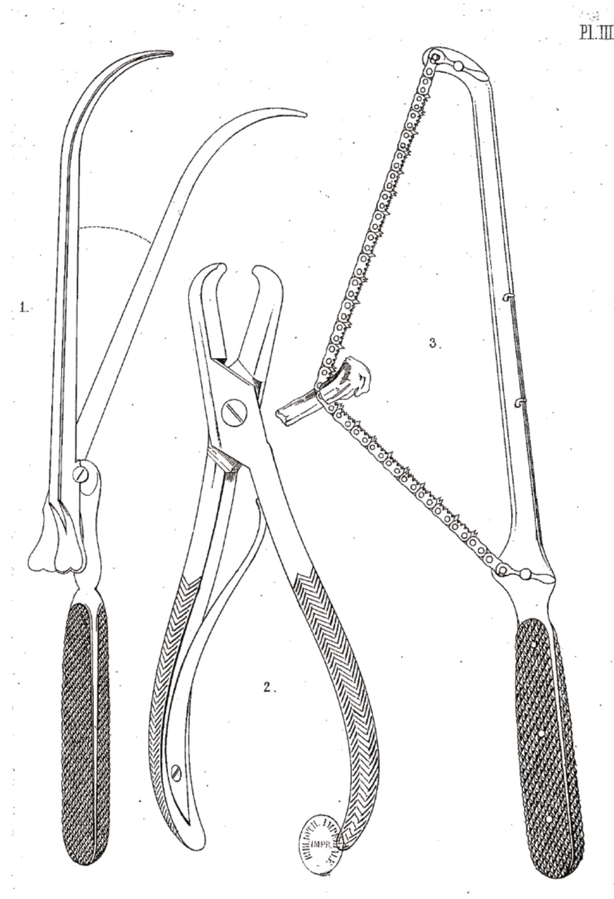


Figure 3: Treatise on resections.

Chapter 10 of his treatise discusses ‘Resections of contiguity, or articular resections’.[11] Resection arthroplasty of the hip was less common, and in 1860 Prof. Léon Le Fort conducted an exhaustive survey which identified 86 articles on the procedure.[12],[13] It wasn’t until the work of Léopold Ollier at the end of the 19th century that a scientific approach towards resection arthroplasty was developed. Ollier established the concept of subperiosteal, subcapsular excision for the shoulder, elbow, hip and knee. However, unlike for the elbow, the aim with the knee was not to obtain a new joint, but bone fusion or even stable fibrous ankylosis. Nevertheless, Ollier explained that the surgical risk (death, complications) was high with knee resections:

- 'The frequency of surgical shock after resection of the knee is not a new concept (Holmes). Even before discovering the absorption of toxic substances, the procedure was considered more dangerous from this point of view than other joint resections.'[14]

Ollier describes two important concepts: scientific justification based on experimental studies, and partial resection of the knee: 'We have clearly shown that in young animals it is possible to rebuild, after subperiosteal resection, separate femoral condyles able to articulate with a newly formed tibial plate... But we do not suggest seeking the same outcome in humans... Instead of releasing the lateral ligaments, we carefully spared them, as well as all healthy parts of the periosteo-capsular sheath to accumulate around the bony union line as much ossifiable tissue as possible. In this manner we considerably increased the chances of bony union, and, if there is still mobility, we have preserved the musculotendinous girdle of the new joint, in other words its source of resistance and mechanism for movement’.[15] 'Next we have semi-articular resections, either femoral or tibial, and partial resections... Within this classification, total removal of the patella is classed as partial resection of the knee.'[16]

The first realignment osteotomies are credited to J. Rhea Barton who performed two procedures, one for the hip in 1827 (Fig. 4) and one for the knee in 1837 (Fig. 5).

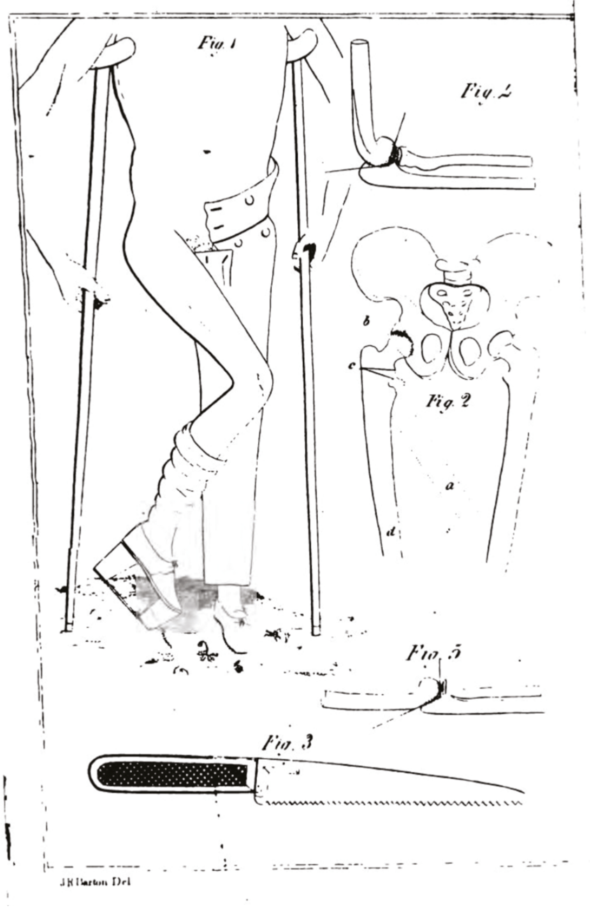


Figure 4: J. Rhea Barton, osteotomy of the hip in 1827.

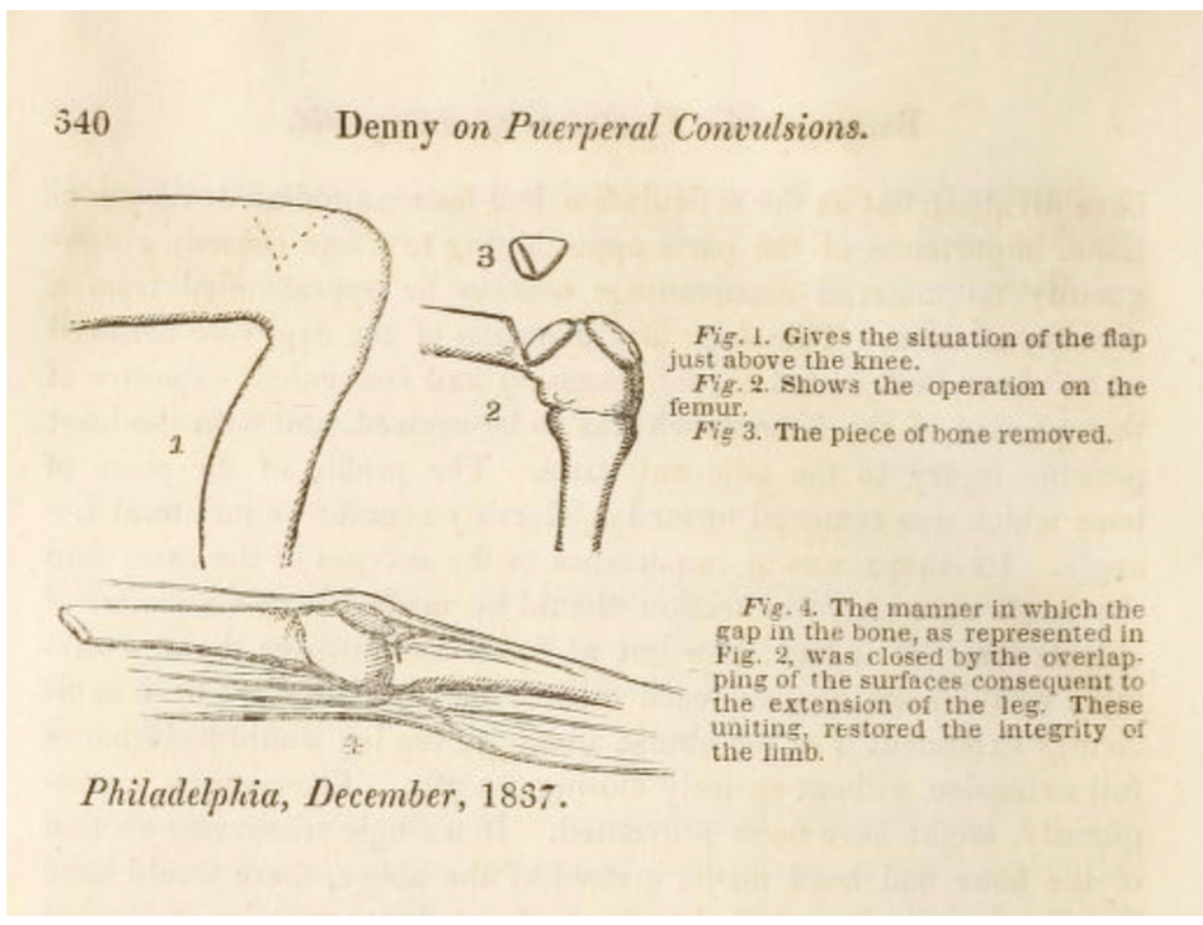


Figure 5: J. Rhea Barton, osteotomy of the knee in 1837.

These realignment osteotomies were very quick procedures, taking just seven minutes for the hip and five minutes for the knee. For the femur, it was a subtrochanteric osteotomy, and for the knee a subcondylar osteotomy.[17],[18] Barton expected that bone fusion would occur around the newly created joint. This was not true for the hip, and the patient was able to resume work with his new joint.

- ‘The patient, upon whom this operation was performed, enjoyed the use of his artificial joint for six years; during which period he pursued a business (trunk-making) with great industry, earning for himself a comfortable subsistence, and a small annual surplus’.[19]

For the knee osteotomy however, there was consolidation involving the use of a stick for four months. At six months post-surgery, the patient (Mr Seaman Deas), wrote a long letter to his surgeon:

- 'Charleston, November 6th, 1837. My dear sir, — ... I walk without a stick or other aid, with the sole of the foot to the ground, and my friends tell me, with but a slight limp; and I have great pleasure in adding that the leg and foot have increased considerably in size, so as now to be nearly equal to the other.... Adieu and I am, my dear sir, very sincerely, your friend. Seaman Deas. To Dr. J. Rhea Barton’.[20]

Resection obviously gave mobility to the new hip joint, but surgeons soon began wanting to use soft tissue interposition to facilitate movement whilst limiting the risk of bony ankylosis. The first attempt at soft tissue interposition is wrongly credited to Aristide Verneuil (1823–1895) during a procedure to resect the temporomandibular joint. The error is due to the concepts of anaplasty and autoplasty as developed by Verneuil, who could be described as one of the founding fathers of modern plastic and reconstructive surgery. For Verneuil, anaplasty was synonymous with reconstructive surgery using natural materials, and autoplasty involved prosthetic reconstruction. However, none of his writings contain any description of soft tissue interposition in the

temporomandibular joint. In 1860, he published an article describing the surgical case studies of Prof. Rizzoli between 1853 and 1857. These operations comprised a mandibular resection osteotomy without interposition during the initial resection: ‘Several years ago now, Mr Rizzoli was presented with the opportunity of providing surgical treatment for a locked jaw. His first observation dates from 1853’. [21]

The concept of soft tissue interposition appeared towards the end of the 19th century, in the treatise by Ollier (Fig. 6): [22]

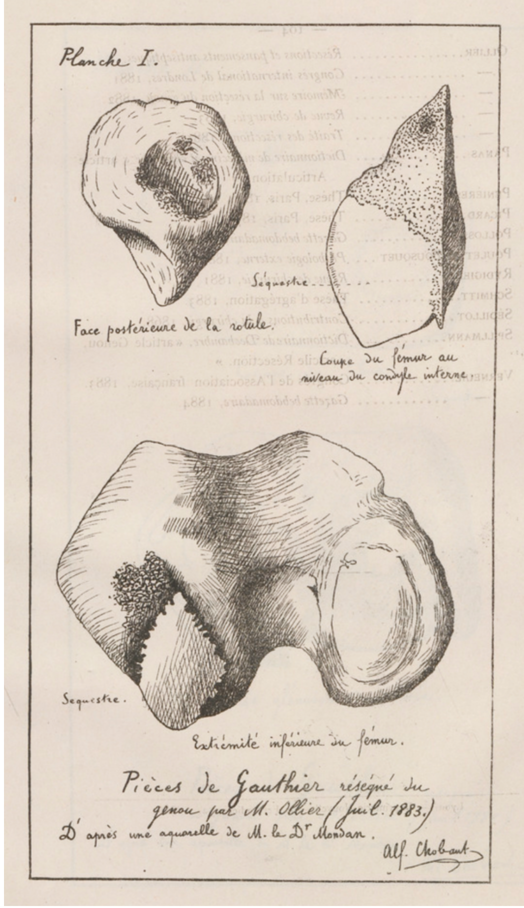


Figure 6: Resected fragment of tuberculosis of the knee. 1883. Prof. L. Ollier.

‘One can, after removal, reconstruct the shape of the region by suturing the palatal periosteum to the lateral periosteum. Thus by joining the horizontal palatal plane to the lateral vertical plane, the nasal and oral cavities are once again separated, which is extremely important in terms of preserving the function of the organs of speech and deglutition’.

SOFT TISSUE INTERPOSITION

In 1886, Ollier suggested soft tissue interposition of the hip using the periosteum, and several years later Gluck proposed it using skin. In 1918, Erich Lexer from the Friedrich Schiller University Jena in Germany, further developed the concept of inserting tissue, especially fatty tissue, into the knee and hip joints.

Regarding fascia lata interpositions, he listed several indications: [23]

- ‘To prevent adhesions: In this connection, from my own experiences, fat transplantation plays a very important role. Fat insertion to prevent rigidity of the joint after operations for ankylosis succeeds with best results in the loose joints of the arm, although favourable results. I have also been obtained in the hip and knee (Murphy, Lexer, Ropke). In operations on the knee, fat pads prevented recurrence of the fixation of the patella. Likewise, fat implantation on the freshened acetabulum has relieved the ankylosis of congenital dislocation of the hip due to haemorrhage (Lexer)… The indications are numerous … application of fascial flaps between articular surfaces after postoperative injury to the synovial membrane; in mobilisation of joints; as a base for haemostatic sutures in organs…’

John Murphy wrote in 1913 that he and his team had performed over 60 arthroplasties involving all the joints, including 28 knees: [24] ‘The knee is the most difficult joint in which to secure the perfect restoration of function and restoration of nearly normal joint anatomy’.

In another article, Murphy described the surgical technique and published numerous photographs. [25] In 1918, Melvin Henderson from the Mayo Clinic pooled the results from several centres and published the results for 121 patients. In the longer term, 80 patients were classified a success. Nevertheless, towards the end of his career Henderson remained cautious about this type of surgery, and in relation to conservative arthroplastic surgery he wrote: [26]

- ‘I am free to confess that my own experience leaves me still far from satisfied with my efforts along these so-called reconstructive lines… I have used all the operations mentioned, with the result that function has been, on the whole disappointing, although the aim was lessened, the results were not such as to awaken my enthusiasm’.

In 1922, Willis Campbell also wrote about the various interposition techniques, advising against the use of animal membranes in favour of pedunculated flaps (Fig. 7): [27]

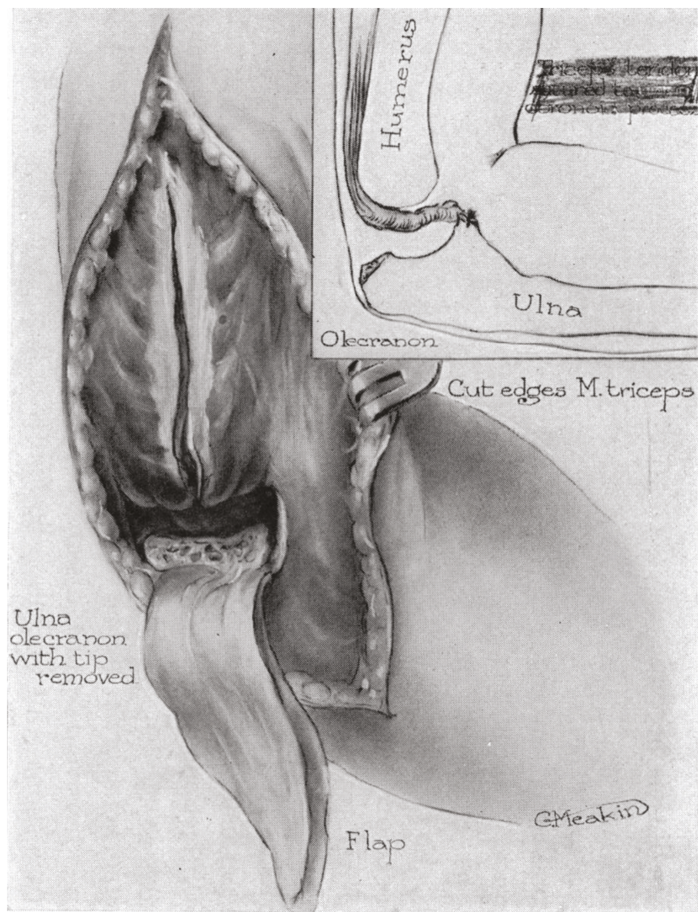


Figure 7: Interposition flap of the shoulder for arthrolysis. Willis C. Campbell. 1922.

- ‘Pedunculated fascial flaps have been extensively employed between the articular surfaces, after remodelling or carving out a new joint. The procedure has been discarded by a majority of experienced operators in this field, interposition of animal membranes specially prepared, such as the fragile membrane, Baer’s pig's bladder, Allison’s fascia, etc. While successes have been reported, the disadvantage is that foreign body irritation invites infection and the material is often excluded. Transplantation of free fascia lata, extensively used by Putti, of Italy, and Russell Mac Ausland, of Boston’.

That same year, Campbell published a series of 24 cases (pedunculated and free fascial flaps, pig's bladder) (Fig. 8), and of the 13 patients available for evaluation only five were reported as having good mobility. [28] In his final publication in 1924, Campbell described an original technique of transferring the contralateral fascia lata (Figs. 9 & 10), saying he had operated sixteen patients over the past few years using ipsilateral and contralateral flaps. Only twelve patients were evaluable, with ten good outcomes and two failures, from which he concluded: [29] ‘My first report was by no means encouraging but from results obtain, especially during the last year, arthroplasty of the knee is justifiable in well-selected cases, with an excellent chance of obtaining satisfactory motion’.

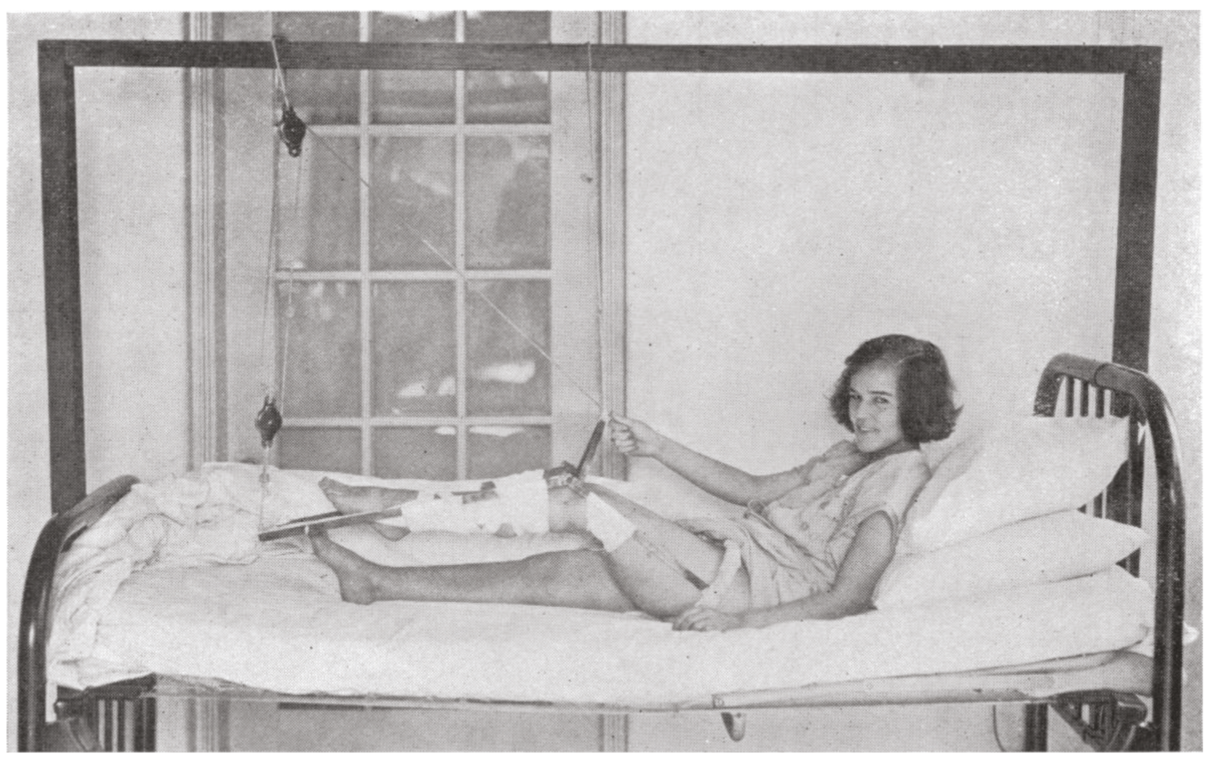


Figure 8: Apparatus for mobilization of the knee after arthrolysis of the joint. Willis C. Campbell. 1924

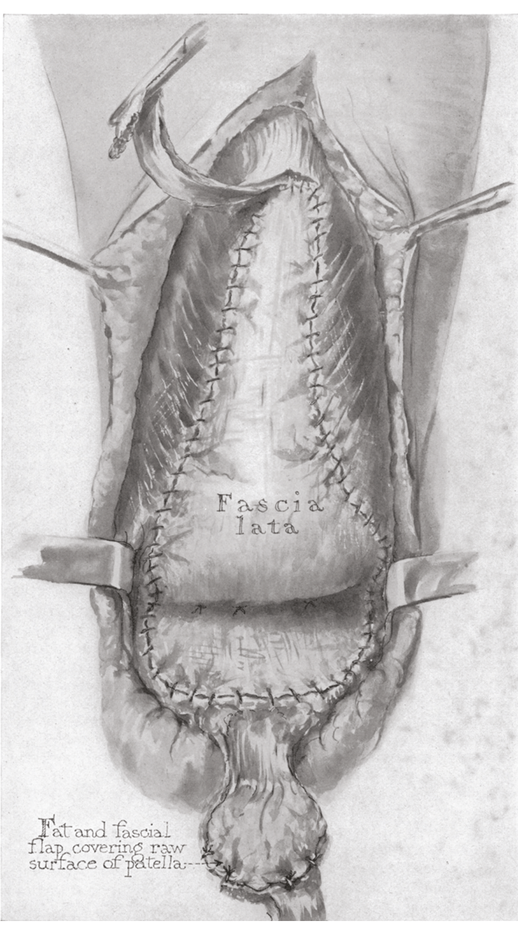


Figure 9: Contralateral fascial flap. Willis C. Campbell. 1924.

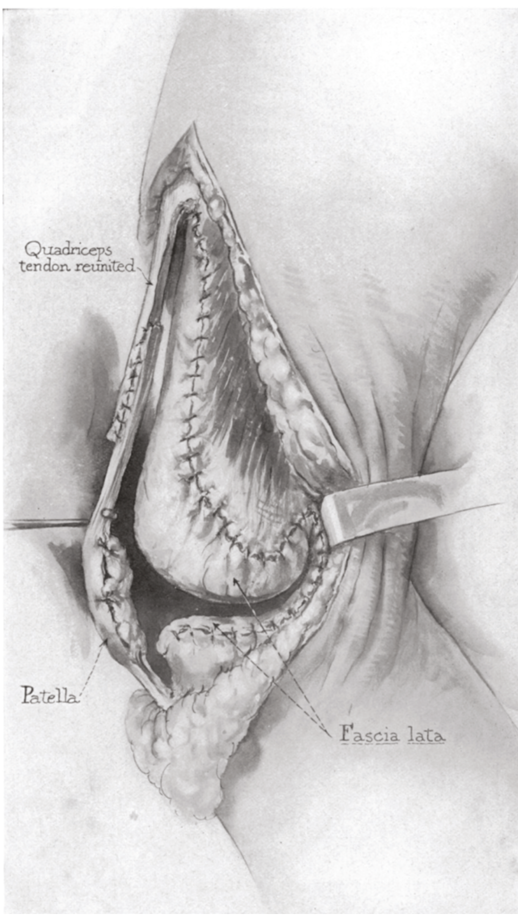


Figure 10: Ipsilateral fascial flap. Willis C. Campbell. 1924.

These results encouraged him to develop another concept, that of inserting inert materials into the joint. Inspired by Smith-Petersen's work on the hip, he opted for vitallium. Before using vitallium, Smith-Petersen had conducted numerous trials with glass, pyrex, viscaloids and bakelite. [30] In 1940, Campbell published his first two case studies involving the interposition of a vitallium plate, which he called a cap. The component was constructed to fit over the inferior end of femur, with the size based on x-rays. Fixation was achieved with two posterior hooks and one anterior screw. His article also mentions that he worked with a tibial plate. [31] These interposition plates were still being used in 1970, chiefly by Ranawat and Sbarbaro. Starting in the 1950s, many types of arthroplasties were developed, some with some anecdotal models revealing the extent of the medical research at the time; in 1952, Rocher proposed a knee replacement using two Judet acrylic femoral heads. [32] However, all these attempts resulted in disappointment.

SYNTHETIC INTERPOSITION

In the 1950s, three surgeons began modifying Campbell's concept with new interposition plates: McKeever in 1953, MacIntosh in 1954 and Spotorno.

1. McKeever

In 1949, McKeever performed two patellofemoral replacements, and in 1955 published a series of 40 cases. In 1960, [33] Robert Elliot then posthumously published McKeever's works on inserting a prosthetic unicompartmental tibia involving 76 cases (Fig. 11).

Figure 11: McKeever prosthesis

The first operation took place in 1952 for villonodular synovitis, involving a single tibial component fixed with a fin:

- 'He had a restoration of both tibial plateaus by a prosthesis, a patellar prosthesis and an extensive joint debridement. Cellophane was interposed to restore the periarticular gliding surfaces and the suprapatellar pouch'. He concluded: 'With this prosthesis it is possible to restore satisfactory function to most of the badly damaged knee joints that ordinarily would be subjected to an arthrodesis. If this prosthesis will function satisfactorily in these severely damaged knee joints, it will function in any case other than that with an infection'.[34]

2. MacIntosh

MacIntosh published his first case in 1966, [35] followed by a second article in 197236 covering 130 operations. The first time a MacIntosh prosthesis was implanted was in 1954 (Toronto). He spoke about it in 1965 during the annual meeting of the British Orthopaedic Association, discussing 58 cases, 51 of which were bilateral. MacIntosh said the operation was best in rheumatoid arthritis, whereas in osteoarthritis osteotomy was to be preferred.

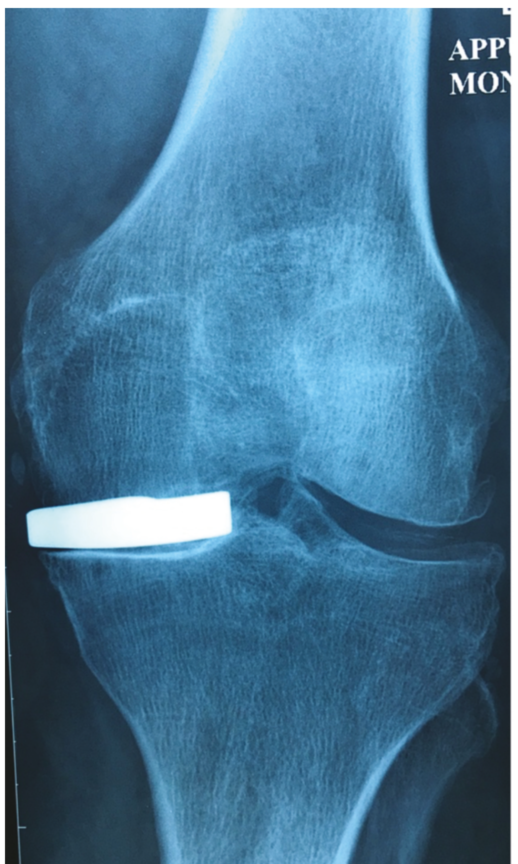
In a 1972 article, MacIntosh described how he had performed his first case in 1954: 'A seventy-three-year-old woman was admitted to the Toronto General Hospital for fusion of the knee'. During surgery, it was noticed that the valgus deformity could be corrected, causing the lateral collateral ligament to become taut and restore stability. He decided there and then to use a hemiprosthesis, which he made by cutting a tibial prosthesis in two and implanting only the lateral part. It was an acrylic component as used by Dr Sven Kiaer and Dr Knud Jansen of Copenhagen. The patient lived with the hemiprosthesis for twelve years. Six other patients were then operated, four of them had a good result at ten years. The acrylic originally used for hip prostheses, based on the work by the Judet brothers, was later abandoned, mainly because of foreign body reactions in the hip. He concludes by

saying that in rheumatoid arthritis, hemiarthroplasty is the procedure of choice because tibial osteotomy does not offer a reasonable alternative.

These implants are all based on the concept of improving the joint by restoring the joint space and collateral ligament tension. The McKeever and Sbarbaro prostheses were stabilised with a stem or a fin inserted into a slot in the tibial plate. The MacIntosh device was freely placed on a prepared tibia, with the shape of the prosthesis creating ligament tension to stabilize the joint (Fig. 12).

Figure 12: MacIntosh prosthesis.

The procedure for implanting these devices was exacting and relatively long. However, there remained two major problems: the lack of secondary fixation of the implants, and femoral cartilage wear. The final attempts with this type of implant were in 2000 with the development of the UnispacerTM (Zimmer, Warsaw, USA). The results were disappointing and Cartier et al. [37] performed six surgical revisions of the 17 implants and did not therefore recommend its use and it was withdrawn from sale (Fig. 13).



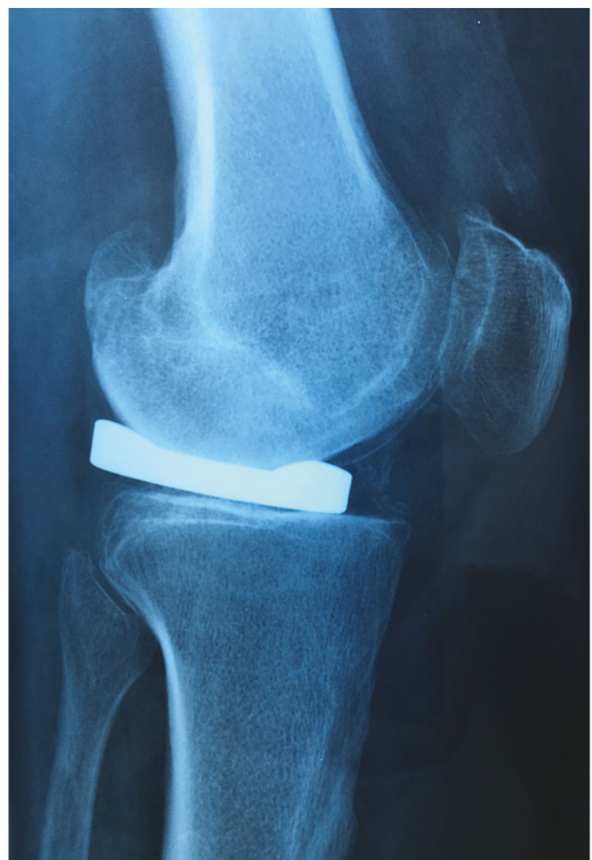


Figure 13: UnispacerTM.

UNICOMPARTMENTAL ARTHROPLASTY

1. Cement

Frank H. Gunston (Winnipeg, Canada) obtained a travel grant to study hip arthroplasty at Wrightington under Sir John Charnley in 1966. During his placement, he worked on a design for a cemented knee implant, and in 1966 published a biomechanical and clinical study of the Polycentric prosthesis (Prosthetic Simulation of Normal Knee Movement). The implant was cemented, and comprised two single-compartment components cemented to the femur and tibia. Upon his return from Canada in 1970, he worked with Petreson at the Mayo Clinic to develop the Polycentric knee replacement (Howmedica, Rutherford, New Jersey, USA).[38] However, it was technically tricky to implant, and long-term clinical outcomes were not very satisfactory (Fig. 14).

Figure 14: Gunston's polycentric knee implant.

In 1984, Lewallen published a ten-year follow-up study from the Mayo Clinic, reporting a 66% survival rate. The causes of failure were instability or ligament laxity 13%, loosening of a component 7%, infection 3%, and patellofemoral joint pain 4%. This double replacement procedure was then abandoned, although surgeons at the Mayo Clinic continued to use it for single-compartment disease. During surgery, if the damage was on one side only, the implant was put on the diseased side. Bryan et al. published a series of 207 knees with a three-year follow-up, reporting a patient satisfaction rate of 83%. [39] But over the same period, other cemented unicompartmental replacements were being developed, such as the Geomedic, Savastano and Marmor.

2. Insall

In the seventies and eighties, John Insall found himself facing a dilemma, and although his thoughts about unicompartmental knee arthroplasty were unclear, he remained open-minded: [40] 'Unicompartmental replacement for osteoarthritis of the knee is an attractive concept. It seems reasonable that limited replacement would come closest to normal functional restoration'. To add to the confusion, that same year he published two contradicting articles! On October 1976, he co-authored an article with P. Walker [41] in which he gave the following conclusion about the Unicondylar prosthesis:

'The best results were seen in the lateral compartment arthroplasties. Such deformities may be the only future indication for the use of this operation as these knees do not do well when treated by tibial osteotomy. However, when only the medial compartment is involved, osteotomy may still remain in the treatment of choice'.

In his second article that year, [42] he compared four models of prosthesis, and his conclusion was clear: 'We now believe there is no indication for this type of prosthesis and that tibial osteotomy or a bicondylar prosthesis should be preferred'.

In 1980, Insall et al. reiterated their thoughts from 1976, and in a study of a series of 32 unicompartmental knee arthroplasties with five-year follow-up, they demonstrated that although the quality was initially considered good, they subsequently showed a marked deterioration: [43] 'The unicondylar prosthesis was used in the mildest cases and gave the least complications, but the quality of results was not superior to that achieved with the other prostheses'.

Following these articles, and even though Install amended his opinions in his book Surgery of the Knee. Total Knee Replacement [44], he still felt that the best UKA was a TKA.

3. Kozinn Scott criteria

In a benchmark article, Stuart Kozinn, Clare Marx and Richard Scott proposed an indication algorithm.[45] In their series they achieved a 92% excellent or good result at 5.5 years, by applying the following selection criteria:

- Age over 60
- Weight under 67kg
- Moderately active
- Low pain at rest
- Flexion contracture < 5°, arc of motion > 90°
- Reducible frontal deformity: varus deformity < 10° and valgus deformity < 15°.

These highly restrictive criteria were supported by the team at Robert Breck Brigham Hospital and applied by John Insall, before spreading to France and the Lyon team, especially Gérard Deschamps et Chol: [46]

- 'Summary: Unicompartmental knee arthroplasty – UKA – is designed for patients presenting arthritic wear limited to a single medial or lateral tibiofemoral compartment. The indication is based on strict criteria. Wear must stem from degenerative osteoarthritis or be secondary to aseptic necrosis of the medial condyle. Inflammatory rheumatism is a contraindication. Age and activity level should be compatible with an indication for arthroplasty. The body mass index should be less than 30 kg/m2. The ligament system must be intact, particularly both cruciate ligaments. Any pre-existing axis deformity should be moderate and the residual axis deformity, after correction of wear with a unicompartmental tibial augmentation spacer, should not exceed 7–10° varus or valgus'.

For over four decades, these criteria were the benchmark and set the new global standard for indications.

4. The 1980s: an awakening

Leonard Marmor in America then Philippe Cartier in France dusted off the UKA and took it down off the shelf to where it had been consigned by John Insall and his colleagues. But it was the team from Oxford who truly put the UKA back on track thanks to over three solid decades of scientific work to review the indications, the surgical technique and the implant designs.

4.1 Marmor

Leonard Marmor developed a unicompartmental knee arthroplasty that he first used in 1974. His initial articles were promising, with an 88% patient satisfaction rate at two years. However, due to wear he advised against using polyethylene tibias thinner than six millimetres: [47]

- 'A follow-up of 2 years or more on 105 patients with the Modular – Marmor – knee replacement revealed that 88 per cent of the patients had a successful result. The complications and failures are analysed in depth. Late loosening of the components were not observed except with the 6 mm tibial plateau. Pain relief was dramatic as well as improved function, stability and motion'.

His second major publication came in 1988 and discussed 60 implants with over 10 years' follow-up. In his introduction, he redefined the scope of the UKA: [48]

- ‘In the past decade, two concepts have caused considerable controversy in orthopedic surgery of the knee. Some orthopedic centers contend that osteotomy of the tibia is the procedure of choice for unicompartmental gonarthrosis of the knee and resist the concept of unicompartmental arthroplasty’. ‘The other concept is that if unicompartmental arthroplasty is necessary, the entire joint should be replaced, since the uninvolved compartment may develop arthritis in the future’.

At 11 years post implant, 70% of the patients in his series were satisfied with 87 pain-free knees. However, the complicated procedure did not help promote the Marmor UKA. In June 1983, Richards Manufacturing Company was ordered to pay $25,000 to Dr Marmor in compensatory damages and $500,000 in punitive damages. Between January 1973 and April 1973, the company had manufactured 4000 medium-size tibial components that did not match the manufacturer's specifications; this change in dimensions created problems during surgery and affected clinical outcomes, with one patient eventually filing a lawsuit. [49]

4.2 Philippe Cartier

A few years later, Philippe Cartier from France reported a positive experience with over 90% excellent and good results at less than five years’ follow-up. [50] He used the Marmor, Mod III Condylar, Mansat Unit and Genesis implants successively. In 2007 he gave a presentation to GECO [51] on 2170 implants in which he describes the factors for UKA revisions. In his experience, the failures with the designs from the seventies were primarily due to technical reasons (instrumentation and surgeon error), whereas the designs from the eighties chiefly failed due to mechanical reasons stemming from poor quality polyethylene (gamma ray sterilisation, insufficient thickness, excessively stiff metal back etc.).

From the 1990s onwards, he experienced only rare complications, performing a total of 46 revisions in 1170 UKAs. The main causes of failure were incorrect initial indications.

4.3. The Oxford revolution

In one remarkable 1978 study on the biomechanics of the knee, John Goodfellow laid the foundations for mobile-bearing implants. He first noticed, as Aldabert Kapandji had done before him, that flexion and extension of the knee are constrained by cruciate ligament tension. Goodfellow expanded upon Kapandji's model by incorporating the role of the menisci. He realised they had a dual purpose - stabilizing the condyles and increasing the contact surface area between femur and tibia. To illustrate his proposal, he made a two-dimensional model (Fig. 15) with a meniscal 'washer’ between the two bones.

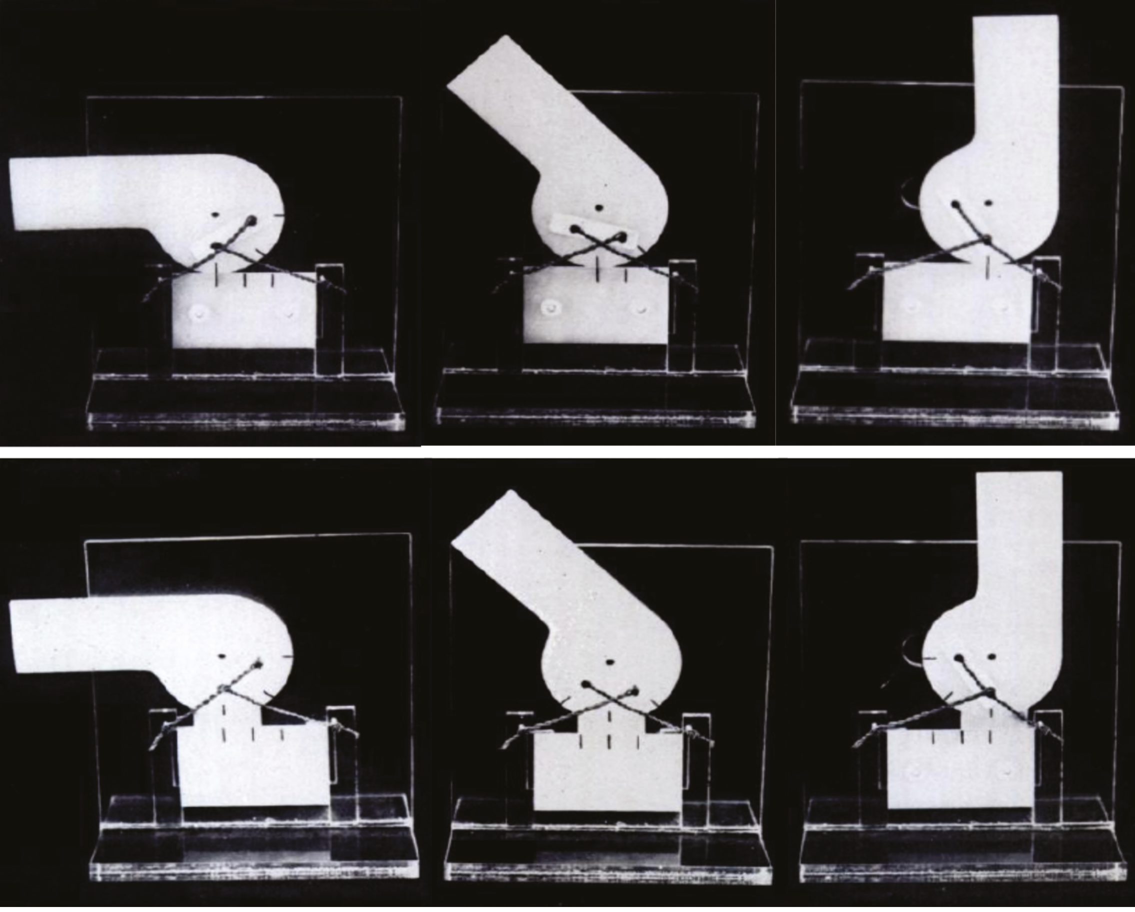


Figure 15: Biomechanical model: importance of the mobile meniscal washer between femur and tibia.

By increasing the contact surface, the meniscal prosthesis reduced constraints. Using this model and based on his articles on constraints in the hip and knee, [52] he developed the concept of the Oxford Knee,[53] and filed a patent (1977, US Patent 21,905) (Fig. 16) jointly with John O'Connor from Oxford and Nigel Shrive from Calgary. [54] They believed the Oxford Knee provided congruency during flexion, little stress at the interfaces and less wear.

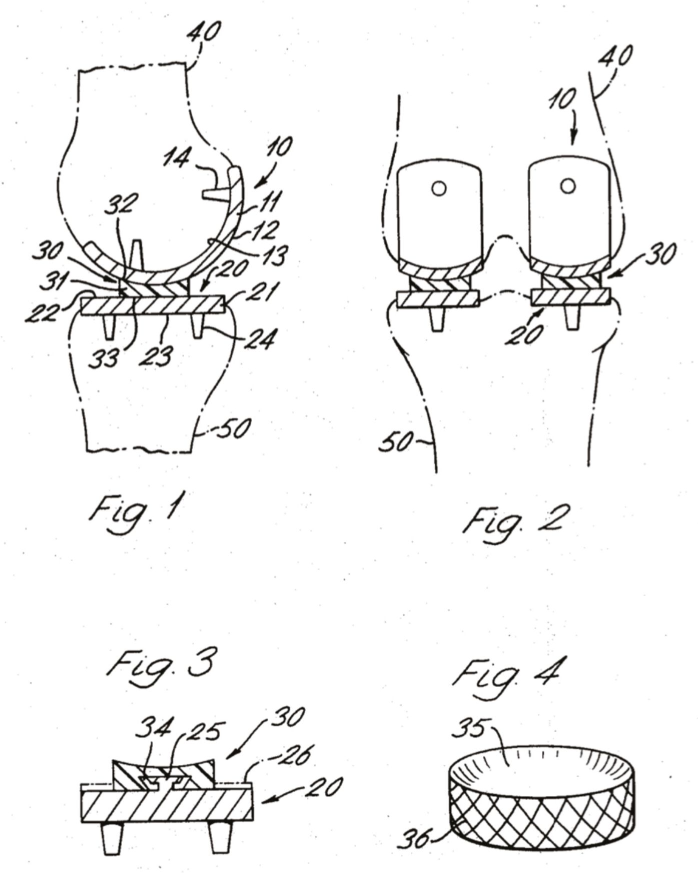


Figure 16: Oxford Knee: 1978 patent design.

Initially the prosthesis was used for bilateral osteoarthritis, but in 1982 it began being used for isolated single-compartment disease. In 1988, Goodfellow et al. published their first clinical findings at 36 months55. They confirmed their very good clinical outcomes and showed that implant wear was minimal, setting it apart from other designs such as the Lotus. [56] They believed the wear rate of the Oxford Knee was negligible, well below that observed with other designs:

- 'The mean wear rate of 0.02 mm/year measured in the vivo study compares favourably with the published results of polyethylene penetration for other forms of arthroplasty which use a metal-on-polyethylene bearing. The value is approximately ten times less than the penetration rates of 0.1 to 0.2 mm/year reported for total hip arthroplasty'.[57]

At 15 years, the clinical results for the Oxford 3 were excellent, [58] confirming the findings of Price & Svard [59] and Liddle [60] who had recorded 92% implant survival at 20 years for the Phase 1 and 2 Oxford models (Figs. 17 & 18).

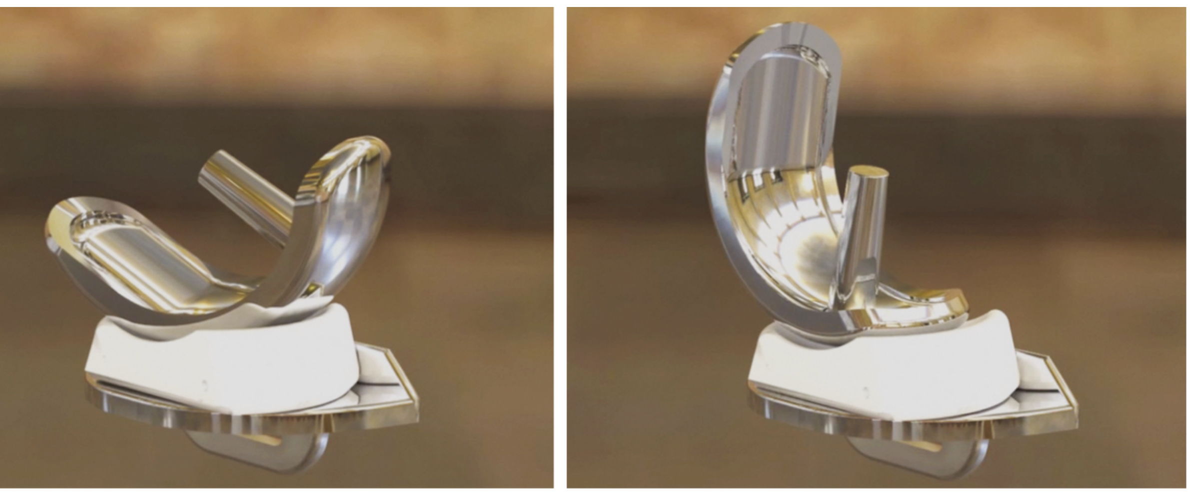


Figure 17: version 3 Oxford Knee.

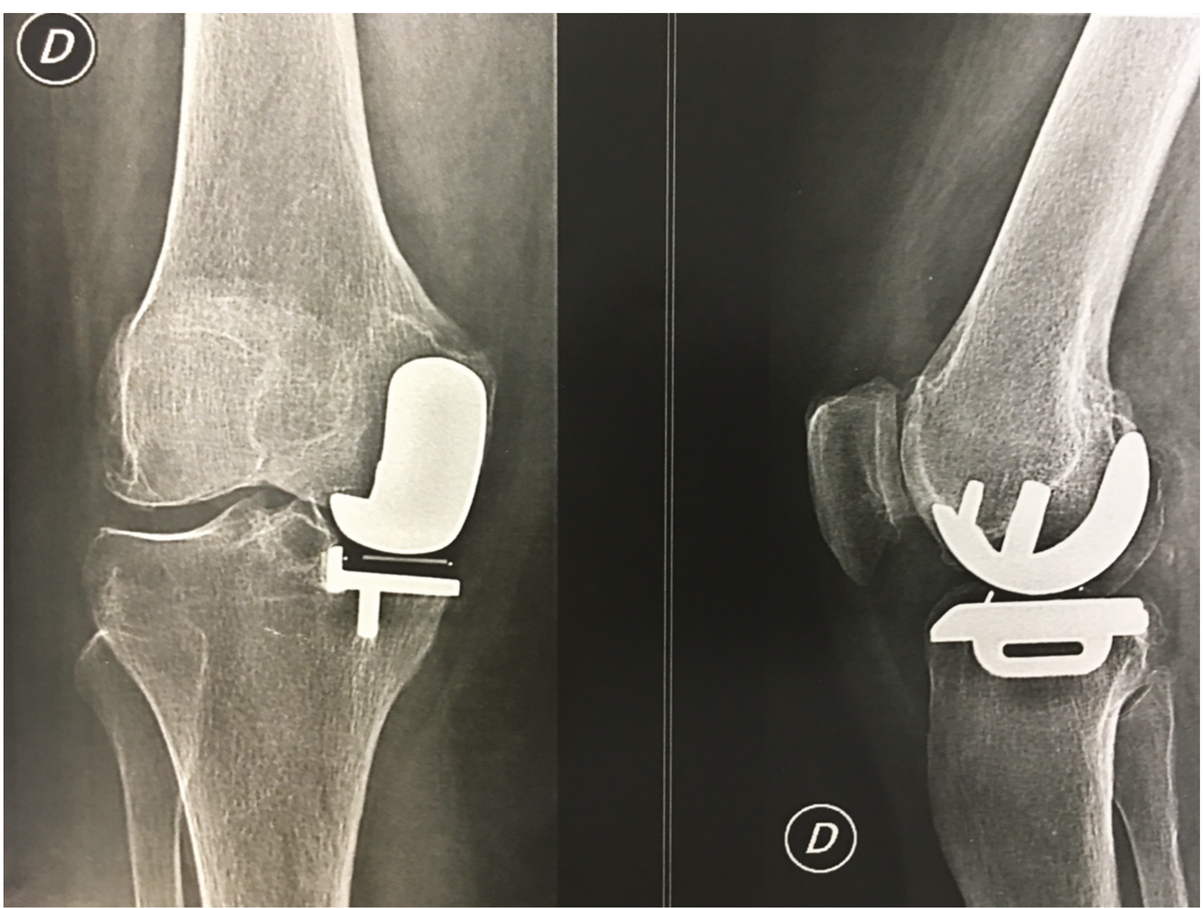


Figure 18: version 3 Oxford Knee X-rays.

CONCLUSION

The unicompartmental knee arthroplasty was conceived over the course of the last century, and represented a shift towards inventive, cautious and respectful surgery, as shown by the clinical and philosophical works of our forerunners.

Let us also not forget the very first procedures, all of which were designed primarily for function, based on a better understanding of patient needs; from Anthony White to Leopold Ollier, surgeons have been driven by a very human desire to correct, restore and treat.

As we move further into the 21st century, the unicompartmental knee arthroplasty has earned its place as a safe and reproducible procedure. In the words of Ahmadou Kourouma, reflecting upon his journey, 'You have to see where you've been to see where you're going'.**[61]**

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