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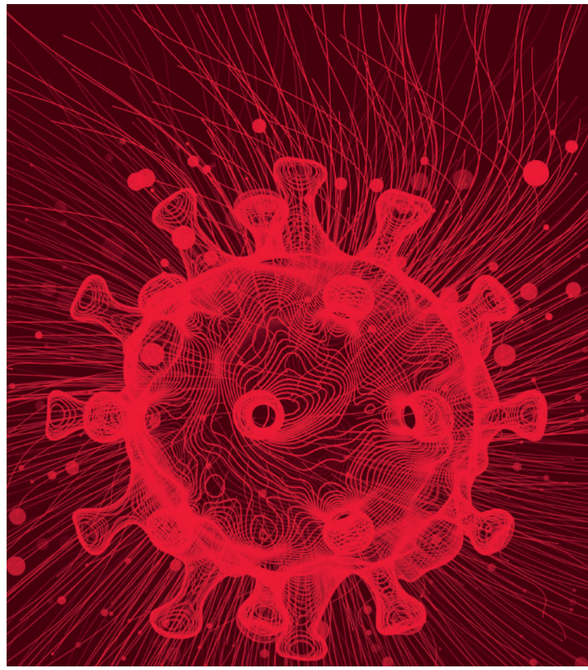

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JOURNAL OF ARTHROSCOPY AND JOINT SURGERY

JAJS

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Journal of Arthroscopy and Joint Surgery (JAJS) is committed to bring forth scientific manuscripts in the form of original research articles, current concept reviews, meta-analyses, case reports and letters to the editor. The focus of the Journal is to present wide-ranging, multi-disciplinary perspectives on the problems of the joints that are amenable with Arthroscopy and Arthroplasty. Though Arthroscopy and Arthroplasty entail surgical procedures, the Journal shall not restrict itself to these purely surgical procedures and will also encompass pharmacological, rehabilitative and physical measures that can prevent or postpone the execution of a surgical procedure. The Journal will also publish scientific research related to tissues other than joints that would ultimately have an effect on the joint function.

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2. The interviews are slated for April 2021 in New Delhi when the recruitment team will be visiting India. The exact dates and venues will be confirmed in due course.
3. **Having cleared the IELTS exam** before the interviews will be of advantage for final selections .
4. The Clinical posts would start in July 2021 although if candidates were to be interested for August 2022 start, they could still apply.
5. The MCh course is at the Edge Hill University and although most of the payment for the course can be made along the way in installments over the 2 years, there would be an initial Commitment of £8,000 to be made to secure the place before the formalities with Royal colleges and GMC are commenced at this End. The salary scales are detailed with the information sheet as well.
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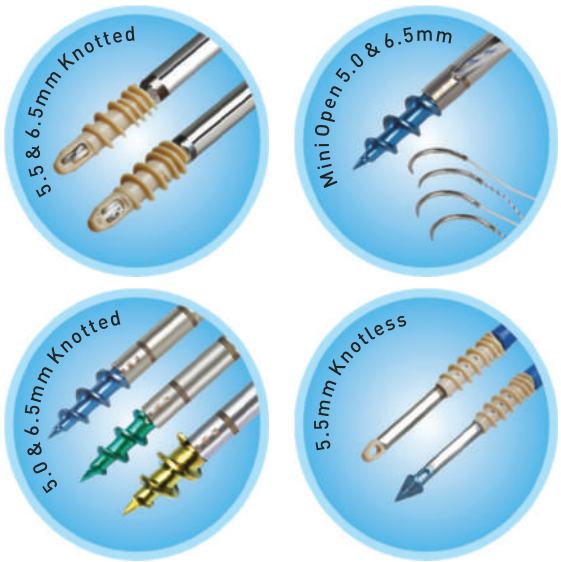

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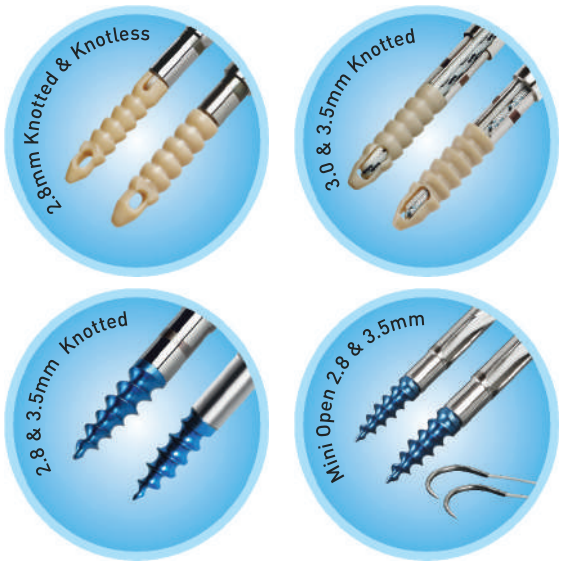

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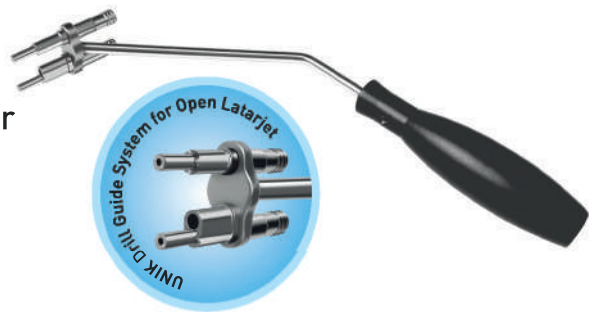

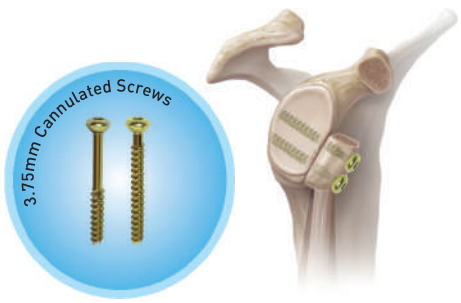

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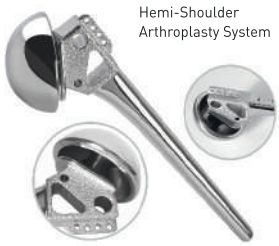

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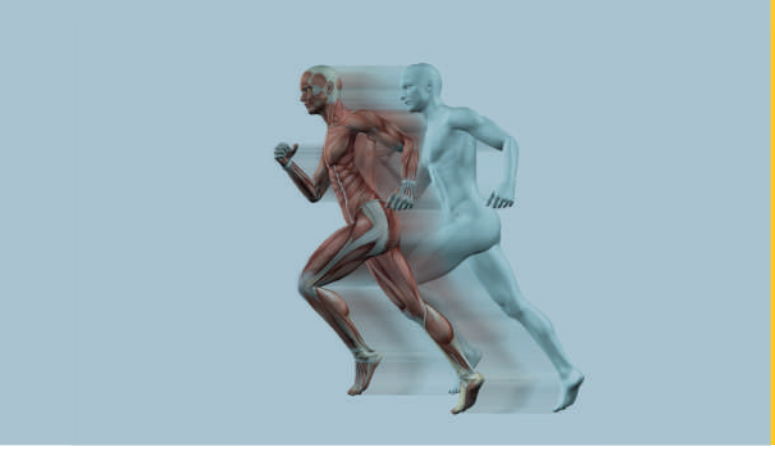

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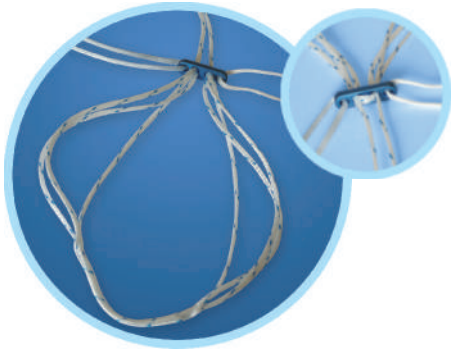

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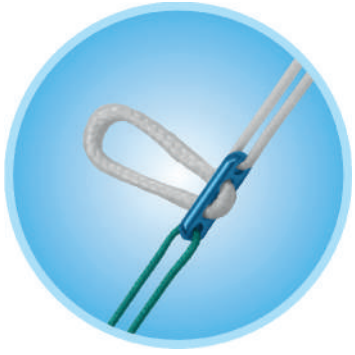

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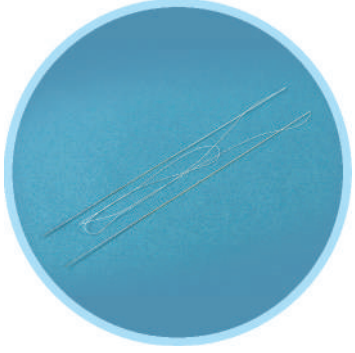

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Editorial

Editorial comment

Focus on Shoulder and Elbow arthroplasty

Shoulder arthroplasty has seen an exponential rise over the last decade. There were about 2500 primary shoulder replacement procedures performed in the UK in 2012, and this number increased to more than 7500 in 2019. Simultaneously there has been a decline in numbers of hemiarthroplasty procedures and a significant increase in the numbers of reverse shoulder arthroplasty procedures, which now account for nearly 2/3 of all primary shoulder arthroplasties.[1]

The types of prostheses being used has also seen a change with resurfacing procedures seeing a decline and increasing popularity of stemless humeral components. The humeral stem and its influence on shoulder arthroplasty is addressed in the paper by *MacSuibhne and Kelly.*

Glenoid component has remained the weak link on shoulder arthroplasty, and there have been ongoing efforts to improve glenoid component, in terms of materials, design and fixation methods. Sircana and colleagues look at glenoid design, modes of failure and prosthetic selection.

Reverse arthroplasty is now the most common type of shoulder arthroplasty and the indications continue to broaden with increasing numbers in proximal humeral fractures in the elderly.[1] There continues to be an evolution in designs of reverse arthroplasty with changes in neck shaft angle, and offset, which aim to address notching, and improved functional outcomes in terms of restoration of rotations. The biomechanical principles that drive these design changes are addressed in the paper by Sabharwal and Bale.

As the number of primary procedures has gone up there has been a corresponding increase in revision arthroplasty. A well performed primary arthroplasty procedure should not only improve clinical outcome, but also improve the longevity of the prostheses. Technological advances including Computer software for planning, Patient specific implants and Navigation. Tambe et al. explore the role of navigation for shoulder arthroplasty.

Numbers for Elbow arthroplasty are significantly less than the numbers for Shoulder arthroplasty, but over the last decade there has been a change in the indications. While inflammatory arthritis was the commonest indication for Elbow arthroplasty a decade ago, most elbow replacements are now performed for acute trauma.[2]

The evolution of designs of elbow arthroplasty is addressed by Shah and Patel, while Challangudla et al. look at common challenges of elbow arthroplasty with technical tips to deal with these.

The increasing numbers of upper limb arthroplasties, differing techniques and numerous prosthetic designs and systems pose a challenge not only to the budding surgeon but even to a well practiced clinician. It is hence important that the principles that underpin successful arthroplasty are studied and understood by everyone who embarks on arthroplasty in the upper limb. This will ensure that correct choices are made, desirable clinical results are achieved and we have met our patients' expectations.

This special issue is an attempt to address this very important issue and facilitate a focussed discussion that should endure in the long term.

We hope that the spectre of 2020 and Covid 19 is behind us and we wish you all a safe, enjoyable and enlightening 2021.

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Review article

History of shoulder arthroplasty

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ABSTRACT

Since the end of the 19th century, when the first shoulder prosthesis was implanted, an impressive development took place, leading to many different designs, based on the philosophy of either an anatomic replacement or the inverse prosthesis for shoulders with an absent or insufficient rotator cuff. An overview is given on these developments from the beginning to the present.
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1. Introduction

The first joint prosthesis implanted in the body was a total shoulder prosthesis. The procedure was carried out in 1893 in Paris (France) by a surgeon Jules Emile Péan for the treatment of tuberculosis of the shoulder.[1]

He firstly developed an ivory implant, based on the work of the German surgeon Themistocles Gluck,[2] who implanted several ivory prostheses in knee, hip, wrist and elbow, mainly for the treatment of tuberculosis. However Péan never used this ivory prosthesis out of concern of its mechanical properties.

A new prosthesis was constructed for him by a Parisian dentist who specialized in prosthetic development. It was made of an iridescent platinum tube with screw holes at the distal end for attachment to the humeral bony stump, a hardened rubber ball with 2 metal loops inserted into a groove for attachment to the glenoid and to the proximal aspect of the stem (Fig. 1). It was implanted in a young patient with end stage tuberculosis in the shoulder, who refused an amputation. It lasted for 2 years, chronic fistulae developed and finally it was removed, after which the sepsis subsided. Interestingly, on the radiographs a shell of bone was surrounding the metal implant.

This was the first metal implant in the body, preceding the first metal total hip, which was implanted in 1953 and the first metal total knee in 1973.

In the 1950s several new designs were introduced, made of plastic (acrylic,polyamide or polyethylene) or metal.

The main indications were fractures or tumours.

Richard[3] as well as Borin4 from France implanted an acrylic prostheses for proximal humeral fractures (Fig. 2); even though the tuberosities were fixed to the acrylic head, the function was generally poor.

In the Royal National Orthopaedic Hospital in the U.K. a polyethylene prosthesis, fixed to the humerus with plates and screws, was used following tumour resection; all of them failed due to loosening of the plates.

1.1. Metal implants since 1950

Krueger[5] implanted the first metal anatomic hemiarthroplasty in 1950, made of chrome-cobalt alloy (vitallium), for treatment of avascular necrosis of the humeral head, resulting in a well functioning shoulder without pain.

1 year later Neer developed a shoulder prosthesis for patients with poor function and pain after a fracture.

He worked in his early days in a fracture department and was intrigued by the pathology of the shoulder fractures, which led him to develop a hemiarthroplasty as well as a classification system of proximal humeral fractures. He focused on a design made of inert material with an elasticity close to bone, mimicking normal anatomy and including sufficient anchorage with a long stem in the bone to avoid bone resorption (Fig. 3). He published the results of this Neer I in 1955 with good results.[6]

In the early 1970s both in the US[7] and in Germany US[8] independently polyethylene glenoid components were developed, combined with the Neer I prosthesis, which stimulated Neer to develop his Neer II prosthesis, usable as a non constrained

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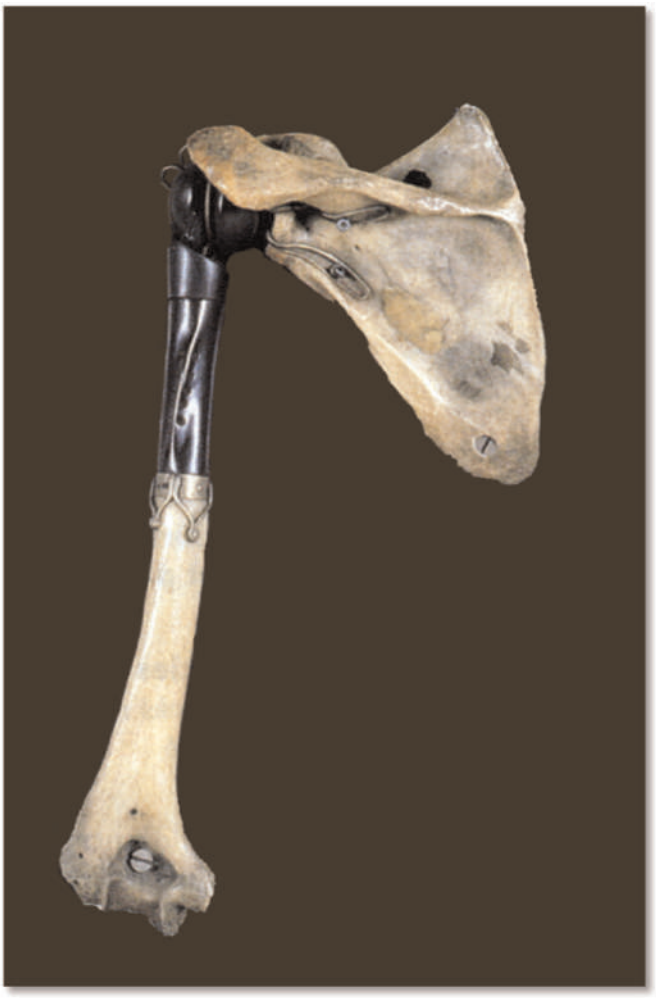

Fig. 1. Constrained prosthesis of Péan of platinum and rubber.

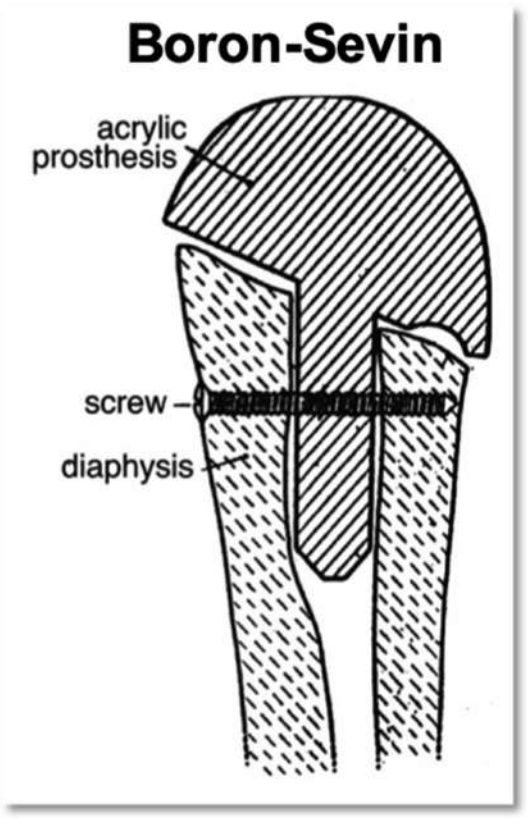

Fig. 2. Borin-Sevin devised an acrylic prosthesis for fractures.

prosthesis in arthritis. This system however did not solve the problem of a deficient cuff, for which he developed a fixed fulcrum prosthesis, the Mark 1.

In the UK, the Stanmore prosthesis was introduced in 1972 for rheumatoid arthritis; it is a ball/socket configuration and looks like a hip prosthesis. Being a constrained design the authors reported a rather high loosening rate of the glenoid component and disappointing results.

In the US a similar type of constrained fixed fulcrum prosthesis was developed by Post,[9] with initially a stainless steel and later vitallium humeral stem and a combined polyethylene/metal glenoid component. This prosthesis also showed a rather high rate of complications, mainly dislocations and loosening.

Swanson[10] developed a bipolar shoulder prosthesis, with an unfixed metal cup with polyethylene liner articulating with a small ball of the humeral titanium cemented stem; the main indication was rheumatoid arthritis and in arthritic shoulders without cuff.

In this innovative period, when many designs appeared, Neer showed the best results with his total shoulder prosthesis and therefore paved the way for further developments, based on his type II prosthesis with a long anatomical stem and polyethylene glenoid component.

1.2. Developments on humeral side

While the Neer II prosthesis was a monoblock stem, in the 1980s modularity was introduced in the second generation, consisting of a stem as well a separate head of several sizes, increasing the variability of the anatomy of shoulder.

Walch and Boileau,[11] based on extensive anatomical studies, showed the wide variety of the anatomy of the proximal humerus, with variation in the retroposition, inclination and offset of the head related to the humeral shaft axis as well as the retrotorsion related to the epicondylar axis of the elbow. This led to the development of the third generation, with a wide variety of implants enabling to adapt the prosthesis to the anatomy instead of the earlier deigns where the anatomy was adapted to the available prostheses.

Following the trend in hip arthroplasty in the last decades shorter stems were introduced, mainly relying on metaphyseal support.

The first implants in shoulder arthroplasty were made of Vitallium, a Chrome/Cobalt alloy, later on added with Molybdenum for increasing strength. In the 1980s implants of a TitaniumAluminum/Vanadium were introduced. Presently both alloys are now widely used, either with a smooth surface, where cement is needed for fixation or they are enhanced with a variety of surface modifications, either porous coated or calcium phosphate coating with hydroxyapatite to promote ingrowth in a so-called press fit fixation.

Another development was the introduction of bone preserving implants.

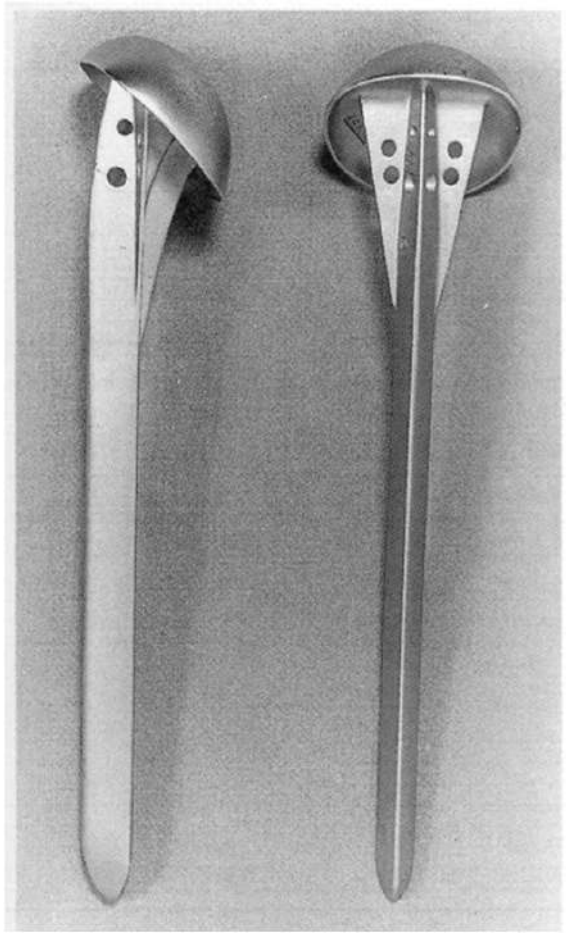

Fig. 3. Neer's first design of a vitallium prosthesis, primarily developed for fractures.

Zippel[12] was the first surgeon to publish a report in 1975,describing the use of a metallic humeral shell used to resurface the humeral head while articulating with a polyethylene glenoid component. Resurfacing became popular at the end of the twentieth century with good results, largely published by Copeland.[13]

Building on this concept, a 4th generation, stemless implant was evolved, the TESS[14]; for this prosthesis the head is resected and fixation is only in the metaphysis, based on metaphyseal fixation; in some later designs stability is achieved by placing the circumference of the humeral implant on the cortical bone of the neck after resection of the humeral head;

With this type of implant the approach to the glenoid is easier compared to the surface replacement, by still avoiding the stem-related problems. This caused the decline of surface replacement and might probably surpass conventional stemmed arthroplasty in the future.[15]

1.3. Developments om glenoid side

Since the introduction of the first glenoid component, designed by Kenmore,[8] composed of UltraHigh Molecular Weight Polyethylene(UHMW PE) this material has shown a long track record.

Since the beginning 2 variations for fixation in the glenoid have evolved, either a keeled or a pegged design.

Despite its durability and rather good wear behavior, long term wear and its subsequent periprosthetic osteolysis stimulated research to improve this polyethylene, leading to Highly cross linked UHMW PE(HXLPE), created by a radiation and sterilization process. Another development involved the addition of an anti-oxidant stabilizer, Vitamin E, with the aim to inhibit oxidative degradation.

Cofield[16] in the 80ties was the first to use a metal backed glenoid component with a polyethylene liner. There was a high rate of lucency on the long term. Many other designs have since then emerged, e.g hybrid metal/polyethyelene without metal on the glenoid surface.[17]

Another recent development is the inlay design, where the polyethylene component is inserted in the glenoid, leaving its surface flush with the remaining glenoid.

1.4. Reverse arthroplasty

Between 1970 and 1973 Neer developed 3 types of a reverse prosthesis, because he had a high failure rate of his anatomic prosthesis in patients with a deficient cuff. The Mark I had a larger ball to allow more motion, but limited the refixation of the cuff. The Mark II had a smaller ball for reattachment of the cuff; the smaller cuff however decreased the range of motion. To improve the excursions the Mark III had again a smaller ball, to allow cuff attachment but an axial rotation element in the humeral stem to facilitate a better motion.

The glenoid implant was cemented. Due to a high failure rate he abandoned further development.

In Europe the first reverse prosthesis was developed by Reeves[18] in 1972 for patients with a deficient cuff. It consisted of a glenoid component with a diverged threaded peg, which was cemented in the glenoid. It had an anatomic center of rotation (Fig. 4).

Since then several constrained prosthesis were described, with a small metallic sphere to reproduce either an anatomic or even lateralized center of rotation.

Gérard[19](Fig. 5) published in 1973 the early results of a reverse total shoulder prosthesis, with a metal glenoid plate fixed with 2 screws in the scapula and a hole in the center where a 20 mm metal sphere was screwed into the plate. The humeral component consisted of a polyethylene semi-retentive cup fixed on a metal stem. In contrast to the implants from Neer and Reeves, this was the first uncemented glenoid component.

The Kölbel prosthesis was developed for reconstruction after tumour resection.The glenoid component was cemented as well secured with a flange, that was screwed to the base of the scapular spine or the scapular pillar.[20]

Kessel[21] introduced in 1973 a design with a large screw in the glenoid and a polyethylene humeral stem, also creating an

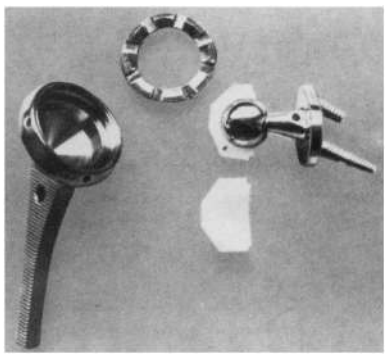

Fig. 4. First reverse prosthesis by Reeves.

Fig. 5. Gérard-Lannelongue reverse prosthesis.

Fig. 6. The "Trompette ", Grammont's first design of a medialized reverse, with a polyethylene humeral component and alumina-ceramic 2/3 sphere.

anatomic center of rotation. He published in 1979 on 21 patients with overall good results. Although there were failures, no loosening of the glenoid component was reported.This model was later modified by Bayley and Walker, with the screw coated with hydroxyapatite, the center of rotation was moved medially and distally.The humeral component was changed to metal with a polyethylene retentive liner.

Several other designs were presented:

The Liverpool shoulder was designed in 1969 by Beddow and Elly[22] and was based on a reverse hip prosthesis: the glenoid component and stem were cemented in the scapular pillar, a polyethylene cup was cemented in the proximal humerus.They reported a high failure rate.

Fenlin23 made a larger polyethylene glenoid sphere articulating with a large cup on a metal stem. He was concerned about the scapular fixation and to overcome this problem he designed a glenoid component with 2 extensions, to be fixed in the most dense cortical bone, namely in the base of the coracoid and the scapular pillar. The deltoid function improved, but there was a high failure rate at long term follow-up. Buechel[24] introduced in 1978 a double mobility cup, facilitating motion between the glenoid sphere and a polyethylene ball, which in turn articulated with the humeral metal cup. The Gristina trispherical system was also a constrained system, including a small humeral metal ball and a small glenoid metal ball,that both articulated with a large, central polyethylene sphere.[25]

1.5. Grammont

While all the above implants were not very successful and many abandoned further use, Grammont's design provided a revival of the concept of the "reverse" philosophy: His basic concept was to medialize and lower the center of rotation(COR) compared to the place where it is normally found. The rationale was, that with a medialized COR the deltoid lever arm would be increased, leading to a better function.[26]

His first design in 1985 ("Trompette prosthesis" (Fig. 6), consisted of a two-thirds of a alumina ceramic sphere, which was fixed with cement to the glenoid. Although elevation was at or above

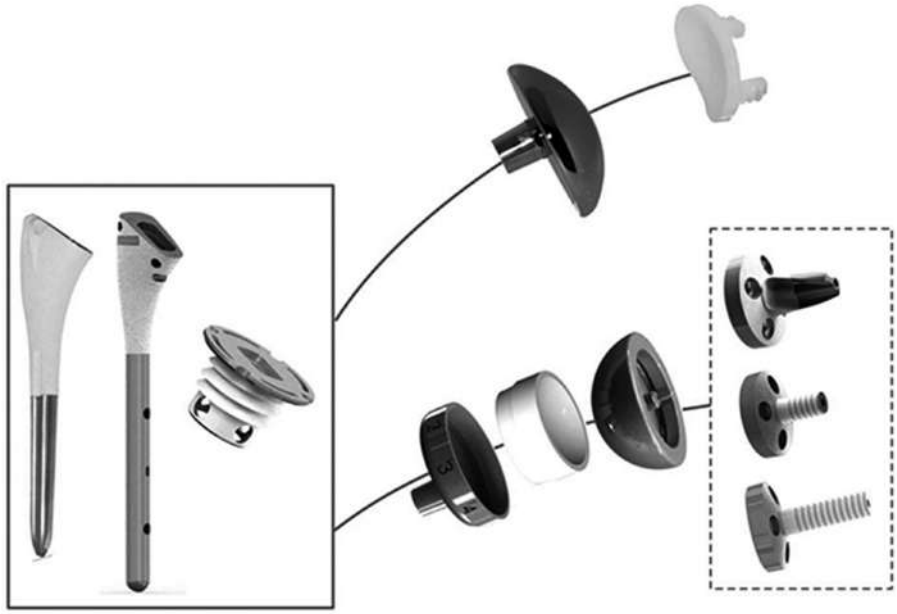

Fig. 7. Contemporary "platform" system, with a stemmed and stemless variant.

100^0, loosening was seen. Subsequently he changed the glenosphere to a hemisphere, thus even more medializing the COR. He also changed the fixation, making a baseplate, which was fixed with a central peg and 2 diverging screws, counteracting the shear forces. This led to the first modular prosthesis in 1991, the Delta III, consisting of 5 elements, an uncemented baseplate, a gleno(hemi) sphere, a polyethylene liner, a cemented or un cemented neck and stem.

From the 1990s, the Grammont system was adopted by many shoulder surgeons for the treatment of cuff deficiency, as it was superior to all other systems.

Since the introduction of the reverse prosthesis extensive research has been carried out, to overcome 2 problems of this philosophy: notching and poor rotations. Designs with a more lateralized center of rotation try to solve these problems. Presently more than 25 variations are available on the global market.

2. Conclusion

Nearly 130 years passed since the first shoulder prosthesis was implanted. It took a long journey with several interesting designs, but the concepts of Neer for the anatomic prosthesis and of Grammont for the reverse prosthesis were the golden standard and formed the basis for further development.

Presently newer designs offer the possibility to implant an anatomic or reverse prosthesis on the same humeral stem or stemless implant ("platform" systems, Fig. 7).

Newer technologies, like navigation or, as alternative, PSI (patient-specific instrumentation) have increased the accuracy of implanting the prosthesis.

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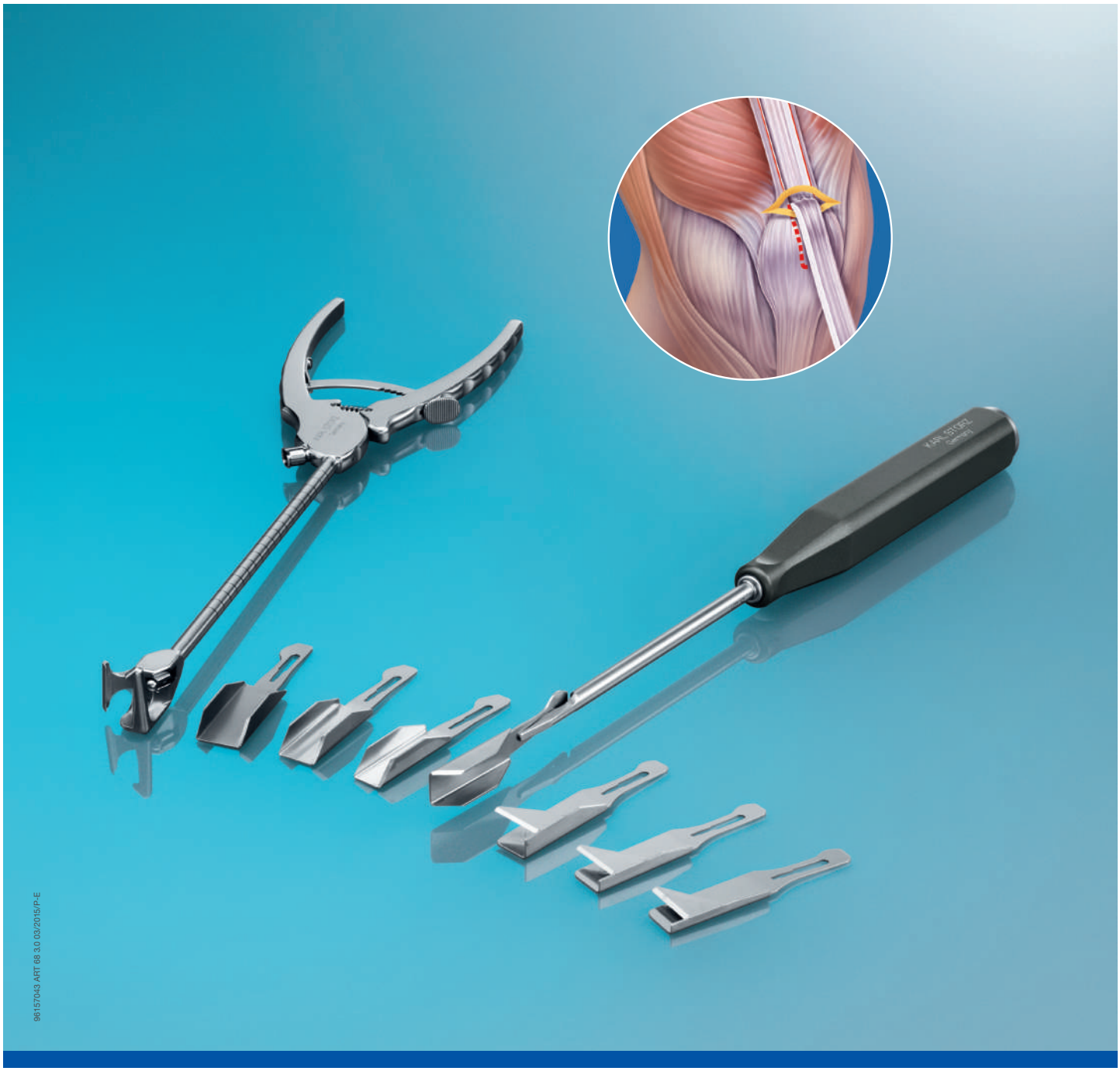

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