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ISKSAA International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

ISKSAA (**I**nternational **S**ociety for **K**nowledge for **S**urgeons on **A**rthroscopy and **A**rthroplasty) is a society of orthopaedic surgeons from around the world to share and disseminate knowledge, support research and improve patient care in Arthroscopy and Arthroplasty. We are proud to announce that ISKSAA membership has crossed the **1600** mark (India & Overseas) making it the fastest growing Orthopaedic Association in the country in just over 4 years of its inception . With over **300000 hits from over 157 countries** on the website **www.isksaa.com** & more and more interested people joining as members of ISKSAA, we do hope that ISKSAA will stand out as a major body to provide opportunities to our younger colleagues in training, education and fellowships.

Our Goals.........

- To provide health care education opportunities for increasing cognitive and psycho-motor skills in Arthroscopy and Arthroplasty
- To provide CME programs for the ISKSAA members as well as other qualified professionals.
- To provide Clinical Fellowships in Arthroscopy and Arthroplasty
- To provide opportunities to organise and collaborate research projects
- To provide a versatile website for dissemination of knowledge

ISKSAA Life Membership

The membership is open to Orthopaedic Surgeons, Postgraduate Orthopaedic students and Allied medical personal interested in Arthroscopy & Arthroplasty.

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- Eligibility to apply for **ISKSAA's Prestigious Fellowship Programme** . We are finalising affiliations with ESSKA , ISAKOS , BOA , BASK , Wrightington and FLINDERS MEDICAL CENTRE , IMRI AUSTRALIA to provide more **ISKSAA Fellowships** in India , UK , USA , Australia and Europe . **We awarded 14 ISKSAA Fellowships in Feb 2013 , 6 ISKSAA IMRI fellowships in Feb 2014 , 54 ISKSAA fellowships in September 2014 , 22 ISKSAA wrightington MCh fellowships in December 2014 , 40 ISKSAA Fellowships in October 2015 , 15 ISKSAA Wrightington MCh Fellowships in December 2015 , 61 ISKSAA Fellowships in November 2016 and 56 ISKSAA Fellowships in Chandigarh in October 2017**
- **Free Subscription** of ISKSAA's official , SCOPUS INDEXED , EMBASE INDEXED peer reviewed , online scientific journal **Journal of Arthroscopy and Joint Surgery (JAJS**).
- **The next round of ISKSAA fellowships interviews will be in ISKSAA LEEDS UK 2018 in June 2018 where we are offering over 60 ISKSAA Clinical fellowships along with the ISKSAA Wrightington MCh Fellowships .**
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ISKSAA GLOBAL SUMMIT

18th - 22nd June 2018 | Leeds, UK

ISKSAA 2018 GLOBAL SUMMIT

18th - 22nd June 2018 | Leeds Beckett University

International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

We are all geared up for the first ever overseas ISKSAA EVENT the

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to be held from 18th June - 22nd June 2018 at Leeds, London and Wrightington, UK under the leadership of Dr Sanjeev Anand (Congress President). The Congress is the signature event of ISKSAA (International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty) & we are proud to announce that ISKSAA membership has crossed the 1600 mark . With over 300000 hits from over 155 countries on the website www.isksaa.com & more and more interested people joining as members of ISKSAA, we do hope that ISKSAA will stand out as a major body to provide opportunities to our younger colleagues in training, education and fellowships

It promises to be an action packed affair with

- Participation of Top UK Centres & Surgeons
- Delegate strength of 500
- Live Surgeries transmitted from various centres in the UK and overseas
- 60 ISKSAA Clinical Fellowships and ISKSAA Wrightington MCh Fellowships Interviews
- 40 ISKSAA Accredited One week Clinical Fellowships pre & post event for ISKSAA members
- 40 One day Visitations at several centres across UK
- Pre-conference Cadaveric Workshops on PELVIS & ACETABULUM, SOFT TISSUE KNEE RECONSTRUCTION in Leeds 2 delegates / 1 body part / 1 faculty ratio

We invite you to participate in ISKSAA Leeds UK 2018 which may prove to be another historic milestone in the history of ISKSAA

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1. The interested candidates are encouraged to look at the University website link . The programme is aimed at motivated candidates who wish to come to UK to obtain 2-3 years of clinical experience, specialist surgical training and an MCh degree from Wrightington Hospital and Edge Hill University.
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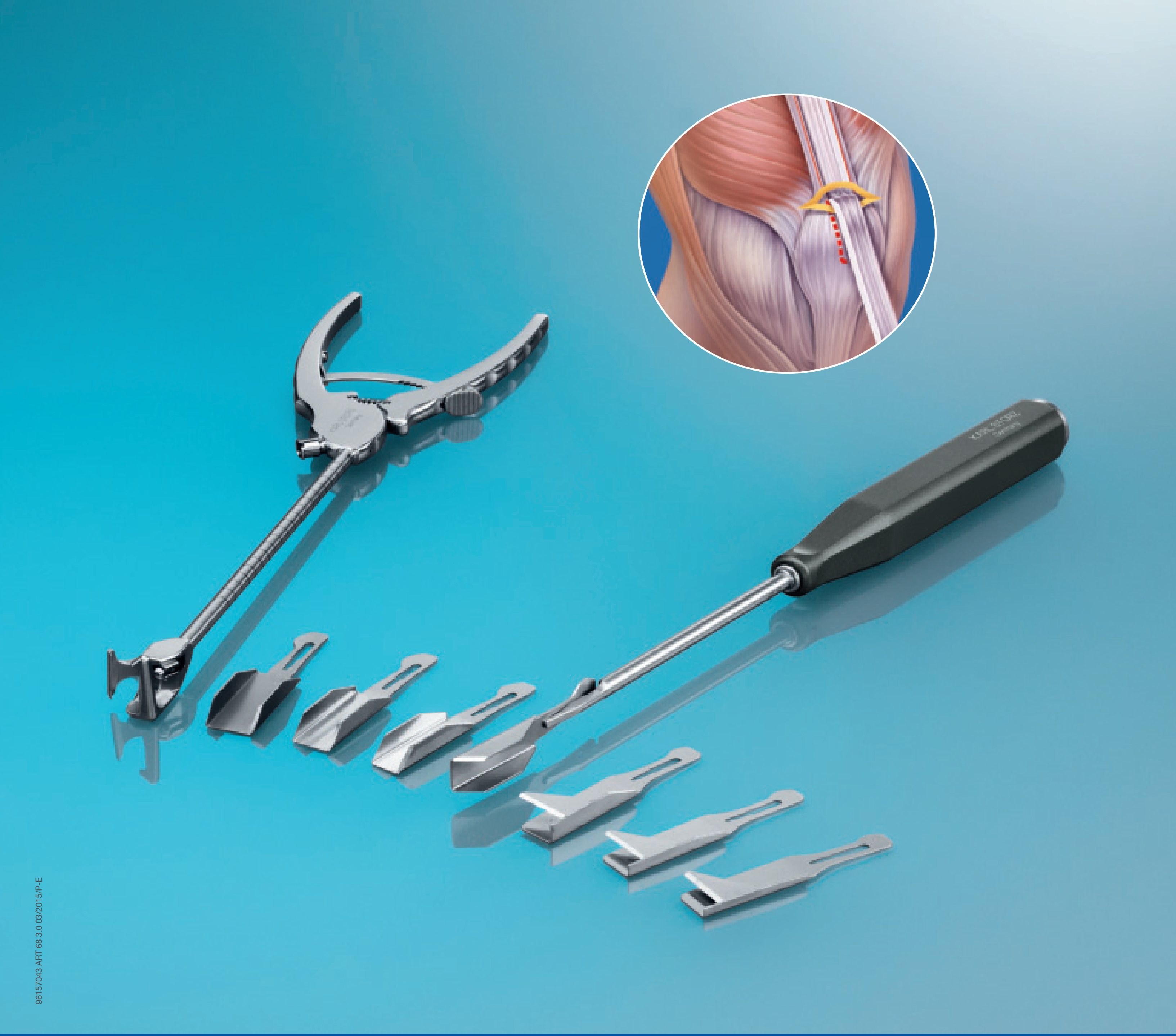
3. The interviews are slated for 22nd June during ISKSAA GLOBAL SUMMIT LEEDS UK 2018 in Leeds , UK .
4. **Having cleared the IELTS exam** before the interviews will be of advantage for final selections .
5. The Clinical posts would start in August 2019 although if candidates were to be interested for Aug 2020 and August 2021 start, they could still apply.
6. 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 £17,500 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.
7. There will be two posts per year as the "Wrightington - ISKSAA MCh Fellowship". There would be an **assured Wrightington placement** during the 2-year UK rotation via this stream . **Only ISKSAA Life Members can apply for these posts** .



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Aims and Scope

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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Editorial

Simsalabim**—Simulation in (Orthopaedic) training

Recently, on a day of 'Open Doors' at the University Hospital I am working at, we showed the newly built surgical theatre to the public. Many visitors strolled through the rooms and were impressed by the technology which was on display.

An arthroscopy simulator (knee, shoulder) was on display. And it created interesting discussions with the audience. Some were potential patients. After the demonstration one visitor said:

> 'Let the trainees work on simulators before they touch my knee – and everything will be fine'

Really?

Teaching and learning is a complex task. Especially in technical professions.[2,6,7,9]

Simulation is standard in teaching and training of many professions which do require specific skills – and in which failure to master those skills may result in costly and life-threatening disasters: Airline pilots, train drivers, captains of cargo ships and oil tankers, nuclear power plant controllers, as a few examples.

It is not yet standard in medical education. Some exceptions are known, however.[11]

All the professions mentioned above do heavily rely on simulation based training. As early as 1910 the first 'simulators' were utilized in aviation pilots training.

In avionic simulators normal interpersonal functioning in the cockpit as well as any imaginable disasters and catastrophic scenarios can be trained and can be repeated as many times as necessary; until the trainee and/or his group are able to master the complication.

Airline pilots are re-certified at pre-defined time intervals and recertification does take place on simulators.

Simulator training is a well established part of the structured training and re-evaluation procedures. This is in contrast to most surgical specialties in most countries of the world,

Shouldn't we introduce more formalized simulator training in orthopaedic surgery?

Actually simulation based training has a long history in orthopaedic and trauma surgery, Since 1958 the AO (Arbeitsgemeinschaft Osteosynthesefragen) has revolutionized fracture treatment by standardizing surgical procedures and by training numerous surgeons on plastic bones.[5] A crude simulation, sure. However it helped to get similar level of expertise worldwide. Training programs were clearly structured and are now being offered worldwide.

One procedure, one standard.

Today's trainees – and their teachers – are faced with several problems:

- Exposure to cases: Due to work-hour regulations in most countries of the world the trainees do get less exposure to actual surgical tasks than ever before.
- Patients expectations: Patients are today more aware of quality in surgery and they do less and less accept to be (mis)used as a training object for young trainees.
- Health care costs: There is increased pressure on health care providers to optimize any procedures. Hospital authorities do make every effort to streamline surgical procedures and to minimize any extra time on any surgical procedure. There is less and less time for teaching at the bedside, or as in our case, at the OR-Table. The procedure has to be completed as quickly and as efficient as possible.

Surgical simulation has shown to be able to give a solution to the problems mentioned above.

However: Simulation has to be tightly incorporated into a very well structured training program for trainees.[13,14] Intermediate and final (surgical skill) goals have to be outlined. Standards have to be defined. Simulation shall no longer be a nice 'add-on' to the curriculum but has to become an essential part of young surgeon's training – well supervised and regularly evaluated.[1,12]

And simulation may well become the most important tool for re-certification of our surgeons. To the safety and well-being of our patients.[3]

Newer technologies will evolve in simulation. There will be soon possibilities to train today on the virtual knee of the patient whom you will operate on tomorrow, based on the MRI the patient will present. Special haptic feedback will provide even more realistic simulations of arthroscopies of shoulders, knees, hips, ankles etc. 3D imaging will become even more realistic.[3,8,10]

However no simulation will be getting you to become not only an average surgeon but to become a very good surgeon. There is a

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parallel statement from the airline industry (Fred George) *Sim training has long been recognized as essential to safety of flight. It's so rigorous, it's almost gained the stature of a professional rite. But sim training alone does not guarantee you have all the knowledge and skills to be truly safe in the cockpit.*[4]

Let's get our trainee to the simulators.

And let's get our training curriculae be adapted accordingly.

Simsalabim**[1].

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[1] **Sim Sala Bim: Codeword used by magicians, after Ali Sim-sala-bim, a desert wanderer and a magician.

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Review article

Shoulder arthroplasty—Past, present and future

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ABSTRACT

Shoulder arthroplasty is one of the most successful procedures to treat end stage arthritis of glenohumeral joint. It was popularised and pioneered by Dr Charles Neer around 50 years ago but the indications, implant designs as well as techniques for performing this procedure are continuously evolving. Amongst all orthopaedic joint replacements, it is the most rapidly growing with a seven fold increase envisaged over the next 15 years. This article discusses the evolution, current trends and the future direction of shoulder arthroplasty.

Contents

1. Introduction

Shoulder arthroplasty is one of the most successful procedures to treat end stage arthritis of glenohumeral joint. It was popularised and pioneered by Dr Charles Neer around 50 years ago but the indications, implant designs as well as techniques for performing this procedure are continuously evolving. Shoulder arthroplasty is the most rapidly growing procedure amongst all orthopaedic joint replacements with a seven-fold increase envisaged over next 15 years. This article discusses the evolution, current trends and the future direction of shoulder arthroplasty.

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2. Indications

Shoulder arthroplasty is indicated for Primary as well as secondary glenohumeral arthritis, inflammatory arthropathy (rheumatoid arthritis), osteonecrosis, post-traumatic arthritis, cuff arthropathy. It is also increasingly used for proximal humeral fractures. The two main types of shoulder arthritis are glenohumeral arthritis and rotator cuff arthropathy. These two conditions completely differ in terms of biomechanics as rotator cuff is mostly preserved in pure glenohumeral arthritis, whereas in the cuff deficient shoulder the humeral head subluxes superiorly due to unopposed deltoid force causing it to articulate with undersurface of acromion. Patients with glenohumeral arthritis usually require an anatomical replacement, whereas the patients with cuff arthropathy require reverse geometry shoulder replacement. Combined data from national arthroplasty registries to cover

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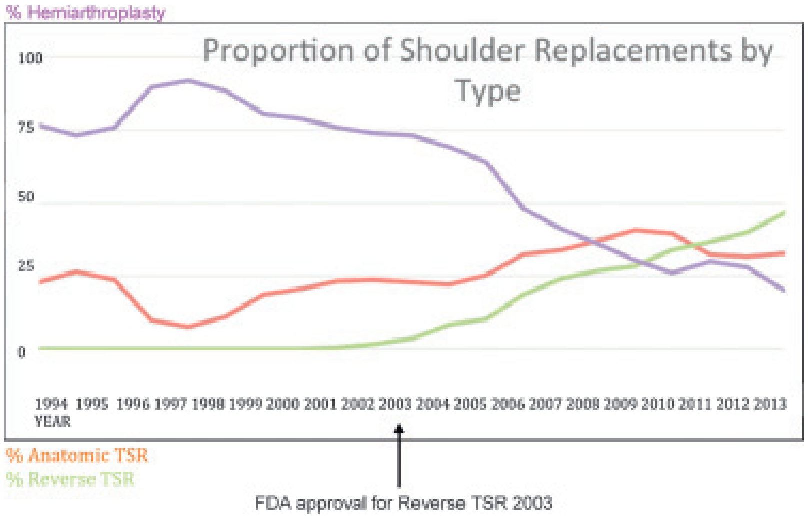

Fig. 1. Shoulder Arthroplasty Trends: Combined data from international shoulder registries- Presented at the Wrightington Arthroplasty meet March 2016. (E Griffiths, P Monga).
% Hemiarthroplasty FDA approval for Reverse TSR 2003.
% Anatomic TSR.
% Reverse TSR.

the period from 1994 to 2003 are depicted in Fig. 1 and reveal the changing trends over the recent years. It can be seen that since FDA approval of Reverse geometry TSR in 2003 there has been dramatic rise in the use of reverse TSR, where as the use of hemiarthroplasty has steadily declined and the anatomic TSR has remained the same. The resurfacing arthroplasty has steadily declined in popularity.

The American Academy of Orthopaedic Surgeons now recommends Total Shoulder replacement over hemi-resurfacing arthroplasty for glenohumeral arthritis.[1] The demand for shoulder arthroplasty is projected to increase by 755.4% by 2030.[2] Such an increase is not only related to improvement in prosthetic design, but also represents the influence of training. Surgeons with Fellowship training in shoulder surgery are more likely to perform total shoulder replacement over hemiarthroplasty for glenohumeral arthritis.[3] It has also been noted that fellowship trained surgeons are 5 times more likely to use arthroplasty for fractures and 20 times more likely to use a reverse polarity shoulder replacement.[4]

The exact reason for decline in resurfacing is difficult to explain. However there is growing evidence to show that long-term results of TSR are better than hemi-resurfacing arthroplasty for pain relief, range of motion and patient satisfaction.[29] The notion that the resurfacing will have advantage of preserved bone stock in a younger patient has to be weighed against potential glenoid erosion due to resurfacing making further revision surgery more challenging and difficult.

3. Evolution and design

The first recorded shoulder arthroplasty was carried out by Jules-Emile Péan in Paris in 1893 for a patient with tubercular arthritis. His prosthesis was made of rubber head and platinum stem. This prosthesis was removed at 2 years for persistent tubercular infection.[5] Thermistocles Gluck (1853-1942) was a Romanian surgeon working in Germany. He is widely credited as the first arthroplasty surgeon. He implanted Ivory prostheses in wrists, elbows, shoulders, hips, knees and ankles during 1880s.[6] However his results were not published and fate of these prostheses remains unknown.

The first generation humeral Implants were mono-block implants. In 1950, Krueger performed first modern shoulder arthroplasty with an anatomic shaped humeral implant for a patient with osteonecrosis.[7] Dr Charles Neer pioneered the modern era of shoulder arthroplasty. His mono-block stem was designed for proximal humeral fractures and such a prosthesis was in use from 1953.[8] It was in 1974, that he implanted the first Total shoulder replacement for glenohumeral arthritis.[9] Neer's original prosthesis had single fixed humeral head with variable stem diameters. But this was modified to articulate with glenoid resurfacing and 2 head size options were available in mono-block stem.

The second-generation humeral implants incorporated the concept of modular humeral head sizes and coating for bone ingrowth. Modular heads with different radii of curvature were available. These head components were articulated with the stem through a Morse taper mechanism. It was also possible to alter the height of prosthesis due to different length of stem sizes. Based on the hip joint implants some designs incorporated a collar at the neck of the stem to aid stability when resting against the calcar. These second generation implants, however, did not cater to normal proximal humeral anatomy.

The third generation humeral implants were modeled on anatomic study of proximal humeri. They allow for variability in humeral head diameter, articular surface thickness, inclination, retroversion, posterior offset, medial offset.[11] These components are commonly referred to as anatomic or adaptable. Boileau et al. in an anthropometric study defined these parameters of proximal humerus. According to this study the diameter of curvature of articular surface of humeral head is measured in both the coronal and axial planes. The articular surface diameter is defined as the diameter of articular surface at the level of margin of cartilage (in both coronal and axial planes). The articular surface thickness is defined as perpendicular distance from articular margin to the apex of the diameter of curvature. The inclination angle is the angle between proximal metaphysical axis and that perpendicular to the articular margin plane. The retroversion angle is the angle between a perpendicular to articular margin plane and the trans-epicondylar axis. The medial offset is the perpendicular distance between axial plane containing the center of epiphyseal sphere and the central axis of metaphysical cylinder. The posterior offset is the perpendicular distance between coronal plane containing center of epiphyseal sphere and the axis containing the central axis of metaphysical cylinder. The hinge-point distance is the distance between axial plane containing the axis of the cylinder and the upper border of the articular surface. This study proposed the new concept of prosthetic adaptability in shoulder arthroplasty that allows the correct placement of the prosthetic head, with restoration of normal glenohumeral anatomy and shoulder joint kinematics.[10] These humeral prostheses are anatomic (adaptable) and adapt prosthesis to patient rather than vice versa (Fig. 2).

One can say that currently we are in the era of fourth generation humeral implants, which are platform based. Such systems allow for conversion from anatomic to reverse geometry shoulder replacement without a need to exchange the humeral stem.

There is a wide variety of choice available in context of humeral component design and fixation, ranging from resurfacing of the humeral head to metaphyseal bearing implants, short stemmed implants and classic stemmed prosthesis. Both cement fixation, press-fit fixation and bone ingrowth/on-growth have been used successfully in humeral component fixation. Cemented fixation of humeral component offers immediate stability, is associated with low rate of mechanical failure and allows better implant positioning in osteoporotic bone, proximal humeral fractures and deformity. It also allows addition of antibiotic to prevent infection.

Stemless humeral implants were introduced in clinical practice since last 14 years. They are designed to be implanted in humeral metaphysis with cementless fixation with some form of anchorage. This concept seems quite attractive in younger patient with good bone stock where this type of implant will preserve bone for subsequent revision surgery. The stemless humeral component would be beneficial in cases of proximal humeral deformity (malunion) where a conventional stemmed implant may not be appropriate. The violation of medullary canal is avoided, as well with stemless implant that may have implications in future revision surgery where a risk of humeral shaft fracture would be minimal. However long-term studies are lacking and we need more data to confidently advocate the use of these implants in routine clinical practice.

Neer implanted his glenoid component for glenohumeral arthritis in 1974. This was a keeled, rectangular metal backed prosthesis cemented on a congruous articular surface.[9] Since then various design changes have taken place to improve the component survivorship. The surgeon carrying out shoulder replacement needs to understand the key concepts involved in glenoid design including the back surface shape & convexity, conformity and fixation technique.

Convex back design is bone conserving, resists shear forces and is associated with less radiolucent lines on long-term follow-up. Anglin et al. carried out laboratory testing and recommended that glenoid component loosening can be reduced by having a non-constrained, non-conforming, curved-back design with macro-structure on the cemented surface.[12] Szabo et al. compared flat-back and curved back glenoid components and concluded that though radiolucency was present in all implanted prostheses, flat-back glenoid components were significantly worse.[22] Iannoti et al. conducted a Finite Element Analysis and concluded that curved-back glenoid components are less susceptible to malposition-related failure modes.[28]

The articulation between glenoid and humeral head components can be conforming or non-conforming. This articular conformity commonly known as radial mismatch is defined as difference in curvature between humeral head component and glenoid component. The implants having a reduced radial mismatch have greater conformity but are at risk of increased constraint and are at risk of limiting humeral head translation during movement. This leads to increased shear forces leading to edge loading and hence compromising the fixation. In contrast, less conforming implants with larger radial mismatch allow grater humeral head translation but have a lower surface area that can lead to increased wear, polyethylene fracture and instability. The optimal radial mismatch is considered to be between 6–10 mm diameter.[13]

For cemented glenoid component fixation technique the common types of fixation method are keeled, pegged and fluted. There is still a debate as to the best fixation technique and the evidence is limited in terms of superiority of one design over the other. Nuttall et al. carried out a RSA study to compare fluted vs. pegged glenoids and concluded that both components migrated by RSA, but fluted components had rotation in 3 planes and migrated at a greater rate.[14] Gartsmann et al. carried out a prospective randomised study to compare pegged and keeled glenoids and reported radiolucent lines in 39% keeled components and only 5% pegged components at 6 weeks after surgery.[15] Such choice is currently guided by surgeon preference and training.

Glenoid component can be cemented or non-cemented. Boileau et al. in a study of 40 shoulders compared outcomes of cemented vs. metal back glenoids.[16] They stated that the incidence of implant loosening requiring revision surgery was significantly higher in

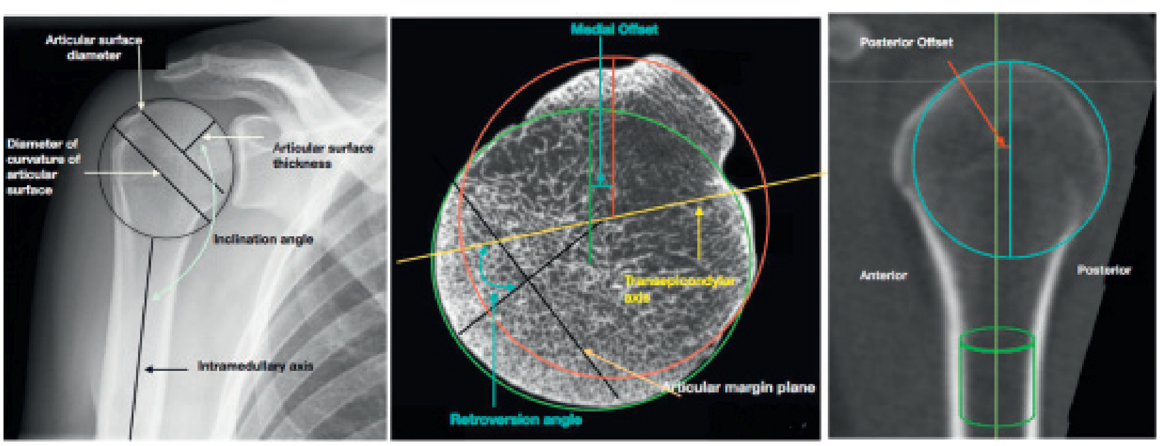

Fig. 2. AP, Axial and Lateral views showing parameters of proximal humerus.

non cemented (metal back) group. The primary modes of failure for metal-back glenoids are insufficient polyethylene thickness, excessive thickness of component that in turn over-tensions the rotator cuff, rigidity of component that accelerates polyethylene wear and stress-shields the glenoid bone and posterior/eccentric loads on glenoid that lead to polyethylene dissociation.

4. Complications and survivorship of anatomic TSR

In a recent current concepts review, Bohsali et al. have studied complications of shoulder arthroplasty. According to this review the most common complications following anatomic TSR are component loosening (4%), glenoid wear (2.3%), instability (1%), rotator cuff tear, periprosthetic fracture, neural injury, infection, haematoma, deltoid injury and VTE. It can be seen that glenoid component wear and loosening remain a common cause of failure after anatomic TSR, despite advances in surgical technique and implant design. Even though radiological loosening around the humeral component has been in 49% of shoulders in this review, this was asymptomatic.[21]

Torchia et al. reported on long-term results of Neer prosthesis in patients with osteoarthritis, rheumatoid arthritis and post-traumatic arthritis. They reported 93% implant survival after 10 years and 87% implant survival at 15 years. Relief of moderate to severe pain was reported in 83% shoulders in this series with improvement in active abduction by an average of 40 degrees to average of 117 degrees. They reported bone-cement radiolucencies in 75% glenoid components and 44% definite radiologic loosening of glenoid components.[24] Sperling et al. reported on 15 year follow-up of Neer Hemiarthroplasty and TSR in patients 50 years or younger. In this study the survival of TSR was 97% at 10 years and 84% at 20 years. It was noted that humeral periprosthetic lucency was present in 60% of patients with TSR and glenoid periprosthetic lucency was present in 76%. The hemiarthroplasty survival was 82% at 10 years and 75% at 20 years. Glenoid erosion was present in 72% patients with hemiarthroplasty. According to this study there was no significant difference between TSR and hemiarthroplasty with regard to pain, relief, abduction or external rotation.[23]

5. Reverse geometry shoulder replacement

Neer recognised that cuff arthropathy patients did not do well with standard arthroplasty. He designed the Mark I (Reverse geometry) prosthesis with large head but this prosthesis did not allow for cuff repair. The Mark II was designed with smaller head but had a disadvantage of increased excursion and motion. He came up with Mark III with axial rotation to gain movement however dislocation and scapular fixation were major concerns and this prosthesis was abandoned. There were similar attempts by Reeves (Leeds shoulder prosthesis, 1972), Beddow and Elloy (Liverpool prosthesis, 1975), Beuchel (1978) and unfortunately none of these had reproducible survivorship. The most successful design introduced in 1985 by Paul Grammont, the Delta prosthesis, forms the basis of current generation of reverse geometry shoulder implants.[17] His implant differed from early designs by making the implant stable, the weight bearing component (glenoid) was convex and supporting humeral articulation was concave, the center of weight-bearing sphere must be at or within glenoid neck and the center of rotation (COR) was to be medialised and distalised.

In contrast to the anatomical Total shoulder arthroplasty, where there is a radial mismatch between humeral and glenoid components to allow for translation and rotation, the glenosphere and humeral component socket in a reverse geometry TSR have exactly same radius of curvature. This results in a concentric motion arc. Newer designs of implants have larger convex component allowing for greater range of motion before impingement occurs, and such a large diameter also increases the stability of the construct.

According to Grammont's principle, the center of rotation of reverse geometry shoulder replacement is medial to anatomic center of rotation (COR). This results in recruitment of more deltoid fibers and also reduces shear forces on glenosphere. Based on this theory the center of rotation should be at implant-bone interface of glenoid. This medialisation of COR however, has been associated with scapular notching, reduction of range of movement of shoulder and leads to a loss of shoulder contour. In the early designs of the reverse shoulder replacement, scapular notching was a significant concern. Scapular notching results from mechanical impingement of superomedial humeral prosthesis against the inferior scapular neck during adduction. Levigne et al. retrospectively reviewed 448 patients who received Grammont type reverse geometry shoulder arthroplasty (461 shoulders) for cuff tear arthropathy and noted scapular notching in 68% of cases. Scapular notching can be avoided by inferior placement of glenoid component, increasing the lateral offset, inferior inclination of glenosphere and varus position (varus neck-shaft angle) of humeral socket.[18,19] Design changes in the humeral component with a relatively steep neck angle (135° compared in new designs compared to 155 degrees in convention humeral sockets) reduce scapular notching as well.

6. Complications and survivorship of reverse geometry TSR

Bohsali et al. [21] have reviewed complications of reverse geometry TSR. According to this study the main complications following reverse geometry TSR are instability (5%), periprosthetic fracture (3.3%), infection (2.9%), component loosening (1.8%), neural injury (1.2%), acromial and/or scapular spine fracture (1%), haematoma, deltoid injury, rotator cuff tear, and VTE. It is noteworthy that this study has not mentioned scapular notching which was one of the most common complications reported in earlier results of reverse geometry TSR. This is because, as our understanding of this issue and biomechanics of reverse TSR has improved, newer designs of implants have been introduced that have reduced the incidence of scapular notching significantly. Bacle et al. have reported long term outcomes of reverse geometry TSR. In this retrospective analysis they found 73% patients had scapular notching. 12% of patients underwent revision surgery. The 10-year survival rate using revision as end point was 93%.[27]

7. The future of shoulder arthroplasty

It is evident that the glenoid has been the weak link in shoulder arthroplasty. It is often the reason for complexity of shoulder arthroplasty and also seen commonly as the reason for revision. As with most surgeries, avoiding complications relies on successful pre-operative planning. Hence, successful implantation of shoulder replacement relies on careful evaluation of glenoid wear pre-operatively in the first place. The most popular classification system for glenoid wear as been described by Walch et al. and further modified but Bercik et al. Using 3-D reconstructions of scapula improves the inter-observer and intraobserver reliability.[20] Indeed a pre-op CT scan and evaluation of glenoid bone loss are highly recommended.

3D printing technology offers a new age solution to assessment of glenoid bone loss. Modern desktop 3D printers allow printing of CT scan using additive manufacturing and provide exceptional 3 dimensional visualisation of bone defects. It is envisaged that such prints would be a routine part of pre-operative planning for complex and revision shoulder replacements. It is also now possible to create a negative image of such 3D models, which then

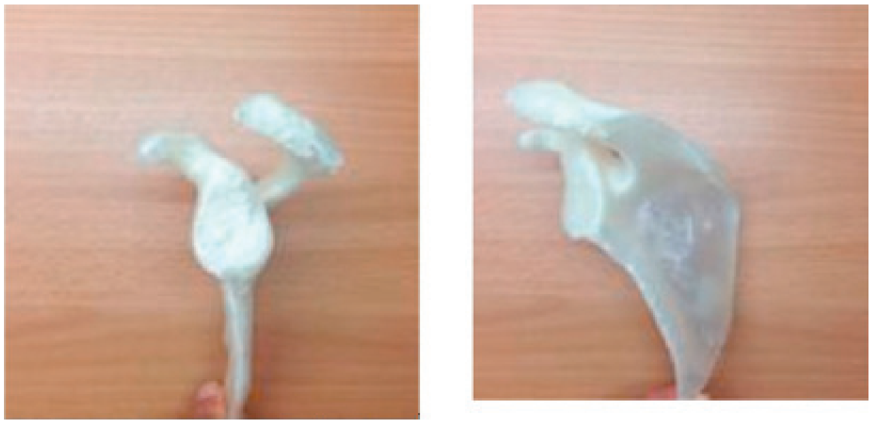

Fig. 3. 3D printed scapula.

serve as a intra-operative jig for placement of the initial glenoid guide wire. Such custom – made jigs increase the accuracy of glenoid placement and are likely to improve implant survivorship and function (Fig. 3).

Modern technology is also likely to help in management of the most challenging problems in shoulder arthroplasty involving glenoid bone loss. Currently, treatment strategies advocated for these glenoid defects include asymmetric reaming, bone grafting and posterior augments. It is now possible to manufacture custom made glenoid components, which match the deformity rather than making the bone to fit the implant. It is still early days for such revolutionary technology, however initial results observed by the senior author are promising. They offer a chance to reconstruct shoulder, which would otherwise not be suitable for such surgery (Fig. 4).

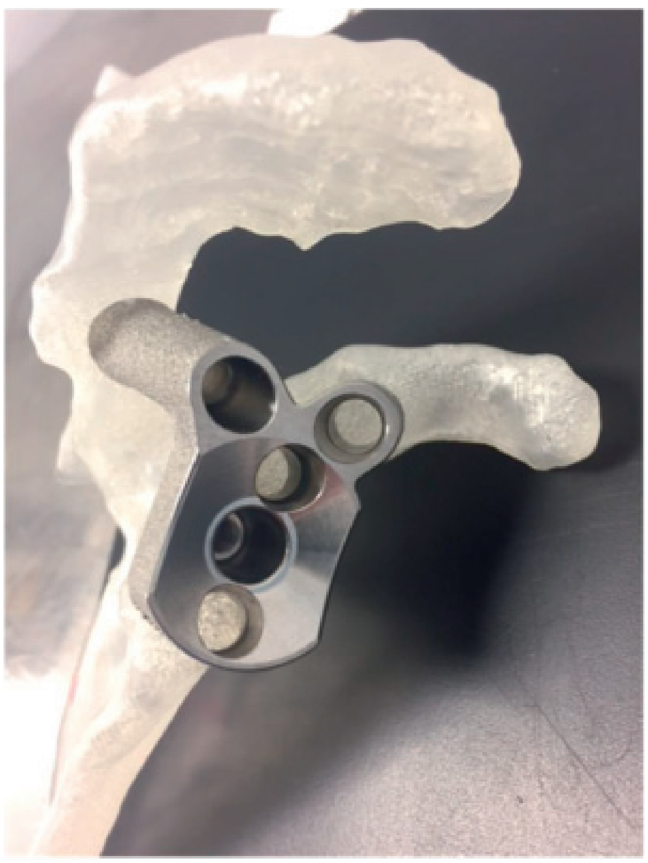

Fig. 4. Custom Made glenoid base plate.

The other area of development in future seems to be intra-operative navigation. The role of navigation is well established in in hip and knee replacement surgery. Kircher et al. carried out a prospective randomised study of 20 patients with osteoarthritis of shoulder treated with total shoulder arthroplasty with or without intraoperative navigation. They found improved accuracy in glenoid positioning in the transverse plane using intraoperative navigation.[26] However this study had very small number of patients and the group advocated larger study with longer follow-up to substantiate results. Such navigation techniques certainly hold promise and technological advances are likely to make them user friendly and more accurate in future.

There has been a rise in use of patient specific targeting instrumentation by shoulder surgeons in complex primary shoulder arthroplasty as well as revision surgery with significant bone loss especially on the glenoid. Throckmorton et al. compared the accuracy of patient-specific guides for TSR with traditional instrumentation in arthritic cadaver shoulders. In this study they found the TSR glenoid components placed with patient specific instrument guides averaged 5-degree deviation from intended position in version and 3° variation in inclination. However the TSR glenoids implanted with standard instruments averaged 8° deviation in version and 7° in inclination. These differences were significant for version ($p = 0.04$) and inclination ($p = 0.01$). They concluded that Patient specific targeting guides were more accurate and had fewer instances of component malposition for glenoid component.[25]

8. Summary

The design and outcomes of shoulder arthroplasty have dramatically improved since its inception in 1950s. There has been a steady evolution of shoulder arthroplasty design and surgery now offers consistent and reproducible outcomes and excellent survivorship. The reverse geometry shoulder replacement has proved to be a revolutionary technique for management of complex shoulder conditions, especially since the changes suggested by Paul Grammont. The key future challenge remains robust methods for managing glenoid bone loss and management of future increases in revision workload. 3D printing technology, patient-specific instrumentation, intraoperative navigation and custom made shoulder components offer promise for the future along with improvements in biomaterials but need to be rolled out with caution under carefully controlled clinical environments.

Conflict of interst

None.

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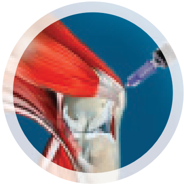

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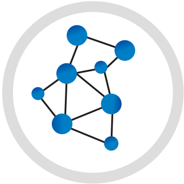

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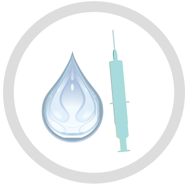

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