'À La Carte' Joint Replacement

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Key Points

- The goal of arthroplasty is to replace arthrosis with high-performance prosthetic joints which accommodate the high expectations and increased life expectancy of modern patients.
- A dogmatic, one-size-fits-all approach to treating arthrosis is unlikely to deliver reproducible, optimal clinical outcomes.
- Decisions regarding choice of approach, implant design, configuration and component orientation should be individualised depending on each patient's anatomy and biomechanics, and should be a shared process between the patient and surgeon.
- Surgeons should aim to reproduce normal function through personalized kinematically aligned, conservative

(soft tissue and bone) joint replacement techniques.

- This 'à la carte' approach to joint replacement challenges current trends. It is technically challenging, but represents the state of the art for arthroplasty. Thus, it targets sub-specialised, high-volume, expert surgeons.

29.1 The 'À La Carte' Joint Replacement Philosophy (Fig. 29.1)

Hip and knee arthroplasties are life-changing procedures, reducing pain and restoring function after end-stage arthrosis. Almost 90% of patients who have undergone hip arthroplasty, and 82% after knee arthroplasty, report improvement in quality of life after surgery [1]; this leaves a significant number of dissatisfied patients. The modern surgeon can make decisions regarding surgical approach, implant design and component orientation. However, it is challenging to gain proficiency in a wide variety of surgical configurations. A smaller repertoire is technically and economically more feasible, and thus a one-size-fits-all approach is commonplace. Hip and knee arthroplasties are forgiving procedures, most frequently performed in older patients

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without high functional demands. The future arthroplasty surgeon is faced with new challenges—patients with higher demand, expectations and longer life expectancy, in addition to an increasing burden of revision surgery. Here, we discuss ‘a la carte’ joint replacement (Fig. 29.1), which is both patient specific and bone/soft tissue conservative. It may improve overall satisfaction while conserving bone stock in the event of future revision surgery.

This concept is borne of the observation that each patient is unique, so a dogmatic approach to managing joint degeneration cannot consistently deliver reproducible, optimal clinical outcomes. Bone quality, joint anatomy, biomechanics and kinematics vary widely between patients. ‘À la carte’ joint replacement aims to tailor each surgical decision based on these factors and patient expectations. Where feasible, conservative surgery performed through smaller incisions or using bone-preserving implant designs, such as compartmental knee arthroplasty and hip-resurfacing arthroplasty, should be favoured to ease and secure potential future revision procedures. Decisions regarding choice of approach, implant design, fixation and configuration and component orientation are therefore made with a patient-specific philosophy. The goal is to replace joints with

high-performance prostheses, which respect and restore native biology.

Kinematic alignment (KA) in hip [2, 3] and knee [4, 5] arthroplasty aims to restore function by placing components in positions and orientations which work in harmony with native joint biomechanics. The KA technique aims to restore the native joint anatomy, plus or minus adjusting the component position to adapt to the individual spine–hip relationship (hip replacement) or knee biomechanics (knee replacement) [6, 7]. These techniques are described in detail in Chaps. 11, 16, 17, 24 and 25. In summary, hip KA is a departure from traditional ‘safe zones’ for implant orientation. It focuses on achieving a centre of rotation, acetabular inclination and combined femoral and acetabular version which confers a stable and impingement-free range of motion. This dynamic concept is of particular relevance in patients with altered relationships between the hip, pelvis and spine, most commonly seen in the elderly, or after spinal arthrodesis. Knee KA focuses on restoring the native, pre-arthritic flexion of the tibia and patella around two transverse femoral axes (cylindrical and patella axis, respectively) and rotation of the tibia around a longitudinal axis. This aims to restore the native joint line’s height and orientation to balance the

Fig. 29.1 The concept of ‘a la carte and patient-specific joint replacement’ consists of personalizing every aspect of the surgery. The decisions regarding choice of approach, implant design and components’ orientation are made on a patient-specific basis. The goals are to replicate the

constitutional joint anatomy unless severely abnormal, adjust component orientation to compensate for poor joint biomechanics and preserve as much as possible the bone stock and the integrity of the peri-articular soft tissue environment

collateral ligaments and restore patellofemoral and tibiofemoral kinematics. Hip and knee KAs take into account the patient's unique joint anatomy, peri-articular soft tissue balance and joint kinematics to produce a biomechanically friendly prosthetic joint. This may improve components' life span through improving prosthetic joint biomechanics (reducing risks of prosthetic impingement and edge loading) whilst improving patient function and satisfaction [8, 9].

The *choice of surgical approach* is of particular interest in hip arthroplasty, where it can have a significant impact on early recovery and longer term clinical outcomes. The most commonly debated approaches to the hip are the posterior (Moore) approach and the direct anterior (Hueter) approach (DAA). The posterior approach offers excellent exposure and is considered the most versatile for revision hip surgery. The anterior approach is intermuscular, internervous, and technically more demanding, but facilitates early rehabilitation and can be performed through an aesthetic 'bikini' incision. When choosing between them, surgeons should consider the age and functional demands of the patient, the presence of anterior or posterior soft tissue contractures, the technical demand of the procedure and probably the individual spine–hip relationship in addition (Fig. 29.2) [2]. Elderly patients who suffer from spine degeneration tend to have a stiff lumbar spine and an increased posterior pelvic tilt when standing—spine–hip relationship type C or D [2, 10]. As the standing pelvic tilt of these patients does not significantly change with arthroplasty, if the cup is orientated parallel to the native acetabulum (e.g. using the transverse acetabular ligament, TAL), these patients are at risk of anterior dislocation when standing. Preserving the anterior capsule by performing a mini-posterior approach would both maintain the integrity of the anterior structures, and facilitate the release of the frequently retracted posterior capsule. In contrast, young patients with hip osteoarthritis secondary to pincer-type femoro-acetabular impingement disease are likely to display spine–hip relationship type B [2]. The pelvis has insufficient posterior tilt when moving from standing to sitting positions [11]. Thus, after

THR, patients are at risk of posterior dislocation. Preserving the integrity of posterior soft tissue structures is sound, and an anterior approach with the cup device sufficiently anteverted is therefore more likely to restore stable range of motion. When the spine–hip relationship is normal (type 2A) [2], either approach is appropriate, although the authors favour the DAA as it does not require post-operative 'hip precautions' and is associated with an earlier return to function [12].

The *selection of the optimal implant design* depends on multiple patient-specific factors, including the patient's functional demands, bone quality (bone density and bone stock), joint morphology, the likelihood of revision surgery (which is mainly influenced by the patient's age at the time of surgery) and the risk of prosthetic instability. Younger patients may benefit from implant designs that are hard wearing and only require conservative bone resection. These properties facilitate high performance and longevity and the potential for easier revision. Compartmental knee arthroplasty (using unicondylar and/or patellofemoral implants), performed on patients without tricompartmental arthrosis, ligamentous instability and significant flexion contracture, is a safer and higher functioning alternative to total knee arthroplasty [13]. Hip-resurfacing and neck-sparing total hip arthroplasties are also conservative options which preserve the femoral neck. Patients with hip-resurfacing devices have a more normal gait than those with conventional length stems. The ability to revise these prostheses to primary standard implants is particularly attractive in the event of failure. In contrast, surgeons must prioritise patient safety above performance in elderly or multimorbid patients. In the authors' opinion, unicondylar knee arthroplasty (UKA) is suitable for appropriate patients of any age. When compared with total knee arthroplasty, UKA is associated with faster return to function, higher functional outcomes and reduced peri-operative morbidity and mortality [14, 15], even in those aged over 75 years [16]. With regards to hip arthroplasty, the use of collared stems, large-diameter heads and dual-mobility implants should be promoted, as they reduce the risks of subsidence and peri-operative femoral fracture [14] and instability [10], respectively.

29.2 Can It Be Done?

Reliably executing kinematic implantation with a wide repertoire of implant designs and approaches necessitates a high level of expertise. The 'à la carte' concept represents the state of the art for implanting joint components and targets highly specialised, high-volume, expert joint replacement surgeons who have received training in each technique. The use of technological assistance such as navigation, patient-specific cutting guides or custom implants may be helpful for reaching higher surgical reliability. Ultimately, delivering personalized and conservative joint replacement depends on the individual surgeon's ability to flexibly consider and then perform procedures tailored to a given patient's requirements.

29.3 Challenging the Status Quo

The concept of 'à la carte' joint replacement challenges the current trend for rationalising the procedures and implants available in a surgeon's armamentarium. Cost-effective arthroplasty is a worthy social goal—reducing unwanted variation in a healthcare system by using affordable implants in technically forgiving procedures. On average, satisfactory function after arthroplasty is more likely if a procedure is capably and frequently performed by most surgeons. Surgeons are less likely to challenge the status quo by offering innovative or creative personalized solutions that are less frequently performed or more technically difficult, such as bicompartamental knee arthroplasty and neck-sparing or resurfacing hip arthroplasty. Open reporting of individual surgeon outcomes has instead encouraged surgeons to perform procedures that are difficult to revise and produce generally good outcomes [17]. The 'à la carte' approach is an evidence-based philosophy but demands an additional level of expertise. Delivering kinematic alignment, compartmental knee arthroplasty and conservative hip arthroplasty requires experience beyond current basic training, but may produce outstanding short- and longer term outcomes when executed by expert surgeons.

29.4 Case Illustrations

29.4.1 Case 1 (Fig. 29.3)

A sagittally balanced 80-year-old patient with right hip osteoarthritis (inserts b, c) and a degenerative, stiff spine responsible for a mixed-type spine–hip relationship type B/C (normal pelvic incidence $\approx 55^\circ$ and low-standing lumbar lordosis $\approx 21^\circ$ for a 24° mismatch, low delta sacral slope $\approx 10^\circ$) (insert a). The patient had a 10° excessive pelvic retroversion when standing, causing a compensated sagittal spinal imbalance, and a 10° lack of pelvic retroversion when sitting. Anatomically aligning total hip arthroplasty components in this patient would result in unfavourable kinematics and impingement during standing (from posterior edge-loading and instability) and sitting (from anterior edge-loading and instability). To prevent these risks, the patient received a kinematically aligned dual-mobility total hip arthroplasty performed through a mini-posterior approach. This preserved the integrity of the anterior capsule, while anatomical implantation (no adjustment) of a dual-mobility cup increases the range of motion before impingement and instability (inserts e, f). To reduce the risk of intra-operative femoral fracture or subsidence, a dual taper-collared cementless stem was implanted.

29.4.2 Case 2 (Fig. 29.4)

A 62-year-old highly active patient with a right osteoarthritic hip (inserts 4b, c) and spine–hip relation type B (normal pelvic incidence $\approx 60^\circ$, normal standing lumbar lordosis $\approx 52^\circ$, low delta sacral slope $\approx 6^\circ$) (insert 4a). Anatomically aligning total hip arthroplasty components would result in unfavourable kinematics and impingement when sitting (posterior edge-loading) and posterior instability. To reduce these risks, the patient received a kinematically aligned total hip arthroplasty performed through a minimally invasive direct anterior approach, preserving the integrity of the posterior capsule and external rotator muscles. The stem was anatomically implanted, maintaining native

Fig. 29.3 Case 1: Right hip osteoarthritis in an elderly patient with good bone quality and spine–hip relationship type B/C. This was managed with kinematically aligned THR using a cementless collared stem and dual-mobility cup, performed through the posterior approach. Pre-operative lateral lumbo-pelvic radiographs (a) in standing

(left) and sitting (right) positions. Pre-operative antero-posterior standing pelvic (b) and lateral right hip (c) radiographs. Digital KA-THA templating (d). Post-operative antero-posterior supine pelvic (e) and lateral right prosthetic hip (f) radiographs

Fig. 29.4 Case 2: A highly active patient with right hip osteoarthritis and spine-hip relation type B. This was managed with kinematically aligned THR using a cementless collarless stem and a large ceramic-on-ceramic bearing, performed through the anterior approach. Pre-operative lateral lumbo-pelvic radiographs (a) in

standing (left) and sitting (right) positions. Pre-operative antero-posterior standing pelvic (b) and lateral right hip (c) radiographs. Digital KA-THA templating (d). Post-operative antero-posterior supine pelvic (e) and lateral right prosthetic hip (f) radiographs

femoral version; the cup orientation was slightly adjusted with an additional 5° of anteversion relative to the transverse acetabular ligament (TAL) skin mark; a 36 mm ceramic-on-ceramic bearing was chosen for stability and durability (inserts 4e, f).

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