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SHOULDER ARTHROPLASTY: THE NEXT 10 YEARS

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Arthroplasty remains an incredible intervention for patients with degenerative joint and tendon disease for which there is yet no biological solution. Although metal and plastic are foreign materials, our ability to engineer them in ways that recreates native anatomy and restores joint function is miraculous for those afflicted with pain and functional demise. Nevertheless, the durability of shoulder arthroplasty is limited both by the imminent wear of these materials as well as the forces that act upon them in relation to the underlying host bone and its pattern and degree of erosion. In the past decade, we have come to appreciate the difficulties in addressing posterior glenoid erosion; and recent advancements, like augmented glenoids, have improved our ability to address these defects while preserving host bone and joint biomechanics. The next decade will see evolutionary forward progress in materials science, prosthesis design, surgical planning and surgical techniques. These in turn will lead to revolutionary advancements that will relegate the current state of arthroplasty into historical perspective.

Such forward progress will also confront the challenge that healthcare reform and value-based purchasing pose to scientific innovation, in that new technologies must improve value in cost-effective ways. This is particularly pertinent as the burden of arthritis at a public health level brings itself to bear on heath care delivery and health economics. A look at past use and forward projections shows the rate of shoulder replacement is doubling about every 10 years and is estimated to reach about 55,000-60,000 cases per year by 2025. The fastest increase is in reverse arthroplasty, which is steadily overtaking anatomical shoulder arthroplasty as its indications widen. In addition, more patients are presenting in their 40s and 50s with advanced arthritis or irreparable rotator cuff tears. These patients seek solutions that permit strenuous employment, high physical demand and sustained durability to mitigate the need for revision surgery. The synthesis of mechanical engineering and biomedical engineering will aim to confront these challenges and provide innovative, lasting solutions that translate directly into better long-term outcomes for patients, both individually and at a public health level. •

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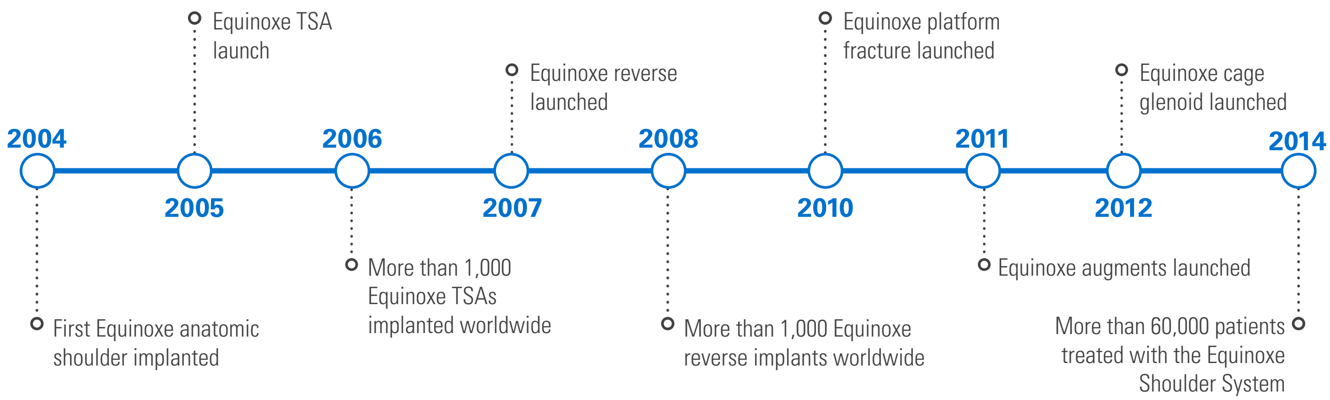
MILESTONES IN SHOULDER ARTHROPLASTY



As follows is a glimpse of where such innovation will lead shoulder arthroplasty both in terms of clinical care, clinical outcomes and biomedical engineering.

Evolutionary Changes

- Shorter humeral stems and an increasing use of resurfacing heads in both hemiarthroplasty and total shoulder arthroplasty will allow bone conservation on the humeral side.
- Tissue-sparing approaches, including preservation of the subscapularis insertion, will facilitate more rapid recovery and allow shoulder arthroplasty to increasingly be performed safely in an outpatient setting.
- Improvements in prosthesis design such as augmented glenoids will allow surgeons to better manage glenoid erosion and wear while preserving bone stock and proper rotator cuff tension.
- Joint registries and improved capture of retrieved failed glenoids will provide a more thorough understanding of modes of glenoid failure that will in turn lead to advancements in wear resistance, hybrid fixation and shape modification.
- Enhanced imaging and computer modeling and navigation will increasingly allow surgeons to virtually plan and perform the procedure preoperatively. These same technologies along with patient-specific instrumentation will allow improved placement of both anatomical and reverse prostheses that restore proper glenoid orientation, offset and bone fixation.
- Data analytics and the drive to improve patient value will innovate clinical care toward the goal of zero complications both medically and surgically.

Revolutionary Changes

- Materials innovation will allow for plastics that have more cartilage-like properties allowing deformation and compliance. Similarly, metals will continue to take on properties more like bone reducing problems like stress shielding and improving biological fixation on both sides of the joint.
- Progress in biomaterials will assist the incorporation of living tissue into mechanical scaffolds that will allow self-healing and remodeling of resurfaced joints.
- The increasing pervasion of 3-D printing in combination with imaging modalities will allow mass customization driving toward patient-specific implants designed to match native anatomy while addressing bone deficiency and wear.
- Finally, 3-D printing of biological tissues may advance to the point where foreign materials can be avoided altogether and joint replacement will be a purely biological procedure.