TECHNICAL BRIEF

Precision Restoration of the Humeral Head Shape and Joint Line

Catalyst OrthoScience Research and Development

Background

The primary goal of total shoulder arthroplasty (TSA) is to reduce pain and increase motion by using implants that restore the joint to the premorbid anatomical state. Improper restoration of the joint can lead to a number of adverse effects, including pain, rotator cuff failure and glenoid component loosening[1-2]. Glenoid loosening can be the result of several factors including: inaccurate prosthetic design, poor surgical technique and malpositioning of the implants[3-6].

Several research studies have demonstrated that the humeral head is of a non-spherical nature[7-9]. Numerous computational and mechanical studies have provided empirical evidence that a non-spherical prosthetic head will more accurately restore the native humeral geometry, range of motion and glenohumeral joint kinematics compared to spherical designs[10-14]. Despite these positive findings, these studies do not take into account the additional variability that can be introduced from the surgical technique of placing the implants precisely at the joint line.

Lately the focus of anatomic TSA has been on stem length. No matter the method of fixation, the optimal implant system replicates the native anatomy with anatomically accurate implant designs, and utilizes a precise and repeatable surgical technique in preparing the bone to place the implants in the correct anatomic position.

Implant Design

The bearing surface of the Catalyst CSR™ Total Shoulder System humeral implant utilizes a non-spherical geometry that the previously discussed research has been shown to accurately restore the native anatomy.

The bone-facing underside of the implant is composed of four independent planar surfaces and four equal diameter pegs that vary in length. This provides rotational stability while the implant rests on dense, subchondral bone in the proximal humerus as opposed to fixation within the metaphyseal bone or the humeral canal. **(Figure 1)** The one-piece implant design also eliminates the need for any implant assembly and potential failures of a morse taper.

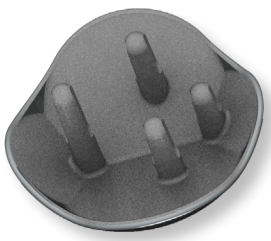
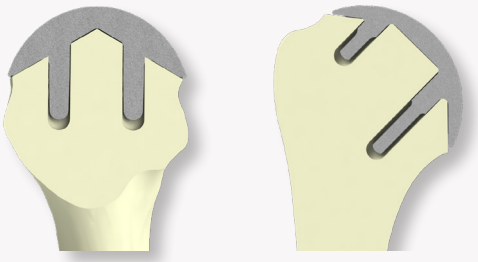


FIGURE 1

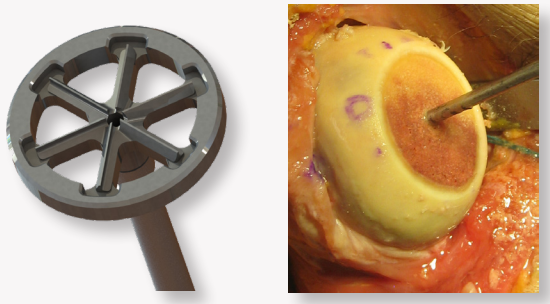


AP and Lateral cross-sections of humeral implant on humeral head.

Surgical Technique

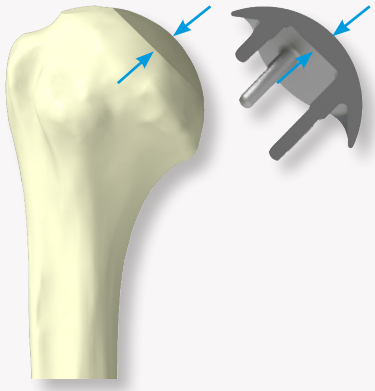
A standard deltopectoral approach is used to access the humeral head. Following placement of a guide pin into the center of the humeral head, a plunge reamer reams the humeral head down to a specific depth based on the size of the head regardless of the presence of any deformity. This precise depth has been factored into the humeral implant thickness and is designed to restore the appropriate height to the humeral head based on its size. **(Figures 2 & 3)**

FIGURE 2



The plunge reamer has a built-in depth stop allowing for the humeral heads to be reamed to an exact depth.

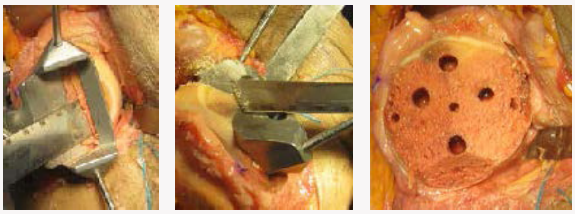
FIGURE 3



Thickness of bone removed matches thickness of final implant.

Two separate cut guides are then used to create a multi-planar surface that matches the four-plane geometry of the underside of the humeral implant. **(Figure 4)**

FIGURE 4

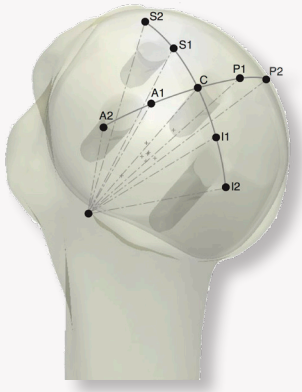


Four guided bone cuts and four guided drill holes are made to prepare the humeral head for receipt of the implant.

This technique lends itself from the principles of total knee arthroplasty which utilize precise cutting guides to reproducibly preserve the joint line as opposing to utilizing freehand techniques and unnecessary removal of additional dense subchondral bone.

The end result is a highly precise restoration of the proximal humeral joint line. In a previously published study[15], we measured nine different locations on the articulating surface, the CSR implant was able to restore the joint line within 0.9 mm from the native anatomy, with no points greater than 2.7 mm deviation over a total of eight cadaveric specimens. **(Figure 5)** The implants were placed following the surgical technique guide, without the use of patient specific devices or planning software.

FIGURE 5



Nine points in the S-I and A-P planes used to characterize joint line restoration.

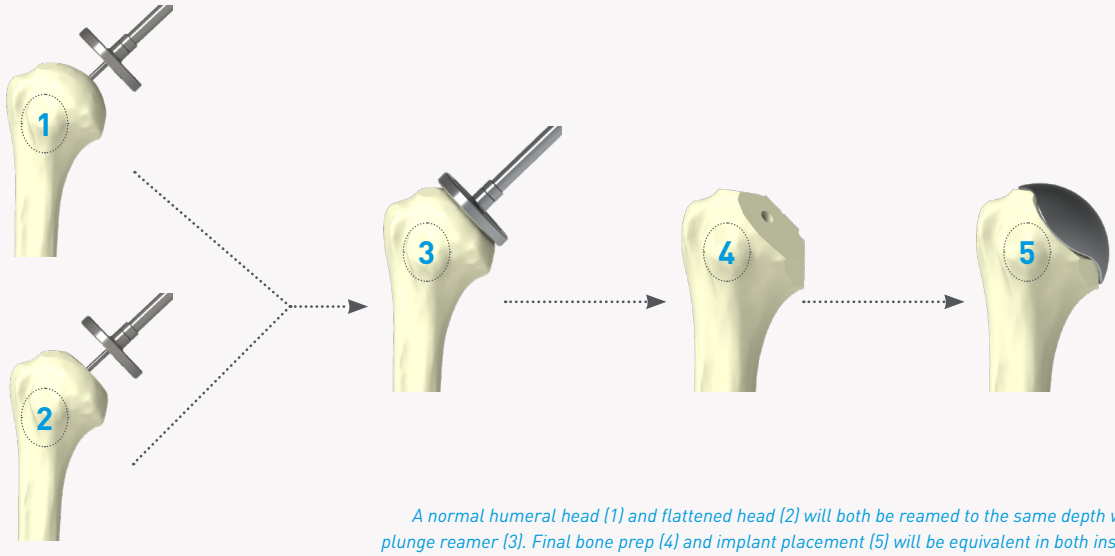
Head Deformity Correction and Flattened Heads

In the presence of a flattened or deformed humeral head, no additional instruments or changes in the surgical technique are required. The humeral plunge reamer will ream to the appropriate depth regardless of the presence of any type of deformity. **(Figures 6 & 7)**

Conclusion

The Catalyst CSR Shoulder System has been primarily developed with the goal of increasing the simplicity, consistency and accuracy by which total shoulder arthroplasty is accomplished. Through this more accurate method of reproducing a healthy proximal humerus, it is believed that clinical outcomes will improve in terms of range of motion, joint kinematics, implant survivorship and overall patient satisfaction.

FIGURE 6



A normal humeral head (1) and flattened head (2) will both be reamed to the same depth with the plunge reamer (3). Final bone prep (4) and implant placement (5) will be equivalent in both instances.

FIGURE 7

Pre-op flattened and deformed head (left). Post-op with Catalyst CSR humeral head (right).

References

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1226-2003-B 042019