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Discoveries in the Management of Shoulder Arthritis: New Solutions for Old Problems

- Shoulder arthritis is a disabling condition that prevents otherwise healthy individuals from sleeping, carrying out activities of daily living and from enjoying sports and other physical activities. In this condition, the normally smooth cartilage surfaces of the ball and socket of the shoulder are lost because of injury, degeneration, inflammation, or surgical misadventure. As a result, the joint loses the characteristics essential for normal function: flexibility, strength, stability and smoothness.
- As recently as fifty years ago, the treatment for shoulder arthritis was nothing more than exercises in which the patient leaned over swinging a heavy weight held in the hand to try to pull the damaged joint surfaces apart. The modern era of shoulder replacement began in the 1950's, when Charles S. Neer II introduced a smooth metal ball to replace the damaged joint surface with a stem to fix the ball to the arm bone.
- Since then, the art and science of joint replacement for the different types of shoulder arthritis has and continues to progress rapidly. Many of the key discoveries are taking place at the University of Washington, where a particular emphasis is placed on minimally invasive, biological approaches to joint reconstruction directed at the best possible return of the shoulder to comfort and function.

After two fellowships with Dr. Neer, Rick Matsen introduced the technique of shoulder joint replacement at the University of Washington in 1975. Since then, the U.W. Shoulder and Elbow team has played a major role in the ongoing development of more effective and less invasive approaches to the management of shoulder arthritis. In addition to Matsen, the team members have included the late Doug Harryman, John Sidles, Kevin Smith, Sarah Jackins and a legacy of outstanding shoulder fellows, residents and students. The team has recently been joined by Winston Warne and Alexander Bertelsen. In an important sense, the team also includes over 7000 individuals for whom we have performed shoulder reconstructions - these individuals have provided

key observations on what works and what does not and especially on how to optimize the rehabilitation after shoulder replacement. A brief summary of some of our advances are listed below, along with the web sites where one can find more details.

Soft Tissue Management (www.orthop.washington.edu/totalshoulder)

We pursue the goal of minimally invasive shoulder replacement, which minimizes the amount of soft tissue dissection needed to perform the procedure. Presently, we perform shoulder replacement with the incision of only one tendon, the subscapularis, which is securely reattached at the conclusion of the procedure. The deltoid, rotator cuff and pectoralis muscles remain intact. An equally

important goal is balancing the soft tissues of the shoulder to optimize both the mobility and stability of this joint. We achieve this by safely releasing motion-limiting contractures and scar tissue, while limiting excessive slack that may contribute to instability.

The Humeral Prosthesis (Replacement for the Ball of the Shoulder Joint) (www.orthop.washington.edu/totalshoulder)

An essential element of shoulder joint replacement is the insertion of a smooth metal ball to replace the joint surface damaged by arthritis. This requires proper component sizing, positioning and fixation. We have developed guidelines for selecting the proper ball dimensions to maximize range of motion and stability. The metal ball is attached to a stem that

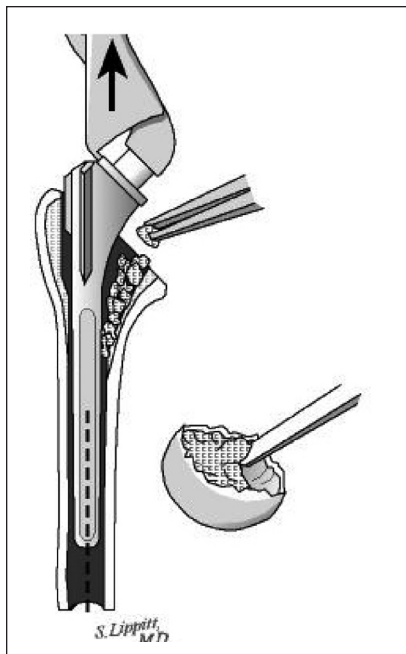


Figure 1: Impaction autografting. Bone harvested from the resected humeral head (right) is impacted into the canal of the humeral shaft providing safe and secure fixation of the humeral prosthesis.

must be secured safely and accurately to the inside of the arm bone. In the past, surgeons have relied on bone cement, which may crack and loosen. Other surgeons have tried to achieve a good fit with the prosthesis by reaming the inside of the bone to a tight fit, an approach that can weaken the bone, and predispose it to fracture. We have developed a method for using bone harvested from the patient's humerus to securely fix the prosthesis in the

ideal position - a process known as impaction autografting (Figure 1). This procedure uses the patient's own bone material to support the implant, minimizing the risks of loosening and weakening the bone.

The Glenoid Prosthesis (Replacement for the Socket of the Shoulder Joint) (www.orthop.washington.edu/totalsoulder)

In total shoulder replacement arthroplasty, the plastic socket has traditionally been the weakest link. This is due in part to the difficulties in achieving durable fixation of the polyethylene prosthesis to the bone of the shoulder blade and due to deformation and wear of polyethylene from which the prosthesis is made. We discovered that using a socket with slightly greater diameter of curvature than that of the ball allowed for a greater range of motion and less risk to the rim of the component. We also learned that bone cement can damage the bone by its heat of curing. Thus we designed a system for fixation that uses precise preparation of the bone surface and fixation holes so that only minimal cement is required. We also developed a system for using carbon dioxide gas to clean and dry the bone for optimal cement fixation (Figure 2).

The Non-Prosthetic Glenoid Arthroplasty ("Ream and Run") (www.orthop.washington.edu/reamandrun)

Many of our more active patients with shoulder arthritis wish to avoid the risks associated with bone cement and a polyethylene glenoid socket prosthesis. These individuals encouraged us to pursue a solution that would enable them to return to unrestricted use of their shoulder. As a result we conducted laboratory research that demonstrated that the bone surface of the socket could heal over with a smooth layer of fibrous tissue and fibrocartilage if it was optimally shaped by reaming (Figure 3). We learned that early motion is the key to inducing the bone to heal and remodel to a durable joint surface. For this reason, we nicknamed the procedure 'ream and run'. We now offer the ream and run to active patients who are dedicated to the rehabilitation program that is essential to its success. In most cases the results have been truly exciting, with some individuals returning to unlimited physical activity with their new shoulder (Figure 4).

Failure analysis

The University of Washington shoulder service welcomes patients who have had unsuccessful shoulder replacement surgery elsewhere. This experience has helped us develop both an understanding of the causes of failure and an approach to managing failed shoulder joint replacements. We have learned that shoulder joint replacement is more likely to fail when it has been performed by a

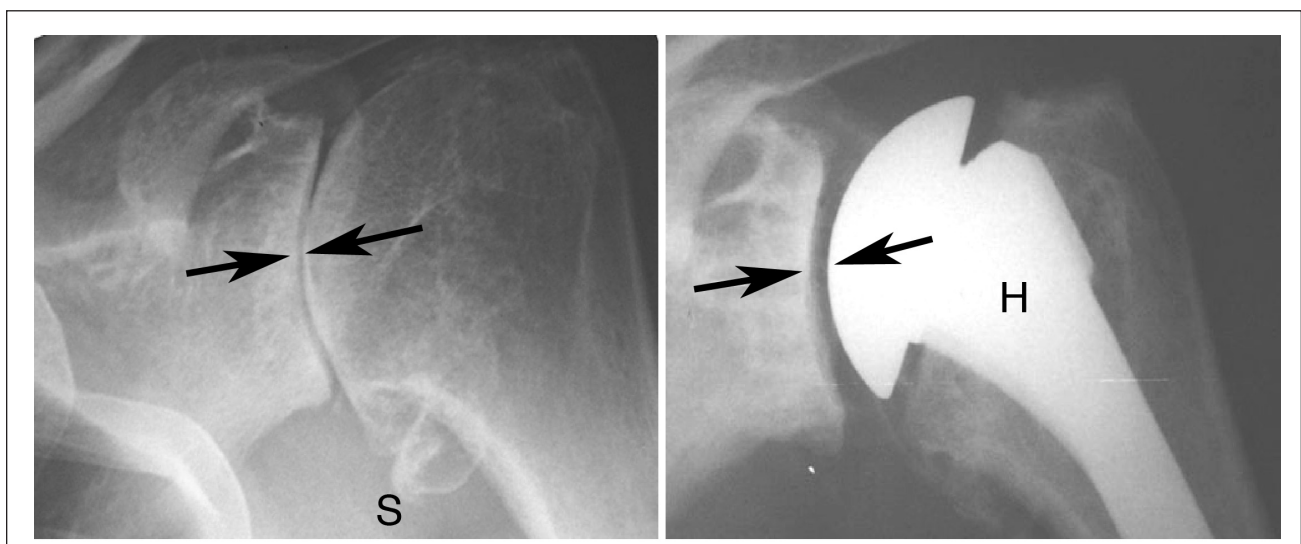


Figure 2: Total shoulder joint replacement arthroplasty. Arthritic shoulder (left) shows bone-on-bone contact (arrows) and bone spurs (S). Total shoulder (right) shows humeral component (H) contacting the dark space occupied by the plastic glenoid socket component (arrows).

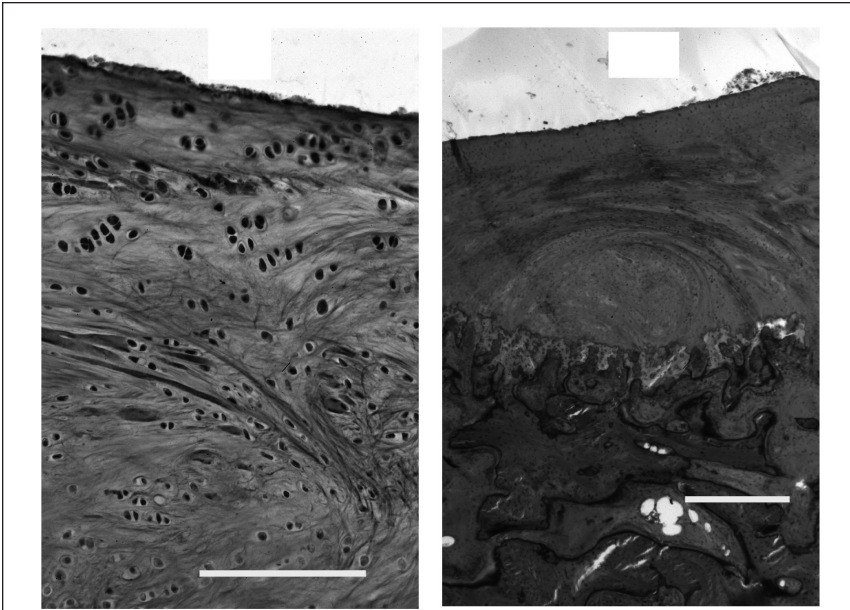


Figure 3: Regenerated biological joint surface 6 months after a ream and run procedure in a laboratory model. Note the smooth joint surface with living fibrocartilage tissue showing the black nuclei of the clear cartilage cells in a matrix of fibrous tissue (left). Note the arcades of fibers binding the regenerated tissue to the bone below (right).

surgeon who does this procedure infrequently. We have also learned that many individuals with painful shoulder joint replacements have previously unrecognized infections with low-virulence bacteria. With

the collaboration of our infectious disease and pathology services, we are developing methods for preventing, diagnosing and managing these infections.

The Reverse Total Shoulder Arthroplasty
 (www.orthop.washington.edu/reverseshoulder)

Conventional approaches to shoulder joint replacement are ineffective when the shoulder is weak and unstable because of massive defects in the rotator cuff tendons. In these situations and in certain circumstances where conventional arthroplasty has failed, we have been able to restore substantial function with a reversed ball and socket prosthesis (Figure 5). We continue to discover improvements in this novel approach to shoulders where previously no reasonable options were available.

Conclusion

Now, over thirty years and over seven thousand shoulder joint replacements after our debut, the shoulder team at the University of Washington continues our pursuit of more effective and less invasive approaches to the management of shoulder arthritis. Our high-priority goals for the next few years are (1) to develop ways in which the ream and run procedure can be effectively applied to an increasing

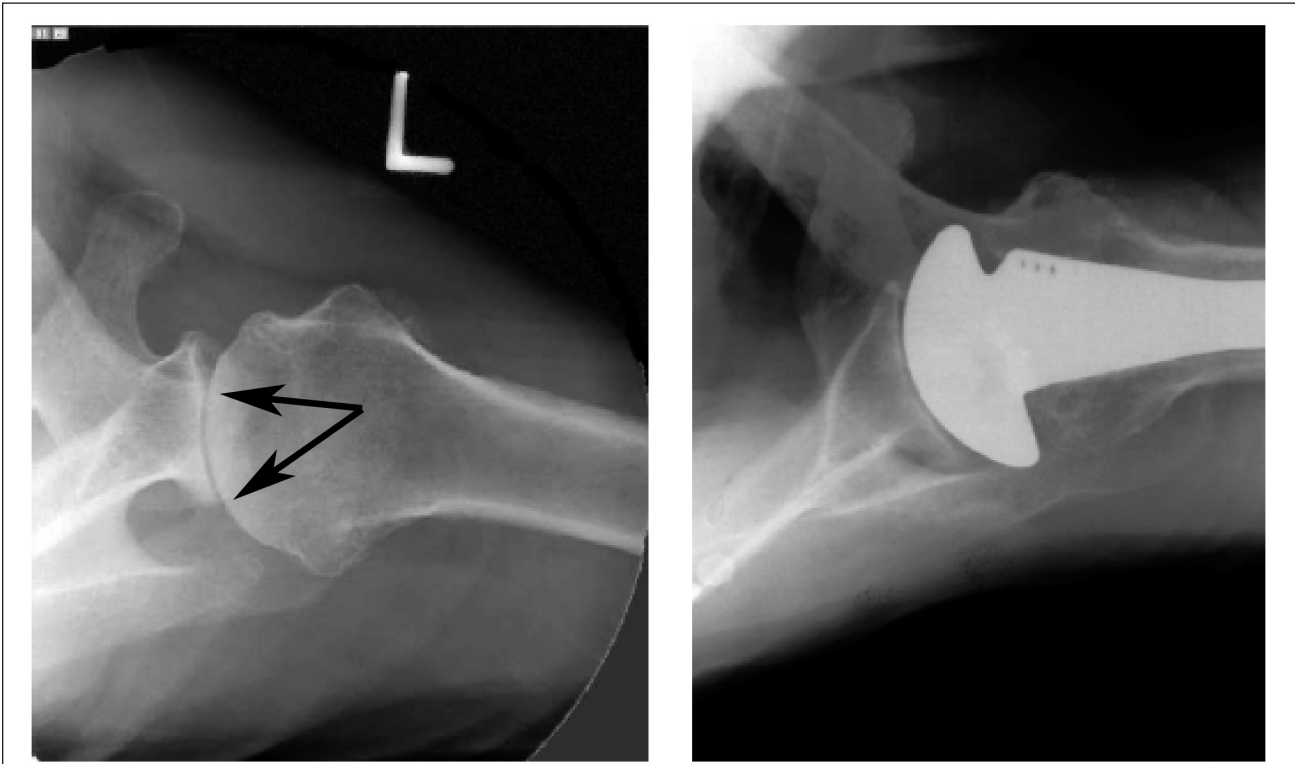


Figure 4: Restoration of glenoid concavity. Arthritic shoulder (left) shows wearing of the back part of the socket allowing the humeral head (ball) to slip backwards. Ream and run arthroplasty (right) has re-established a normally configured socket that properly centers the humeral head.

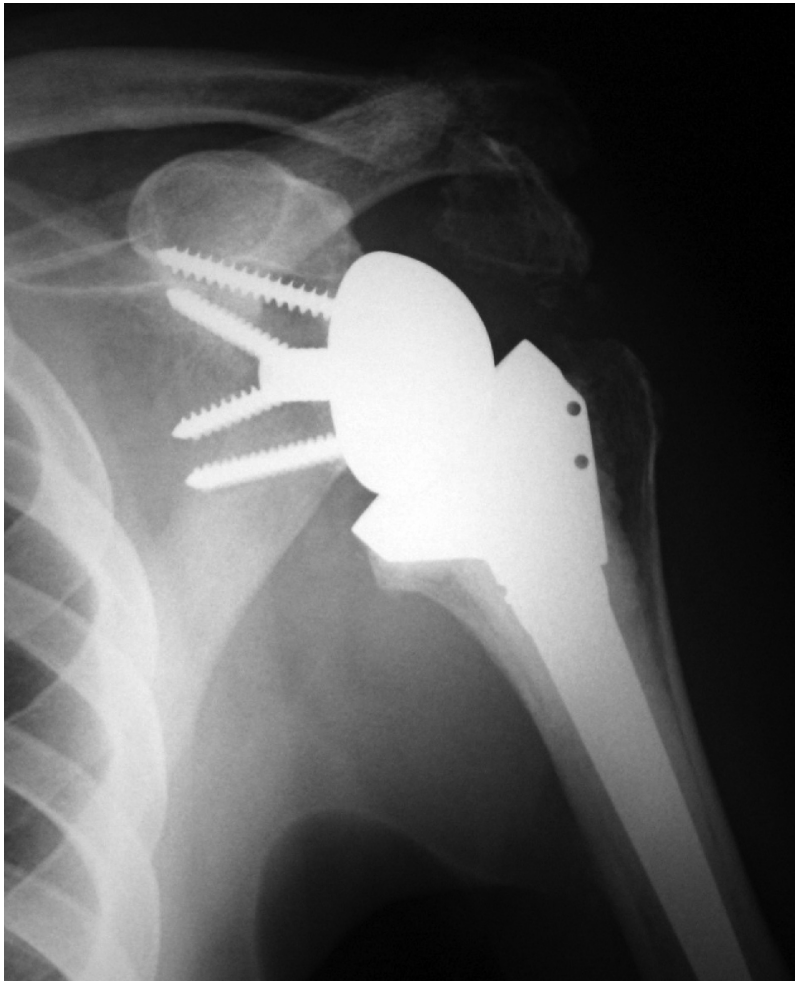


Figure 5: Reverse (delta) total shoulder arthroplasty. Note the ball is on the scapula (shoulder blade, left) while the socket is on the humerus (arm bone, right).

number of patients with shoulder arthritis, enabling them to avoid the risks associated with polyethylene and polymethylmethacrylate bone cement, (2) to speed the recovery of comfort and function after shoulder joint replacement and (3) to develop a better understanding of the ways in which 'stealth' organisms infect shoulder replacements so that these infections can be better prevented and treated.

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efforts.

References

- Braman, J. P., A. Falicov, et al. (2006). "Alterations in surface geometry in retrieved polyethylene glenoid component." *J Orthop Res* 24(6): 1249-60.
- Clinton, J., A. K. Franta, et al. (2007). "Nonprosthetic glenoid arthroplasty with humeral hemiarthroplasty and total shoulder arthroplasty yield similar self-assessed outcomes in the management of comparable patients with glenohumeral arthritis." *J Shoulder Elbow Surg* 16(5): 534-8.
- Franta, A. K., T. R. Lenters, et al. (2007). "The complex characteristics of 282 unsatisfactory shoulder arthroplasties." *J Shoulder Elbow Surg* 16(5): 555-62.

Harryman, D. T., J. A. Sidles, et al. (1995). "The effect of articular conformity and the size of the humeral head component on laxity and motion after glenohumeral arthroplasty. A study in cadavera." *J Bone Joint Surg Am* 77(4): 555-63.

Lynch, J. R., A. K. Franta, et al. (2007). "Self-assessed outcome at two to four years after shoulder hemiarthroplasty with concentric glenoid reaming." *J Bone Joint Surg Am* 89(6): 1284-92.

Matsen, F. A., 3rd, J. M. Clark, et al. (2005). "Healing of reamed glenoid bone articulating with a metal humeral hemiarthroplasty: a canine model." *J Orthop Res* 23(1): 18-26.

Matsen, F. A., 3rd, J. P. Iannotti, et al. (2003). "Humeral fixation by press-fitting of a tapered metaphyseal stem: a prospective radiographic study." *J Bone Joint Surg Am* 85-A(2): 304-8.

Matsen, F. A., 3rd, P. Boileau, et al. (2007). "The reverse total shoulder arthroplasty." *J Bone Joint Surg Am* 89(3): 660-7.

Matsen, F. A., 3rd, R. T. Bicknell, et al. (2007). "Shoulder arthroplasty: the socket perspective." *J Shoulder Elbow Surg* 16(5 Suppl): S241-7.

Matsen III, F. A., Rockwood, C. A., Wirth, M. A., Lippitt, S. B., Parsons, M.: *Glenohumeral Arthritis and Its Management*. In *The Shoulder*, Third Edition, Rockwood Jr, C. A., Matsen III, F. A., (eds), Wirth, M. A., Lippitt, S.B. (assoc. eds.), W. B. Saunders Company, Philadelphia, PA, pp. 879-1008, 2004.