Multilevel Artificial Disc Replacement Supplants Fusions in the Cervical Spine

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Following recent Food and Drug Administration (FDA) approval of cervical artificial disc replacement, this new treatment is becoming more popular for cervical degenerative disc disease. Historically, fusions of the cervical spine have been the mainstay for treatment of chronic neck and radiating arm pain. Unfortunately, fusions cause significant stiffness, and require as much as three months post-procedure for full fusion to occur. In addition, fusions are thought to be one of the leading causes of adjacent segment degeneration, which frequently requires further surgery.

The drawbacks of fusion are amplified in multilevel procedures, which require a longer timeframe for healing and are responsible for increased stiffness as additional levels are fused. By contrast, artificial disc replacement in the cervical spine has now been shown to maintain normal range of motion in three randomized studies of artificial discs with FDA investigational device exemptions. In longer-term follow-up, disc replacement had a three to four times decreased incidence of revision surgery compared to fusion procedures.

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Figure 1: Postoperative X-rays after three-level artificial disc replacement in the cervical spine.
Calcific tendinitis is most common among people between 30 and 60 years of age and typically follows a three-phase chronology described by Sarkar and Uhthoff in 1983. It is during the resorptive phase that patients often suffer excruciating pain, and this phase will usually pass with conservative management as the calcium is resorbed and the dead space is filled with granulation tissue. Conservative therapies, including analgesics, non-steroidal anti-inflammatory drugs, corticosteroid injections and needle aspiration, are typically attempted prior to consideration for surgical intervention. In some patients, however, symptom progression leads to constant pain that interferes with activities of daily living. When such pain fails to improve with conservative treatments, surgical management is necessary.

Clinical case study

Upon referral from another medical institution, a 55-year-old male presented with shoulder pain and neck discomfort that had been occurring for more than a year. X-rays identified calcium deposits in the region of the rotator cuff tendon insertion at the greater tuberosity consistent with calcific tendinitis. An MRI revealed calcific deposits embedded within the substance of the anterior half of the supraspinatus tendon insertion and moderate impingement. The patient was treated with a subacromial cortisone injection, which gave him partial relief for a short period of time. The patient was subsequently sent for fluoroscopically guided aspiration by a musculoskeletal radiologist, which also provided incomplete temporary relief.

Ultimately, the decision was made to proceed with an arthroscopic subacromial decompression and calcific deposit debridement. At the time of arthroscopy, a typical paste-like calcific material was expressed from the tendon at the anterior aspect of the supraspinatus tendon at its insertion on the greater tuberosity (Figure 1). After careful debridement of the deposits, a full-thickness rotator cuff defect was revealed (Figure 2). Additionally, the paste-like calcific deposits were found to be invading the bony substance of the greater tuberosity itself. A curette was used to debride the calcific deposits from all regions of bony invasion (Figure 3). A double-loaded suture anchor was then placed at the lateral aspect of the rotator cuff defect and an arthroscopic modified Mason-Allen stitch was placed. This was accomplished by passing two ends of one of the sutures in a standard horizontal mattress fashion, followed by passing one end of the second suture in a simple fashion medial to the mattress (Figures 4-6). This pattern was placed to decrease the risk of tissue failure at the tendon-suture interface and to decrease tension at the repair site.

Clinical outcome

On postoperative day one, the patient reported resolution of preoperative symptoms. At the one-week follow-up, he was completely pain free. He followed a conservative postop rehabilitation protocol and regained full range of motion and strength. As this case example shows, arthroscopic debridement of calcific deposits within rotator cuff tendons (with repair when appropriate) can lead to an excellent clinical outcome when conservative treatments fail.

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Arthroscopic Debridement of Calcific Tendinitis and Modified Mason-Allen Repair

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Arthroscopic photos from debridement and modified Mason-Allen repair.

Figure 1: Calcific deposits liberated from supraspinatus tendon.

Figure 2: Tendon defect revealed during gentle debridement of calcific deposits.

Figure 3: Curette used to debride calcific deposits invading bone.

Figures 4, 5 and 6: Passage of modified Mason-Allen stitch from lateral anchor.
Phenotypically similar to adult nucleus pulposis cells, human fetal chondrocytes are an excellent cellular candidate for the repair of degenerative intervertebral discs.

Unlike mesenchymal stem cells, the use of human fetal chondrocytes holds the promise of avoiding graft-versus-host mediated rejection response. There is no need to harvest cells from the recipient host, and because fetal chondrocytes are fully differentiated, they eliminate the uncertainty about whether the host environment will transform the stem cells into the appropriate target cells. Chondrocytes integrate functionally from the onset of transplantation, and offer a greater safety profile in terms of oncogenic potential.

Having established a unique cell line of human fetal chondrocytes capable of providing an ongoing supply of donor cells, my research team’s next step was to test the feasibility of using chondrocyte cell transplants to prevent disc degeneration and repair damage. We chose a rabbit model of disc degeneration, and utilizing sequential radiographs, MRI and histology, demonstrated that the spines of chondrocyte recipients ultimately had greater disc height and greater signal intensity than non-transplanted controls. Importantly, there was no evidence of immunologic rejection in the discs with transplanted cells.

Human fetal chondrocytes provide an important avenue of research for disc repair and regeneration, offering the possibility of biological protection against degeneration of the intervertebral disc. Further basic science studies continue in this area, with the possibility of human trials in the foreseeable future.

Dr. Delamarter is Vice Chair for Spine Services, Department of Surgery at Cedars-Sinai Medical Center and Co-Medical Director, Cedars-Sinai Spine Center. As director of the research described above, he co-authored a report on human fetal chondrocyte research to the American Academy of Orthopaedic Surgery with Hyun Bae, MD, Li Zhao, MD and Lea Kanim, PhD. Dr. Delamarter recently relocated his research laboratory and clinical practice to Cedars-Sinai.
Case example: C-4 through C-7 artificial disc replacement

A 35-year-old male in the U.S. Army was serving in Iraq as a paratrooper. After a traumatic jump, he suffered multilevel cervical disc herniations, resulting in more than eight months of incapacitating neck, shoulder and radiating arm pain (Figure 2). After failure of conservative care, including therapy, medications and injections, the patient was unable to continue serving in the U.S. Armed Forces. Had he undergone a three-level fusion, he clearly would not be able to return to the infantry, and would have faced a high likelihood of adjacent-level degeneration. Instead, he was referred for three-level artificial disc replacement of C-4 through C-7.

The patient underwent uneventful three-level artificial disc replacement. He was discharged after two days in the hospital and began physical therapy six weeks after surgical intervention. He returned to the U.S. Armed Forces three months after surgery and returned to a second tour of duty in Iraq. The patient is now four years-postop without neck, shoulder or arm pain, participates in all normal activities, including rigorous sports, and presents as normal upon neurologic examination. The patient’s postoperative X-rays (Figure 1) reveal normal alignment and normal motion of the cervical spine without adjacent-level degenerative changes.

Total disc replacement is a new and exciting area of spinal surgery which can allow normal range of motion, a quick recovery, decreased adjacent level degenerative changes and decreased revision surgery when compared to fusion cohorts.