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Anatomic Radial Head Solutions

Key Publications

The Effect of Prosthetic Radial Head Geometry on the Distribution and Magnitude of Radiocapitellar Joint Contact Pressures

Publication Excerpt

"Commercially available radial head prostheses demonstrated reduced radiocapitellar contact areas and elevated contact pressures during compressive loading. These were significantly greater with symmetrical circular prostheses than with asymmetrical elliptical designs. The prosthesis that best mimicked native contact behavior was the anatomical radial head prototype 2 [ARH Solutions] owing to its design for articulating with the capitellum, the lateral trochlear ridge, and the sulcus between."

Journal Abstract

Objective

To determine if radiocapitellar contact pressures would be elevated with nonanatomical (circular) prostheses over those mimicking native anatomy and if such pressures would be related to the depth and contour of the articular dish and to the pattern of prosthetic articulation against the lateral trochlear ridge.

Methods

Three commercially available circular radial head designs were compared with an anatomical radial head and 2 modified anatomical prototype radial head designs in 10 cadaveric specimens. Each prosthesis and specimen combination was loaded in neutral rotation and maximal extension with a custom testing apparatus while measuring contact areas and pressures using thin-film pressure sensors.

Results

Anatomical radial head prototype 2 had similar radiocapitellar contact areas and mean pressures as the native radial head; all other designs showed significant decreases in contact area and increased mean pressures. Peak contact pressures were also measured and were significantly elevated with all prostheses tested. Anatomical designs are statistically more likely to mimic normal contact with the lateral trochlear ridge and its adjacent sulcus than circular prostheses. They are also significantly less likely to have contact pressures above the 5 MPa threshold that is thought to be harmful to cartilage. The depth of the articular dish had a significant effect on contact area and pressure.

Conclusion

Commercially available radial head prostheses demonstrated reduced radiocapitellar contact areas and elevated contact pressures during compressive loading. These were significantly greater with symmetrical circular prostheses than with asymmetrical elliptical designs. The prosthesis that best mimicked native contact behavior was the anatomical radial head prototype 2 owing to its design for articulating with the capitellum, the lateral trochlear ridge, and the sulcus between.

Reference

Bachman DR, Thaveepunsan S, Park S, Fitzsimmons JS, An KN, O'Driscoll SW. The effect of prosthetic radial head geometry on the distribution and magnitude of radiocapitellar joint contact pressures. *J Hand Surg Am*. 2015;40(2):281–288.

Influence of Radial Head Prosthesis Design on Radiocapitellar Joint Contact Mechanics

Publication Excerpt

"Because high contact pressures can damage the cartilage of the capitellum over the long-term, it may be preferable to use implants that conform more anatomically to the capitellum."

Journal Abstract

Hypothesis

Our aim was to test whether anatomically designed metallic radial head implants could better reproduce native radiocapitellar contact pressure and areas than nonanatomic implants.

Methods

The distal humerus and proximal radius from 6 cadaveric upper extremities were serially tested in supination with 100 N of compression force at 4 angles of flexion (0°, 30°, 60°, and 90°). By use of a thin flexible pressure transducer, contact pressures and areas were measured for the native radial head, an anatomic implant, a nonanatomic circular monopolar implant, and a bipolar nonanatomic implant. The data (mean contact pressure and mean contact area) were modeled using a 2-factor repeated-measures analysis of variance with $P \leq .05$ considered to be significant.

Results

The mean contact areas for the prosthetic radial heads were significantly less than those seen with the intact radial heads at every angle tested ($P < .01$). The mean contact pressures increased significantly with all prosthetic radial head types as compared with the native head. The mean contact pressures increased by 29% with the anatomic prosthesis, 230% with the monopolar prosthesis, and 220% with the bipolar prosthesis. Peak pressures of more than 5 MPa were more commonly observed with both the monopolar and bipolar prostheses than with the anatomic or native radial heads.

Conclusion

The geometry of radial head implants strongly influences their contact characteristics. In a direct radius-to-capitellum axial loading experiment, an anatomically designed radial head prosthesis had lower and more evenly distributed contact pressures than the nonanatomic implants that were tested.

Reference

Sahu D, Holmes DM, Fitzsimmons JS, et al. Influence of radial head prosthesis design on radiocapitellar joint contact mechanics. *J Shoulder Elbow Surg.* 2014;23(4):456–462.

Stress Shielding Around Radial Head Prostheses

Publication Excerpt

"Stress shielding around radial head prostheses is common, regardless of stem design. However, it is typically minor, nonprogressive, and of questionable clinical consequence."

Journal Abstract

Objective

Stress shielding is known to occur around rigidly fixed implants. We hypothesized that stress shielding around radial head prostheses is common but nonprogressive. In this study, we present a classification scheme to support our radiographic observations.

Methods

We reviewed charts and radiographs of 86 cases from 79 patients with radial head implants from both primary and revision surgeries between 1999 and 2009. Exclusion criteria included infection, loosening, or follow-up of less than 12 months. We classified stress shielding as: I, cortical thinning; II, partially (IIa) or circumferentially (IIb) exposed stem; and III, impending mechanical failure.

Results

Of 26 well-fixed stems, 17 (63%) demonstrated stress shielding: I = 2, II = 15 (IIa = 12, IIb = 3), and III = 0. We saw stress shielding with all stem types: cemented or noncemented; long or short; and straight, curved, or tapered. The only significant difference was that stems implanted into the radial shaft had less stress shielding than stems implanted into the neck or tuberosity ($P = .03$). The average follow-up was 33 months (range, 13-70 mo). Stress shielding was detectable by an average of 11 months (range, 1-15 mo). The pattern of bone loss was similar in 16 of 17 cases (94%), starting on the outer periosteal cortex. The 3 cases with circumferential exposure of the stem (stage IIb) averaged 2.6 mm (range, 1-4 mm) of exposed stem. Stress shielding never extended to the bicipital tuberosity, and there were no cases of impending mechanical failure.

Conclusion

Stress shielding around radial head prostheses is common, regardless of stem design. However, it is typically minor, nonprogressive, and of questionable clinical consequence.

Reference

Chanlalit C, Shukla D, Fitzsimmons J, An K, O'Driscoll S. Stress shielding around radial head prostheses. ASSH, 2012.

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