SCIENTIFIC ARTICLE

Stress Shielding Around Radial Head Prostheses

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Purpose 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.

Conclusions Stress shielding around radial head prostheses is common, regardless of stem design. However, it is typically minor, nonprogressive, and of questionable clinical consequence. *(J Hand Surg 2012;37A:2118–2125.*

Type of study/level of evidence Therapeutic IV.

Key words Loosening, radial head prosthesis, radiographic bone loss, stress shielding.

THE USUAL INDICATIONS for radial head replacement are displaced, comminuted fractures of the radial head, especially when associated with complex elbow or forearm instability.[1,2] Patients who require treatment for this type of injury are often young and active.[1–3] Thus, there are many years during which complications could develop after prosthetic replacement of the radial head.

Stress shielding refers to bone loss around an implant in response to altered (diminished) mechanical stress.[4–7] This phenomenon is seen with well-fixed implants in which bone resorption occurs in regions where load transfer across the implant bypasses a portion of bone. There is no clear documentation of any statistical correlation between stress shielding and complications involving implants in the hip, where this phenomenon has been most studied. However, potential complications discussed in the literature include reduced implant longevity and increased fracture risk.[4,6,8–11]

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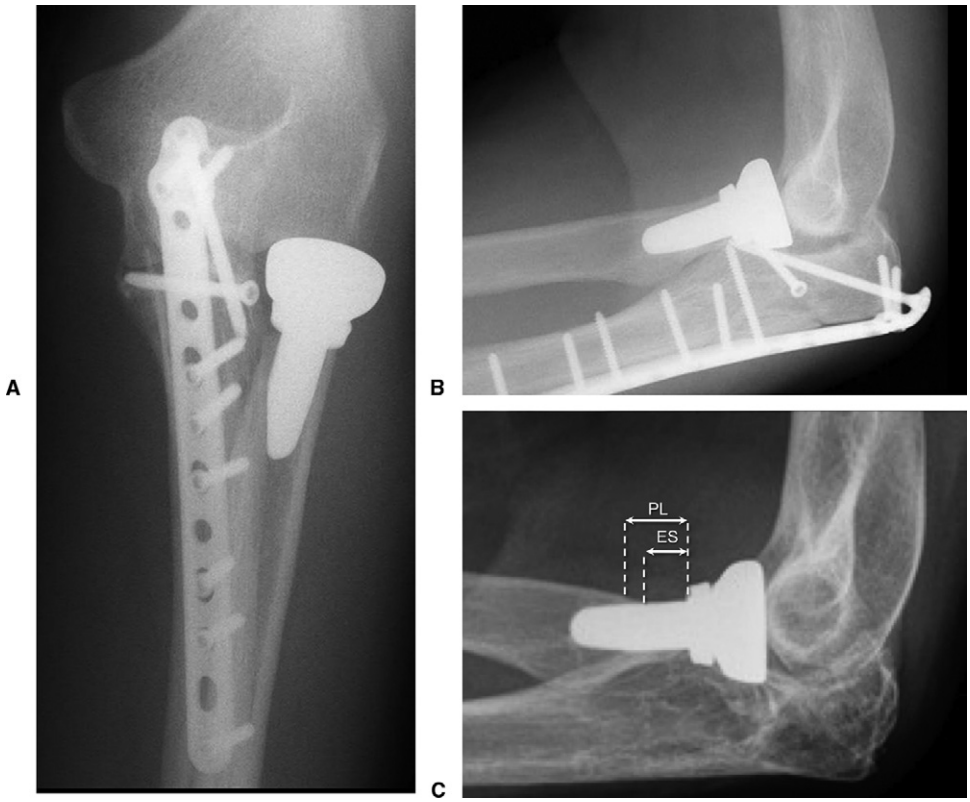

FIGURE 1: A Anteroposterior x-ray in neutral rotation optimizing dorsal and volar cortex visualization showing no stress shielding. **B** Lateral view optimizing medial and lateral cortex visualization showing no stress shielding. **C** Stress shielding was quantitated by measuring periosteal (PL) bone loss and exposed stem (ES). Copyright © 2012 Mayo Foundation. Used with permission.

Popovic et al[12] observed lucencies around 31% of bipolar radial head prosthetic replacements at midterm follow-up. However, the authors attributed bone resorption to polyethylene wear, rather than to stress shielding.

We performed the present study to investigate the prevalence and radiographic characteristics of stress shielding around radial head prostheses. Our hypothesis was that stress shielding around radial head prostheses is common but nonprogressive. In this study, we present a classification scheme to support our radiographic observations.

MATERIALS AND METHODS

We conducted a retrospective review study evaluating 86 consecutive cases from 79 patients on whom the senior author (S.O.D.) performed insertion, removal, or revision of a radial head replacement between August 1, 1999, and March 30, 2009. After we obtained patient consent and institutional review board approval, 42 cases in 40 patients met exclusion criteria, including infection, loosening, inadequate follow-up (< 12 mo), having had a custom-made prosthesis, or having another risk factor for bone loss (ie, chronic regional pain syndrome, particle-induced osteolysis resulting from a disengaging bipolar implant).

Indications for radial head prosthetic replacement were acute or chronic radial head fracture associated with elbow or forearm instability in 8 cases and radiocapitellar arthritis in 3 cases; revision in 11 cases for overstuffed, loose, malaligned, or disengaged radial head; prior resection in 3 cases; and osteochondromatosis in 1.

An observer who was a trained orthopedic surgeon (C.C.) reviewed radiographs and records of the remaining 26 cases of radial head arthroplasty in 26 patients. Multiple variables were reviewed, including type of radial head prosthesis, operative procedure, and radiographic appearance. Types of radial head prostheses investigated included cemented and noncemented stems and long and short stems. In addition, we examined straight, curved, and tapered stems.

We performed radiographic assessment immediately postoperatively and at 6 weeks, 3 months, 6 months, 12 months, and annually thereafter. We obtained anteroposterior (AP) and lateral plain film