CHAPTER 16
Evolve™ Modular Metallic Radial Head Arthroplasty
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Introduction

Radial head fractures are the most common fracture of the elbow [1]. Undisplaced fractures or small (< 33% of radial head) minimally displaced fractures (< 2 mm) can be treated with early motion with an excellent outcome in the majority of patients [2, 3]. Small displaced fractures which cause painful crepitus or limited motion are managed with fragment excision if they are too small or osteopenic to be treated with open reduction and internal fixation (ORIF) [4-6]. Larger displaced fractures are typically managed with ORIF with good outcomes in most patients [7-11]. However, comminuted fractures that have three or more parts have fared poorly with ORIF [10]. These comminuted radial head fractures are generally treated with radial head excision, with or without radial head replacement. In the setting of an associated injury to the medial collateral, lateral collateral, or interosseous ligaments, radial head excision is contraindicated due to its important role as a valgus, varus and axial stabilizer [12-14].

In patients with a concomitant elbow dislocation, radial head excision should be avoided due to associated disruption of the medial and lateral collateral ligaments of the elbow [15]. In the absence of an elbow or distal radioulnar joint dislocation these associated ligament injuries are often difficult to diagnose on clinical examination in patients with pain from a radial head fracture. However, these soft tissue injuries are present in the vast majority of patients with a comminuted radial head fracture, suggesting that radial head replacement should be considered in most patients with an acute unreconstructable fracture [16].

Radial head arthroplasty may also be useful for post-traumatic reconstruction such as radial head malunions, nonunions, and rheumatoid arthritis. They may also be considered for the management of late axial forearm instability from Essex-Lopresti injuries, valgus instability from medial collateral ligament insufficiency, and varus or posterolateral rotatory instability from lateral collateral ligament insufficiency. The success of radial head implantation for these chronic conditions has received little attention to date, with most studies focusing on the acute treatment of radial head fractures.

Silicone radial head implants offer little in the way of axial or valgus stability to the elbow relative to less-compliant metallic implants [17-19]. Silicone implants have been complicated by a high incidence of wear and fragmentation and, in some incidences, led to silicone synovitis and generalized joint damage [20-24]. Clinical experience with an uncemented monoblock metallic radial head implant has been favourable in the setting of complex instability of the elbow, in our experience and that of others [25-32]. Until recently, commercially available metallic implants have not been properly sized and have only been available as a monoblock de-
Rationale for Metallic Radial Head Replacements

In a study comparing the valgus stability afforded by four different radial head implants, King et al. [19] reported that silicone radial head implants did not significantly increase the stability of the medial collateral ligament-deficient elbow. All three metallic radial head implants studied afforded improved stability, similar to the native radial head. Similarly in a study by Sellman et al. [17], the Authors demonstrated that silicone radial head implants did not improve the axial stability of the interosseous ligament-deficient forearm. Metallic radial head implants restored stability similar to the native radial head. Reconstruction of the interosseus ligament further increased stability. These in vitro biomechanical studies provide a rationale for metallic radial head replacement of an unreconstructable comminuted radial head fracture in the setting of a concomitant interosseous or medial collateral ligament injury.

Beingessner et al. [35] reported a subtle but significant alteration in elbow kinematics and stability following radial head excision in cadaveric elbows with intact ligaments. In addition to increasing the varus-valgus laxity of the elbows, the articulation was noted to track slightly more valgus when subjected to simulated active flexion. These subtle but significant alterations in kinematics and stability following radial head excision were corrected by a modular metallic radial head arthroplasty. These biomechanical data suggest that metallic radial head arthroplasty should be considered in all patients following radial head excision in patients with unreconstructable fractures regardless of the status of the collateral ligaments [1, 36]. Randomised trials are needed to determine whether the clinical outcome of metallic radial head arthroplasty is superior to radial head excision in the setting of intact collateral ligaments.

The availability of silicone implants in the 1970’s resulted in the widespread use of silicone radial head arthroplasty [37]. A number of authors have reported the results of silicone radial head replacements. While the early clinical reports were favourable, implant fracture and persistent joint instability have been commonly described in more recent studies [20-23, 38]. Silicone synovitis has also been reported due to particulate debris [24]. As a consequence of problems with silicone devices, metallic implants have become more popular. Although the clinical reports of experience with metallic radial head arthroplasty are limited, they are generally encouraging. Harrington and Tountas [27] reported their preliminary experience with a monoblock titanium radial head implant. A subsequent medium-term follow-up study from this centre demonstrated the durability of this metallic implant at an average of 12 years [26]. Our experience with this uncemented spacer concept has also been encouraging and prompted the development of the current implant [30].

Design Rationale of the Evolve™ Modular Radial Head Arthroplasty

The optimal design features of a radial head implant system are unknown. Our clinical experience with early generations of metallic radial head replacements parallels that of Beredjiklian et al. [39], who studied the anatomic dimensions of the proximal radius and compared them to those of a commercially available titanium implant system. The available implants overestimated the medullary diameter of the radial neck and underestimated the thickness of the radial head, making it difficult to restore normal anatomy. We studied the anthropometric features of the proximal radius using a highly accurate measurement system, a coordinate measurement machine [34]. The native radial head was found to have a somewhat elliptical shape, and the articular dish of the radial head was variably offset from the radial neck. The medullary diameters of the radial neck and the diameter of the radial head were also measured from the radiographs of patients who had had a radial head arthroplasty. There was no correlation of the dimensions of the radial head and neck, suggesting that a modular implant design is needed to optimally size a radial head arthroplasty.

The surgical implantation of a monoblock radial head implant, where the head is fixed to the stem, may be difficult if the elbow is not unstable such as following an elbow dislocation or lateral ligament disruption. Placement of such implants requires subluxation of the proximal radius either laterally or posterolaterally. In the setting of acute fractures it is usually possible to deliver the proximal radius later-