J Shoulder Elbow Surg (2013) 22, 1236-1241

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ELBOW

Linking of total elbow prosthesis during surgery; a biomechanical analysis

Maarten J. De Vos, MD[a], Marc L. Wagener, MD[b,*], Jan C.M. Hendriks, PhD[c], Denise Eygendaal, MD, PhD[d], Nico Verdonschot, PhD[b,e]

[a]*Department of Orthopaedics, Ter Gooi Hospital, Hilversum, The Netherlands*
[b]*Department of Orthopaedics, Radboud University Hospital, Pb 9101, 6500HB Nijmegen, The Netherlands*
[c]*Department of Epidemiology, Biostatistics and Health Technology, Nijmegen, The Netherlands*
[d]*Department of Orthopaedics, Amphia Hospital, Breda, The Netherlands*
[e]*Laboratory for Biomechanical Engineering, University of Twente, Enschede, The Netherlands*

Background: Presently, 2 types of elbow prostheses are used: unlinked and linked. The Latitude total elbow prosthesis allows the surgeon to decide during the implantation whether the prosthesis is placed unlinked or linked, and whether the native radial head is retained, resected, or replaced. The purpose of this study is to assess and to compare the varus and valgus laxity of the unlinked and linked version of the latitude total elbow prosthesis with: (1) the native radial head preserved, (2) the native radial head excised, and (3) the native radial head replaced by a radial head component.
Methods: Biomechanical testing was performed on 14 fresh-frozen upper limb specimens.
Results: Linking the prosthesis predominantly influences the valgus laxity of the elbow.
Discussion/conclusion: Linking the Latitude total elbow prosthesis results in increased valgus stability. In the linked version of the total elbow prosthesis, the radial head only plays a small part in both valgus and varus stability. An unlinked situation is not advised in absence of a native radial head or in case of inability to replace the radial head.
Level of evidence: Basic Science Study, Biomechanics.

Keywords: Elbow; arthroplasty; linking; stability; cadaver

Developments in elbow joint replacement have lagged behind that of the knee, hip and shoulder arthroplasty for different reasons, such as the high failure rate of the early designs. In the first total elbow prostheses, a rigid hinge linked the humeral and ulnar components, which resulted in high stress on the prosthesis-bone-interface with loosening of the prosthesis. In the past decades 2 types of elbow prostheses were developed: unlinked and linked.[4]

Unlinked prostheses rely mainly on the surrounding soft tissue to provide stability to the elbow; although the articular geometry of the unlinked prostheses also contributes to the stability.[1,10,11] In linked elbow systems, the 'sloppy-hinge' consists of a pin and polyethylene construct that provides inherent stability and allows up to about 8° of varus and valgus laxity in the articulation. Linked prostheses are therefore indicated when significant osseous or ligamentous deficiency exists.

*Reprint requests: Marc L. Wagener, MD, Department of Orthopaedics, Radboud University Hospital, Pb 9101, 6500HB Nijmegen, the Netherlands.
E-mail address: mlwagener@gmail.com (M.L. Wagener).

1058-2746/$ - see front matter © 2013 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2013.02.010

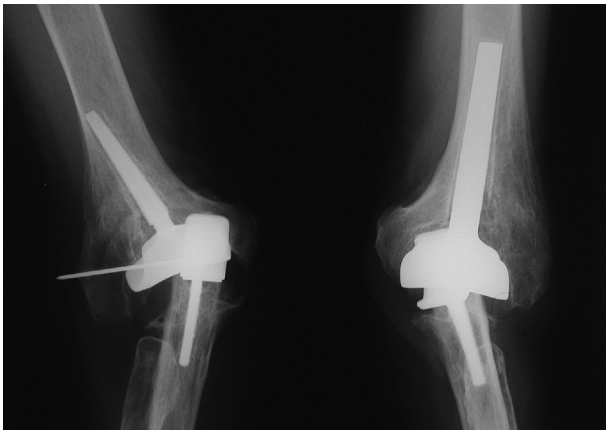

Figure 1 Right elbow: subluxation 9 years after Kudo IV. Left elbow: valgus instability 7 years after Kudo V.

Worldwide both linked and unlinked prostheses are used. A concern of the unlinked prostheses is instability of the prosthesis. Literature[21,23,25] shows a 2.3-4.9% dislocation of unlinked elbow prostheses shortly after surgery. Furthermore, a 'tardy' valgus instability has been described in a rather large number of cases 3-5 years postoperative.[3] Progressive insufficiency of the medial collateral ligament (MCL), in combination with resection of the radial head and progressive polyethylene, wear results in gradual increase of valgus instability that finally results in subluxation of the prosthesis (Fig. 1). As previously mentioned, a linked prosthesis overcomes the problem of dislocation and valgus instability, but might encounter the problem of high forces over the linkage mechanism, resulting in polyethylene wear (bushing wear) and high forces on the stem-cement and cement-bone interfaces, which results in early loosening of the prosthesis.[5,6,16]

Replacement of the radial head as part of a total elbow arthroplasty remains controversial. In most currently available linked and unlinked total elbow prostheses systems, the radial head is resected; although in some systems the native radial head can be preserved.[12] The role of the radial head in relation to axial load bearing and stability of the native elbow joint has been re-emphasized.[13,15]

The Latitude total elbow prosthesis (Tornier, Stafford, TX, USA) is a total elbow prosthesis that allows the surgeon to decide during the implantation whether the prosthesis is placed unlinked or linked, and whether the native radial head is retained, resected, or replaced by a bipolar radial head component.

The unlinked prosthesis can easily be converted into a linked version merely by placing an extra cap on the ulnar component of the prosthesis (Fig. 2). The linked version is a 'sloppy-hinge' prosthesis with a restricted amount of freedom in both valgus and varus direction.

The short-term results in case series of patients with this new elbow system are promising. No biomechanical data of the effect of linking the implant during surgery on the valgus and varus stability are available yet. Until now, no recommendations can be given to the surgeon, based on the currently available biomechanical properties of the Latitude elbow system, whether or not to link the implant in relation to the radial head.

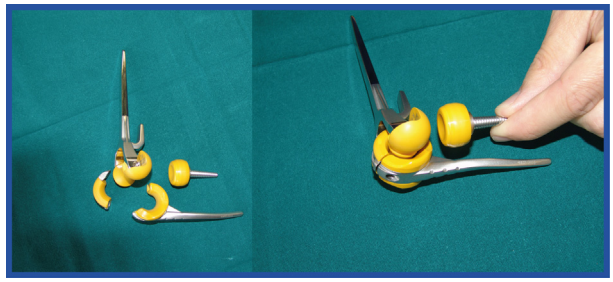

Figure 2 **Left panel**, The disassembled Latitude trial prosthesis. It consists of 4 components: humeral component, ulnar component, bi-polar radial head, and the ulnar cap. The ulnar cap can be placed on the ulnar component to link the prosthesis. **Right panel**, The linked Latitude trial prosthesis with the radial head component held in place before the capitellum.

The purpose of this study is to assess and to compare the varus and valgus laxity of the unlinked and linked version of the Latitude total elbow prosthesis with: (1) the native radial head preserved, (2) the native radial head excised, and (3) the native radial head replaced by a radial head component.

Methods

For this study, 14 fresh-frozen upper limb specimens from 7 donors (3 men, 4 women) were used. The mean age at time of death was 71 years (range, 50-93). All specimens were macroscopically assessed and all osseous structures were radiological analyzed by standard radiographs. The soft tissue of the proximal half of the upper-arm was removed. The biceps, triceps, and brachial muscle were detached at the humerus. The hand and wrist were removed, leaving the triangular fibro cartilaginous complex (TFCC) intact. The prepared upper limb specimens were fixed in a specially designed testing apparatus. The apparatus allowed the humerus to be rotated along its longitudinal axis. A valgus and varus forces could be applied to the forearm using gravity by a weight hanging from a pin that was placed in the distal ulna. In previous similar studies a 0.75N valgus or varus force was used. This results in measurable varus and valgus deviations without damaging the collateral ligaments of the elbow.[8,9,18,19] Forces of respectively 20N, 10N, and 10N were applied to the triceps, biceps and brachial muscles, respectively, to imitate active contraction and to apply axial loading to the elbow joint. A pin was inserted into the distal ulna and radius. All tests were performed with the forearm in neutral position.

The flexion and extension of the elbow was realized manually. One of the researchers used a rod to push against the pin that was inserted distally into the ulna. The rod was held perpendicular to the flexion-extension direction of the elbow and no friction between the ulnar pin and the rod was noticed. During the testing the specimens were kept in optimal condition by keeping them moist with a 0.9% saline solution.