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Arthroplasty of the shoulder in rheumatoid arthritis with rotator cuff dysfunction

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Abstract We carried out a retrospective analysis of 17 total shoulder replacements using the reversed Delta III prosthesis in patients with rheumatoid arthritis of the glenohumeral joint complicated by rotator cuff dysfunction. Outcome was assessed using the Constant-Murley scoring system. In addition, general health status was assessed with the Short Form Health Survey and radiographical analysis of the prostheses undertaken. Mean age at the time of surgery was 64 years. Thirteen shoulders were followed up for more than 5 years (mean 87 months). Median Constant-Murley score was 59.0; median scores for general health were 33.40 and 49.36 for the physical and mental components respectively. Radiographical analysis revealed evidence of lucencies about the humeral component in all cases and about the glenoid component in five cases. Despite the good clinical results, the high incidence of radiographical lucencies is of concern.

Résumé Nous rapportons une analyse rétrospective de 17 remplacements prothétiques de l'épaule qui utilisent la prothèse renversée Delta III chez des malades atteints de polyarthrite rhumatoïde compliquée par un dysfonctionnement de la coiffe des rotateurs. Le résultat a été étudié en utilisant le score de Constant-Murley et une analyse radiographique. De plus, l'état général a été apprécié avec le score « Short Form Health Survey ». L'âge moyen à l'opération était 64 années. 13 épaules ont été suivies plus de cinq ans (moyenne 87 mois). Le score de

Constant-Murley médian était 59.0. Les Scores médians pour l'état général étaient 33.40 et 49.36 pour les composants physiques et mentaux respectivement. L'analyse radiographique a révélé des liserés autour du composant huméral dans tous les cas et autour de la glène dans cinq cas. En dépit des bons résultats cliniques, la haute fréquence des liserés radiographiques est inquiétante.

Introduction

Prosthetic replacement of the glenohumeral joint in the presence of rotator cuff dysfunction presents the surgeon with the difficulty of relieving the patient's pain whilst maintaining a stable joint with as much functional range of motion (ROM) as possible. Some authors [7, 14, 19, 21] have advocated the use of hemiarthroplasty, including bipolar arthroplasty, but clearly, involvement of the glenoid in the arthritic process compromises such treatment. Adverse results with hemiarthroplasty in the presence of massive rotator cuff tears due to antero-superior instability of the implant have been reported [7]. Other authors [3, 8, 12, 16] also showed a high incidence of glenoid component loosening when total shoulder arthroplasty was used in the presence of irreparable, massive rotator cuff tears. This loosening is caused partly by increased component translation made possible by the cuff deficiency.

Constrained prostheses prevent translation and confer stability, replacing the function of the rotator cuff. However, significant translational forces are transmitted to the prosthesis-bone interface and can result in increased rates of glenoid loosening. Grammont [9] has introduced a constrained reversed 'Delta' prosthesis, incorporating the principles of a large glenoid ball (the glenosphere) with hydroxyapatite-coated uncemented fixation. Contrasting results have been reported with this prosthesis [2, 3, 11, 13, 16, 20]. In order to validate the favourable results reported with the reversed Delta III prosthesis, we carried out a retrospective analysis of our experience with the prosthesis in patients with rheumatoid arthritis of the glenohumeral joint complicated by rotator cuff dysfunction.

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Fig. 1 a Delta III total shoulder system showing its modularity. b Glenoid component of the Delta III total shoulder system

Materials and methods

Between June 1992 and January 2001, 15 patients underwent 17 total shoulder replacements for glenohumeral rheumatoid arthritis with rotator cuff dysfunction using the reversed Delta III total shoulder system. Pre-operatively, all patients complained of pain sufficient to disturb sleep and interfere with activities of daily living. Radiographs were obtained prior to surgery and graded according to the system described by Larsen et al. [10].

The Delta III total shoulder prosthesis (DePuy, France, SA) is a fully constrained, modular prosthesis available in either 'anatomical' or 'reversed' configuration. In all our cases, the reversed configuration was used (Fig. 1). The stainless steel glenoid baseplate and humeral stem were fixed to the bone in a press-fit manner, enhanced by hydroxyapatite coating. Modularity of both components allows soft tissue balancing and adjustment of degree of constraint.

All procedures were carried out by the senior author (JGB). A standard deltopectoral approach to the shoulder was used. In all cases, disruption of the rotator cuff was confirmed at surgery, with either massive tearing or gross attenuation rendering the cuff non-functional. Satisfactory soft tissue balancing and component positioning was achieved in all cases.

Physiotherapy was commenced on the first post-operative day, with self-assisted shoulder flexion and passive shoulder adduction and abduction to 45°. Active abduction was commenced at 10 days; stabilisation and aggressive strengthening commenced at 3 weeks. Physiotherapy was continued until maximal ROM was achieved.

All patients were reviewed by an independent observer (MJW) on four separate occasions. They were assessed using the Constant-Murley score [5]. The power component of the score was assessed using the method described by Bankes [1]. Assessment of the patient's general health was made using the 12-item Short Form Health Survey (SF-12), a multipurpose generic measure of health status [18]. Standard radiographs were obtained on all patients at the times of review and assessed for evidence of radiolucent lines or a change in component position. The radiographical scoring system described by Franklin [8] was used to assess glenoid component loosening. This classifies lucency around the glenoid component from 0 to 5, with 0 as no lucency.

Results

Mean age at surgery was 64 (range 43–72) years. Fourteen patients were women. There was a peri-operative fracture of the glenoid in one patient, and broken drill bits in two cases. There were no neurovascular problems, and no wound complications. One patient was lost to follow-up after 1 year. Eleven patients (13 shoulders) have been followed up for more than 5 years (mean 87 months, range 60–110 months). The median Constant-Murley score for these thirteen shoulders was 59.0 (interquartile range 50.5–64.5, 95% CI 50.7–64.3). Eight patients (ten shoulders) reported no pain. General health,

Fig. 2 Antero-posterior radiograph of Delta III prosthesis. Note the translation of the glenoid component and the proximal stress shielding

Table 1 Patient details and clinical results for the Delta III total shoulder prosthesis. *Age* (years) at time of surgery, *HD* hand dominance, *PC* physical component, *MC* mental component

Patient	Age	Gender	HD	Operation side	Follow-up (months)	Larsen grade	Constant-Murley score (total)	SF-12 (PC)	SF-12 (MC)	Glenoid (Franklin grade) [8]
1	62	F	R	L	110	3	53	48.22	41.66	0
1	67	F	R	R	66	3	56	48.22	41.66	1
2	72	F	R	L	85	3	74	43.19	37.11	5A
3	68	F	R	L	99	4	64	56.86	42.01	0
4	69	F	R	R	60	3	59	29.44	52.68	0
4	66	F	R	L	96	3	64	29.44	52.68	0
5	44	F	R	R	110	4	86	44.76	47.16	1
#6	64	F	R	R	110	3	51	30.52	55.30	5A
7	68	F	R	L	80	4	61	33.4	66.38	0
8	72	F	R	L	67	3	65	31.63	54.01	0
9	53	F	R	R	67	4	37	32.73	49.43	0
10	69	F	R	R	98	4	50	30.08	49.04	0
11	64	F	R	L	81	5	40	38.27	49.36	1

Glenoid fracture

as measured by the SF-12, revealed a median physical component score of 33.4 (interquartile range 30.3–46.49, 95% CI 30.4–45.6) and a median mental component score of 49.4 (interquartile range 41.8–53.3, 95% CI 41.9–53.3).

Radiographical review at the most recent follow-up revealed radiolucent lines about the glenoid component in five cases. This included two grade 5A glenoid loosening (Fig. 2), one of which occurred in a patient in whom a peri-operative glenoid fracture occurred. This patient had a very deficient glenoid at the time of surgery. Assessment of the humeral component identified proximal stress shielding in all cases. No humeral components displayed radiographical evidence of migration. Results are further summarised in Table 1.

Discussion

Our results indicate that the reversed Delta III prosthesis is useful in the treatment of rheumatoid arthritis of the glenohumeral joint complicated by rotator cuff dysfunction. Pain is reliably improved, although function, ROM and power was more variable.

The SF-12 has become one of the most widely used instruments for purposes of monitoring the health of both general and specific populations. It has been shown to be as reliable and valid as the longer SF-36, but easier to use in practice [18]. To our knowledge, this is the first study to document scores following shoulder arthroplasty. The median physical component score in this study was 33.4 (mean 38.2). This compares with a mean physical score of 50.12 (SD 9.45), the reference norm for the general U.S. population. The median mental component score in this study was 49.4 (mean 49.1), which compares with a mean mental score of 50.04 (SD 9.59) for the normal general U.S. population. Whilst it would be wrong to draw any firm conclusions from these scores, they do suggest that, despite these patients having functional capabilities below the norm, mentally they are

equivalent to the norm. This is born out by the patients' positive reaction to the results of their surgery.

Poppen et al. [15] have shown that at 90° of unloaded shoulder abduction, a joint reaction force of 0.89 times body weight is transmitted across the glenohumeral joint, with a superiorly directed force vector at 30° and 60°. The magnitude and direction of these forces is unfavourably altered in deficiency of the rotator cuff [17], increasing the loosening forces applied to the glenoid component. Development of a constrained prosthesis must therefore attempt to reduce the resulting joint reaction force and enhance glenoid fixation to minimise the risk of loosening. Joint reaction force can be reduced by medialisation of the centre of rotation of the shoulder [6], but this must be achieved whilst maintaining adequate soft tissue tension in the abductor musculature. Enhancement of glenoid fixation is required because the glenoid provides only marginal bone stock for fixation, reduced even further in cases of erosive arthropathy as in rheumatoid arthritis, with significant translational forces transmitted to it.

Recognising the high incidence of radiolucent lines reported with cemented fixation, some authors have advocated the development of tissue ingrowth components, which seem to have reduced the incidence of radiolucent lines around the glenoid component [4, 20]. Despite the satisfactory functional scores, in five of the 13 cases we have followed up for more than 5 years, there was evidence of possible loosening of the glenoid component. This confirms the belief that glenoid fixation in cases of poor bone quality and stock, as in rheumatoid arthritis, presents a formidable challenge to the surgeon. This is especially so when a constrained type of prosthesis is employed. In the case of the humeral component, satisfactory stable fixation was evident in each case, although all radiographs demonstrated proximal stress shielding. Although hydroxyapatite coating was the mode of fixation in this prosthesis, the reliability of bone ingrowth has not yet been demonstrated in the glenoid component, and further studies are required to assess the

development of either bone ingrowth or stable fibrous fixation.

Although the clinical results we have shown are satisfactory, concern remains surrounding the quality of fixation of the glenoid component as part of a constrained total shoulder replacement in patients with rheumatoid arthritis and co-existing rotator cuff deficiency. The case for glenoid replacement in such instances remains unproven, and continued follow-up is required.

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