Outcome after primary hemiarthroplasty for fracture of the head of the humerus
A RETROSPECTIVE MULTICENTRE STUDY OF 167 PATIENTS

We have examined 167 patients who had a hemiarthroplasty for three- and four-part fractures and fracture-dislocations of the head of the humerus in a multicentre study involving 12 Austrian hospitals. All patients were followed for more than a year.

Anatomical healing of the tuberosity significantly influenced the outcome as measured by the Constant score and subjective patient satisfaction. With regard to pain, the outcome was generally satisfactory but only 41.9% of patients were able to flex the shoulder above 90°. The age of the patient and the type of prosthesis significantly influenced the healing of the tuberosity, but bone grafting did not. Achievement of healing of the tuberosity was inferior in institutions at which less than 15 hemiarthroplasties had been performed (Mann-Whitney U test, p = 0.0001).

Primary replacement of the head of the humerus head is recommended in selected three- or four-part fractures and fracture-dislocations of the glenohumeral joint. Further indications are split fractures of the head or those involving damage to large areas of the articular surface.1-3 Whereas a good range of movement without pain after hemiarthroplasty has been recorded by many authors, recent publications question these results.2-10

The management of these complex fractures is still a challenging and unresolved problem. A major factor in the quality of the result is the healing of the tuberosity in an anatomical position.5,11-13 We have therefore evaluated the outcome after primary hemiarthroplasty in a large series. Factors influencing the outcome were tested statistically and compared with those of other studies.

Patients and Methods

Between 1994 and 1998, 167 patients were examined in 12 Austrian hospitals after primary hemiarthroplasty. The mean follow-up period with clinical and radiological evaluation was 29 months (12 to 88). There were 127 women (76.0%) and 40 men (24.0%) with a mean age at the time of fracture of 70 years (22 to 91). The dominant arm was affected in 55.7%.

According to Neer’s classification,14 17 patients (10.2%) were rated as three-part fractures, 109 (65.2%) as four-part fractures and 41 (24.6%) as fracture-dislocations. At the time of injury two patients presented with evidence of paresis of the axillary nerve and two with signs of a brachial plexus lesion. In every case hemiarthroplasty was carried out within 30 days after the injury.

The Global shoulder prosthesis (De Puy, Leeds, UK) was used in 90 patients (53.9%), the Neer II model (Smith & Nephew, Memphis, Tennessee) in 39 (23.4%), the Biomet (Warsaw, Indiana) in 15 (9.0%), the Aequalis (Tornier, Montb, France) in 12 (7.2%), and the Howmedica (Stryker Howmedica Osteonics, Mahwah, New Jersey) in 11 (6.6%). Fixation of the tuberosities was achieved by either absorbable suture materials, by non-absorbable materials, or by metal wires. In several cases the material used was not recorded. Fixation was carried out with sutures through the bone and to the fin systems of the implant; in no case was the fixation of the tuberosity made to the shaft in a cerclage style.

After operation 164 patients (98.2%) were immobilised for a mean period of 3.26 weeks (1 to 10). Passive movement was initiated on the ninth day after surgery (0 to 49). Active movement was started on the 30th day (0 to 180). Post-operative infection occurred in two patients, one deep and one superficial. There was no case of loosening of a prosthesis. Three patients developed anterosuperior subluxation attributed to insufficiency of the rotator cuff.

At the time of follow-up all patients were interviewed and underwent physical and
Table I. Healing of the tuberosity according to the type of prosthesis by number and percentage

<table>
<thead>
<tr>
<th>Type of prosthesis</th>
<th>Not healed</th>
<th>Healed with displacement of &gt;0.5 cm</th>
<th>Healed with displacement of &lt;0.5 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global (n = 90)</td>
<td>51 (56.7)</td>
<td>13 (14.4)</td>
<td>26 (28.9)</td>
</tr>
<tr>
<td>Neer 2 (n = 39)</td>
<td>13 (33.3)</td>
<td>12 (30.8)</td>
<td>14 (35.9)</td>
</tr>
<tr>
<td>Aequalis (n = 12)</td>
<td>6 (50.0)</td>
<td>1 (8.3)</td>
<td>5 (41.7)</td>
</tr>
<tr>
<td>Biomet (n = 15)</td>
<td>1 (6.7)</td>
<td>2 (13.3)</td>
<td>12 (80.0)</td>
</tr>
<tr>
<td>Howmedica (n = 11)</td>
<td>6 (54.5)</td>
<td></td>
<td>5 (45.5)</td>
</tr>
<tr>
<td>Total (n = 167)</td>
<td>77 (46.1)</td>
<td>28 (16.8)</td>
<td>62 (37.1)</td>
</tr>
</tbody>
</table>

Results

Pain. Of the 167 patients 13 (7.8%) had severe pain, 22 (13.2%) moderate, 65 (38.9%) mild and 67 (40.1%) no pain. The situation in regard to the tuberosities at follow-up did not significantly correlate with pain. The amount of vertical elevation required in a patient's job was directly related to pain. In the group with severe pain, 8 (61.5%) presented with a stiff shoulder and none was able to carry out functions at head level. Seven patients (11.3%) of the anatomically healed, rated their pain as severe and had a stiff shoulder. Good function was present in the group without pain; 4 (67.1%) were able to carry out work at head level or higher. All but 1 (6%) were able to reach above chest height (Kruskal-Wallis test, p = 0.0001).

Patient satisfaction. Subjectively, 57 (91.9%) of the patients with healed tuberosities (<0.5 cm of displacement) rated their result as satisfactory or very satisfactory. Only 16 (57.1%) of those with healed but displaced tuberosities and 43 (55.9%) of those in which union had not occurred rated it in the same way (chi-squared test, p = 0.031).

Healing of the tuberosities. At the time of follow-up, 77 of the patients (46.1%) (mean age 72 years), had an absorbed, united or malpositioned tuberosity; 28 (16.8%) (mean age 70 years) had healing of the tuberosities, but with displacement of more than 0.5 cm and 62 (37.1%) (mean age 67 years), had healing with less than 0.5 cm of displacement. The influence of age on healing of the tuberosity was significant (one way ANOVA, p = 0.044). The mean overall Constant score was 55.37 points on the injured side, compared with 86.50 on the normal side. Respectively, 70 (41.9%) of all patients were able to elevate the arm forwards above the horizontal and 58 (34.7%) to abduct beyond 90°. Patients with healed tuberosities had significantly higher Constant scores. A mean of 49.21 points were scored by patients with reabsorbed or ununited tuberosities, 53.14 points in the healed but displaced group and 64.03 points in the healed but undisplaced group (one-way ANOVA, p = 0.0001).

Healing of the tuberosities was not significantly influenced by bone grafting or by the use of cement to secure the prosthesis. Moreover, the method of fixation of the tuberosity had no measurable effect on union or functional outcome. The mean value of the height of implantation for the unhealed group was -3.64 mm, for the healed but displaced group -2.04 mm, and for the anatomically healed group -1.47 mm. The differences were not significant (one-way ANOVA, p = 0.335). Overall, the mean value was -2.56 mm (-70 to +15).

The type of prosthesis used for hemiarthroplasty did influence the healing of the tuberosity (Kruskal-Wallis test, p = 0.01; Table I). Institutions performing fewer than 15 hemiarthroplasties achieved inferior results (Mann-Whitney U test, p = 0.0001); 49 (62%) of those operated upon by surgeons treating less than 15 patients remained ununited, whereas in the larger groups only 28 (31.8%) were ununited.

Good rates of healing were achieved with the Biomet prosthesis (80%) with healing in an anatomical position, followed by the Howmedica (45.5%), the Aequalis (41.7%), the Neer 2 (35.9%) and the Global (28.9%). The mean age of the patients was lowest in the Biomet group at 64 years; in the Neer 2 and Howmedica groups it was 68 years, in the Global 71 years and in the Aequalis 74 years. In order to show that the type of prosthesis and not the youth of the patients in the Biomet group was the important factor, a partial correlation analysis was performed. After extracting age, the significant influence of the Biomet prosthesis on the healing of the tuberosity remained (partial correlation coefficient 0.213, p = 0.006). The lowest overall healing score was achieved with the Global prosthesis which was the most frequently used throughout the whole series (90 patients). Institutions performing less than 15 hemiarthroplasties, using the Global system showed significant differences in healing of the tuberosity (chi-squared test, p = 0.0001). Those performing more than 15 hemiarthroplasties had a healing rate of 51.4%. In the healed but displaced group it was 20% and in the unhealed group 28.6%. The rate of nonunion with the Global system increased to 74.5% in institutions performing fewer than 15 arthroplasties. In the healed but displaced group it was 10.9% and in those healing in the anatomical position 14.5%. Only three patients were not immobilised in a
shoulder bandage post-operatively. None of these showed healing of the tuberosity.

Discussion

Hemiarthroplasty for three- and four-part fractures and fracture-dislocations is expected to provide relief from pain and useful function. Neer\textsuperscript{16} was the first to propose surgical treatment of three- and four-part fractures, because conservative treatment gave poor results. Three-part fractures were treated by ORIF or hemiarthroplasty, and prosthetic replacement was recommended for four-part fractures. The results were excellent or good in at least 80% of the patients. However, Neer\textsuperscript{16} stated in his summary: “Using these indications, the typical result was satisfactory but imperfect and many months were required for maximum recovery”. Compito et al\textsuperscript{3} achieved excellent results in 48.5% of their fractures after hemiarthroplasty. Zyto et al\textsuperscript{7} found no statistical difference between three- and four-part fractures according to the Constant score and range of movement, but their series was small.

The outcome regarding pain has never correlated with the anatomical healing of the tuberosity, but patients with healed tuberosities and severe pain lost movement to the point of ankylosis. This shows that anatomical healing of the tuberosity is only part of the success; healing with function must be the aim. The range of movement in our series is rather poor and can be compared with that of more recent studies.\textsuperscript{4,7,9} The excellent results described by Compito et al\textsuperscript{3} were obtained in our series only in patients with healed tuberosities with displacement of less than 0.5 cm.

Age is considered to be a relevant factor in decision-making.\textsuperscript{11,13} Our findings suggest that older patients have a significantly higher risk of nonunion or malunion of the tuberosity. Older patients were subjectively no more satisfied with their shoulder after hemiarthroplasty than younger ones. Satisfaction correlated with anatomical healing of the tuberosity. Therefore the assumption that acceptance of pain and loss of function are greater in the older age group, with less functional demands, cannot be confirmed from these data.

The only factor significantly influencing the outcome, according to the Constant score, was healing of the tuberosity in the anatomical position. Patients in whom the tuberosity healed with displacement were only slightly better than those in whom it did not heal or reabsorbed. A tuberosity which remained displaced led to a decreased range of movement because of impingement. Primary fixation of the tuberosity in a displaced position gave universally bad results which emphasises the value of using an image intensifier during surgery.

A French multicentre study\textsuperscript{17} of 406 patients showed that height of implantation, retroversion, positioning of the tuberosity, the use of a fracture jig, rehabilitation and immobilisation are of prognostic value. The height of implantation did not significantly influence healing of the tuberosity and hemiarthroplasties implanted at an incorrect height were present throughout all groups in almost equal numbers.

Severe pain was always associated with stiffness when radiologically both tuberosities were healed in the anatomical position. This indicates the importance of early passive movement. Hemiarthroplasty of the shoulder following fracture is technically demanding as is shown by the relationship between the results and the experience of the surgeon. The major shortcoming of our study is that although the data contain much interesting information, a single retrospective analysis can only reflect a part of the whole. However, it appears that complex fractures of the head of the humerus can be treated successfully using primary hemiarthroplasty. Satisfactory relief from pain can be expected in most patients, whereas function and the subjective outcome are closely related to the healing of the tuberosity.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References