NON-CEMENTED REPLACEMENT OF
THE TRAPEZIOMETACARPAL JOINT

S. W. WACHTL, G. R. SENNWALD

From the Chirurgie St Leonhard, St Gallen, Switzerland

We treated 43 patients (38 women and 5 men) with osteoarthritis of the basal joint of the thumb by non-cemented arthroplasty of the first carpometacarpal joint as described by Ledoux. The probability of a patient avoiding revision for 12 months was 62% and for 16 months 59%. The indications for revision were aseptic loosening in 83% and luxation in 17%.

The surviving prostheses were reviewed clinically and radiologically at a mean follow-up of 25.3 months. Pain on loading, movement or at rest was seen in 75% of the patients. There was significant reduction in the range of movement of the trapeziometacarpal joint and of wrist strength. Radiological assessment showed significant subsidence of the stem in the first metacarpal and migration of the cup, with the stem loose in 15% and the cup in 46%.

We no longer recommend this method of joint replacement.

Received 23 April 1996; Accepted 16 May 1996

Osteoarthritis of the first trapeziometacarpal joint is a disabling disease which reduces the function of the thumb and the hand. Many operative procedures have been described for this condition including osteotomy of the first metacarpal (Wilson and Bossley 1983), arthrodesis of the trapeziometacarpal joint (Müller 1949), resection of the trapezium with or without filling the defect (Gervis 1949; Varley et al 1994) or with a silicon spacer (Amadio, Millender and Smith 1982), excision of the trapezium combined with a stabilising technique (Eaton and Littler 1973; Tomaino, Pellegrini and Burton 1995) and replacement of the joint with a prosthesis.

Replacement arthroplasty has revolutionised joint reconstruction since it offers a painfree joint immediately after operation, as well as mobility, stability and strength. A cemented prosthesis for the trapeziometacarpal joint was introduced by de la Caffinière and Aucourtier in 1979 and the results have been reviewed (August, Coupland and Sandefer 1984; Nicholas and Calderwood 1992; Sennwald and Segmüller 1993). Other cemented designs based on the ball-and-socket concept have also been developed. Most, like the de la Caffinière prosthesis, have a polyethylene socket cemented into the trapezium articulating with a cemented stem situated in the first metacarpal (Braun 1982; Ferrari and Steffee 1986). The Mayo implant has a metal trapezial component with a polyethylene cup placed in the first metacarpal (Cooney, Linscheid and Askew 1987).

In 1994, Ledoux introduced an uncemented prosthesis to avoid problems with cement loosening. We now report our experience with this device.

PATIENTS AND METHODS

Between 1992 and 1994 we performed 45 arthroplasties of the first trapeziometacarpal joint in 43 patients using the Ledoux prosthesis. There were 38 women and five men, with a mean age of 63 years (39 to 79). The right side was operated on in 25 and the left in 20. The dominant side was involved in 25 and the non-dominant in 20.

The indications for operation were osteoarthritis in 43 thumbs, rheumatoid arthritis in one and post-traumatic arthritis in one. No patient had undergone a previous operation on the joint. According to the classification of Kellgren and Lawrence (1957) there was grade-II wear in 7, grade-III in 23 and grade-IV in 15 thumbs.

Osteoarthritic change was present in the trapeziometacarpal joint of the opposite thumb in 34 patients. Eight had an operation using the de la Caffinière prosthesis in five, the Ledoux prosthesis in one and tendon suspension arthroplasties in two.

Prosthesis. The Ledoux prosthesis (Dimso S.A., Marmande, France) is a ball-and-socket design with the centre of rotation in the trapezium. The trapezial component is made of a titanium ring which is conical on the inside and cylindrical on the outside, with a cylindrical polyethylene inlay. The metal cup has six longitudinally arranged wings, which expand as the polyethylene element is introduced into the cup, producing a ‘plug’ effect; this allows immedi-
ate anchorage in the trapezium. The titanium stem reproduces the anatomical shape of the medullary space of the first metacarpal and its introduction creates a mechanical self-locking system. The fulcrum of the stem is near the head of the cup, the lever arm, and consequently, the stress in the distal part of the stem is minimised.

The stems and the cups are available in four sizes and the neck in two. We implanted 16 stems of size one, 14 of size two, 12 of size three and 3 of size four. We used 36 short necks and 9 long necks, and 12 small cups, 27 medium, and 6 large.

**Operative technique.** Through a straight dorsal skin incision osteotomy of the proximal surface of the first metacarpal is performed perpendicular to the long axis of the medullary canal, 7 mm distal to the joint. The restraining ligaments are sectioned and a cavity prepared using drills and a calibrated rasp which is introduced at 45° to the second metacarpal. The medullary space of the metacarpal is reamed to take the largest possible implant. The thumb is immobilised for two weeks after operation followed by six weeks of passive movement. Normal activity may begin after three months.

**Complications and revisions.** Four joints dislocated and 14 implants became loose. Seventeen patients required reoperation at a mean time of 9 months (2.5 to 16) after the initial procedure. Another Ledoux prosthesis was used in 12 patients and a de la Caffinière implant in one. Two had simply removal of the prosthesis, one had an interposition arthroplasty and one an arthrodesis of the joint.

At review we defined two groups of patients, namely 28 in whom the original prosthesis was still in place and 17 who had had a revision.

**Clinical evaluation.** Pain was graduated as follows: absence of pain, pain at rest, pain during movement and permanent pain. Each patient was asked to evaluate the success of the operation by scoring it on a scale from 0 to 100; 25 was a bad result, 50 average and 75 good. We also investigated various functions of the hand such as the ability to write, use a key, manipulate money, and hold a can, a book or a weight such as a grocery bag.

Measurement of the mobility of the carpus, the trapeziometacarpal joint and the metacarpophalangeal joint was carried out using the opposite side as a normal reference. The strength of both wrists was measured using a Jamar device at position 2 and key pinch from the pulp of the thumb to the radial border of the distal phalanx of the index, or tip pinch from the pulp of the thumb to the pulp of the index with a single Preston pinch meter.

**Radiological evaluation.** Standard anteroposterior and lateral views of both wrists were taken.

We defined five zones of osteolysis: zone 1 represents the curved proximal portion of the stem near the articulating part of the prosthesis, zone 2 is situated around the middle part of the stem, zone 3 is located at the distal part of the stem, zone 4 is at the distal half of the cup near the articulation and zone 5 is around the proximal half of the cup (Fig. 1).

To define the position of the cup immediately after the operation and to assess its migration, we measured the angle ‘y’ which is formed between the axes of the cup and the second metacarpal (Fig. 2).

To measure stem subsidence, we defined the ratio B/A
where $A$ represents the length of the stem from the centre of rotation of the head to the distal end and $B$ is the distance between the centre of rotation of the head and the distal end of the first metacarpal (Fig. 3).

Loosening of the stem was defined by the presence of osteolysis in zones 1 to 3 with subsidence of more than 1%. Loosening of the cup was determined by osteolysis in zones 4 and 5 with migration of more than 5° on the anteroposterior and/or the lateral radiograph.

**Survivorship analysis.** Survivorship analysis was calculated using life tables (Scuderi et al 1989; Murray, Carr and Bulstrode 1993). Revision was considered as failure.

**Statistical analysis.** The paired two-tailed $t$-test was used. For clinical assessment the opposite side served as a control. Migration and subsidence were assessed by comparison with the position immediately after operation and that at review or before revision. Chi-squared tests were used to analyse the occurrence of osteolysis in the different zones. The level of significance was set at $p < 0.05$.

**RESULTS**

**Clinical results.** Of the 28 prostheses which were still in place 26 were available for follow-up after a mean time of 25.3 months (7 to 42). The mean subjective evaluation by the patients was 79 points (5 to 100). Pain occurred during load in 13 patients (50%), on movement in five (19%) and at rest in two (8%); six were painfree (23%). The assessment of activity after operation is shown in Table I. Activities which required less strength were carried out more easily.

The ranges of movement after operation in the wrist, the trapeziometacarpal joint and the first metacarpophalangeal and the wrist and pinch strengths are shown in Table II as are the findings on the normal side. There was a significant reduction in mobility after operation, with marked loss of wrist strength but not of key and tip pinch.

**Radiological results.** Radiographs were taken at follow-up in the 26 prostheses which remained in situ and before revision in the 17 which required this (Fig. 4). More osteolysis occurred around the proximal part of the stem than at the distal part (Table III). In the cup similar amounts of osteolysis occurred in the two zones. The pattern and distribution of osteolysis are identical in the surviving and revised groups.
The radiological assessment of migration of the cup and of stem subsidence is shown in Table IV. From the time of implantation until follow-up, the stem sank into the first metacarpal in both groups. The cup migrated from the time of implantation until follow-up in a radial direction in both groups as seen on the anteroposterior radiographs. In the 26 surviving prostheses, 16 cups had migrated between 0° and 5°, two between 6° and 10°, three between 11° and 15°, one between 16° and 20°, two between 21° and 30° and two between 31° and 40°. Migration in a dorsal direction was seen on the lateral radiographs but with no significant differences; 13 cups migrated between 0° and 5°, six between 6° and 10°, two between 11° and 15°, one between 16° and 20°, one between 21° and 30°, two between 31° and 40°, and one more than 40°.

Cup migration was time-related. The 14 cups with a follow-up of less than 24 months showed little difference between implantation and follow-up. The average ‘y’ angle was 27° on the anteroposterior radiograph after implantation and 30° at follow-up. Comparison with the cups which were in place for more than 24 months showed a significant increase in migration between implantation and follow-up. The ‘y’ angle was 30° after implantation and 42° at follow-up.

Using the criteria described above we considered that 15% of the stems and 46% of the cups were loose.

Survivorship analysis. The cumulative survival rate is shown in Table V and Figure 5. The survival rate at 12 months was 62% and at 16 months 59%.

DISCUSSION

After total arthroplasty of the trapeziometacarpal joint with the non-cemented Ledoux prosthesis, the subjective evaluation of the patients was rated as good, but 75% had pain. Most were handicapped in daily living and tended to avoid using their hand. The objective results on the operated hand, particularly as regards mobility of the thumb and wrist strength, were worse than on the opposite side, which also had pathological changes in many cases. Pinch showed no difference between the affected and opposite hands.

The radiological assessment of osteolysis and migration of the cups and of stem subsidence is shown in Table IV. From the time of implantation until follow-up, the stem sank into the first metacarpal in both groups. The cup migrated from the time of implantation until follow-up in a radial direction in both groups as seen on the anteroposterior radiographs. In the 26 surviving prostheses, 16 cups had migrated between 0° and 5°, two between 6° and 10°, three between 11° and 15°, one between 16° and 20°, two between 21° and 30° and two between 31° and 40°. Migration in a dorsal direction was seen on the lateral radiographs but with no significant differences; 13 cups migrated between 0° and 5°, six between 6° and 10°, two between 11° and 15°, one between 16° and 20°, one between 21° and 30°, two between 31° and 40°, and one more than 40°.

Cup migration was time-related. The 14 cups with a follow-up of less than 24 months showed little difference between implantation and follow-up. The average ‘y’ angle was 27° on the anteroposterior radiograph after implantation and 30° at follow-up. Comparison with the cups which were in place for more than 24 months showed a significant increase in migration between implantation and follow-up. The ‘y’ angle was 30° after implantation and 42° at follow-up.

Using the criteria described above we considered that 15% of the stems and 46% of the cups were loose.

Survivorship analysis. The cumulative survival rate is shown in Table V and Figure 5. The survival rate at 12 months was 62% and at 16 months 59%.

DISCUSSION

After total arthroplasty of the trapeziometacarpal joint with the non-cemented Ledoux prosthesis, the subjective evaluation of the patients was rated as good, but 75% had pain. Most were handicapped in daily living and tended to avoid using their hand. The objective results on the operated hand, particularly as regards mobility of the thumb and wrist strength, were worse than on the opposite side, which also had pathological changes in many cases. Pinch showed no difference between the affected and opposite hands.

The radiological assessment of osteolysis and migration of the prosthesis in hip and knee replacement has been accurately defined (DeLee and Charnley 1976; Gruen, McNeice and Amstutz 1979). The analysis of zones of...
Radiolucency gives a precise image of the progression of osteolysis and quantifies it. Measurement of the ‘y’ angle allows recognition of the exact placement of the prosthesis and accurate evaluation of migration. The B/A ratio documents stem subsidence.

Radiolucency has been clearly established as related to failure of the prosthesis (Ritter and Campbell 1987; Kwong et al 1992), but periprosthetic bone loss has also been reported in stable implants (Maloney et al 1990). We therefore incorporated migration and osteolysis in our assessment of loosening.

Loosening of the stem is probably underestimated because as it progresses, the distal part of the stem sinks, compresses the bone and masks osteolysis. To try to decrease the amount of subsidence a dorsal keel was added to the original flat surface of the dorsal part of the pros-

Table IV. Radiological evaluation of surviving and revised prostheses

<table>
<thead>
<tr>
<th></th>
<th>After primary implantation</th>
<th>At follow-up/before revision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Min</td>
</tr>
<tr>
<td>y angle in degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anteroposterior</td>
<td>28.4</td>
<td>12.5</td>
</tr>
<tr>
<td>Lateral</td>
<td>30.38</td>
<td>9.00</td>
</tr>
<tr>
<td>Ratio B/A</td>
<td>1.32</td>
<td>1.08</td>
</tr>
<tr>
<td>Revised (n = 17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>y angle in degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anteroposterior</td>
<td>25.75</td>
<td>7.5</td>
</tr>
<tr>
<td>Lateral</td>
<td>31.38</td>
<td>12.00</td>
</tr>
</tbody>
</table>
| Ratio B/A           | 1.43 | 1.24 | 1.57 | 0.10 | 1.38 | 1.24 | 1.57 | 0.11 | 2.128 * significant at p < 0.05

Fig. 5

Survivorship curve with a 95% confidence interval (upper and above line).

Table V. Life table with failure defined as revision

<table>
<thead>
<tr>
<th>Months since operation</th>
<th>Number at start</th>
<th>Failure</th>
<th>Lost to follow-up</th>
<th>Withdrawal</th>
<th>Number at risk</th>
<th>Monthly failure rate (percent)</th>
<th>Monthly success rate (percent)</th>
<th>Cumulative success rate (percent)</th>
<th>Standard error (percent)</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1</td>
<td>45</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>45</td>
<td>0.00</td>
<td>100.00</td>
<td>100.00</td>
<td>0.00</td>
<td>92.1 to 100</td>
</tr>
<tr>
<td>1 to 2</td>
<td>45</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>45</td>
<td>0.00</td>
<td>100.00</td>
<td>100.00</td>
<td>0.00</td>
<td>92.1 to 100</td>
</tr>
<tr>
<td>2 to 3</td>
<td>45</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>45</td>
<td>2.22</td>
<td>97.78</td>
<td>97.78</td>
<td>2.20</td>
<td>88.1 to 100</td>
</tr>
<tr>
<td>3 to 4</td>
<td>44</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>44</td>
<td>2.27</td>
<td>97.73</td>
<td>95.56</td>
<td>3.07</td>
<td>84.5 to 99.8</td>
</tr>
<tr>
<td>4 to 5</td>
<td>43</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>43</td>
<td>2.33</td>
<td>97.67</td>
<td>93.33</td>
<td>3.76</td>
<td>81.0 to 98.9</td>
</tr>
<tr>
<td>5 to 6</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>41</td>
<td>0.00</td>
<td>100.00</td>
<td>93.33</td>
<td>3.76</td>
<td>81.0 to 98.9</td>
</tr>
<tr>
<td>6 to 7</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>41</td>
<td>0.00</td>
<td>100.00</td>
<td>93.33</td>
<td>3.79</td>
<td>80.9 to 99.0</td>
</tr>
<tr>
<td>7 to 8</td>
<td>41</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>40.5</td>
<td>9.88</td>
<td>90.12</td>
<td>84.12</td>
<td>5.67</td>
<td>67.9 to 94.5</td>
</tr>
<tr>
<td>8 to 9</td>
<td>35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>35</td>
<td>0.00</td>
<td>100.00</td>
<td>84.12</td>
<td>5.67</td>
<td>67.9 to 94.5</td>
</tr>
<tr>
<td>9 to 10</td>
<td>35</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>35</td>
<td>11.43</td>
<td>88.57</td>
<td>74.50</td>
<td>6.81</td>
<td>55.7 to 88.1</td>
</tr>
<tr>
<td>10 to 11</td>
<td>31</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>30.5</td>
<td>6.56</td>
<td>93.44</td>
<td>69.62</td>
<td>7.25</td>
<td>49.7 to 86.4</td>
</tr>
<tr>
<td>11 to 12</td>
<td>28</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>3.57</td>
<td>96.43</td>
<td>67.13</td>
<td>7.48</td>
<td>46.5 to 85.1</td>
</tr>
<tr>
<td>12 to 13</td>
<td>27</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>26.5</td>
<td>7.55</td>
<td>92.45</td>
<td>62.06</td>
<td>7.89</td>
<td>40.2 to 82.7</td>
</tr>
<tr>
<td>13 to 14</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>23.5</td>
<td>0.00</td>
<td>100.00</td>
<td>62.06</td>
<td>8.24</td>
<td>39.2 to 83.9</td>
</tr>
<tr>
<td>14 to 15</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>21.5</td>
<td>0.00</td>
<td>100.00</td>
<td>62.06</td>
<td>8.66</td>
<td>38.0 to 85.3</td>
</tr>
<tr>
<td>15 to 16</td>
<td>20</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>19.5</td>
<td>5.13</td>
<td>94.87</td>
<td>58.88</td>
<td>8.90</td>
<td>34.0 to 84.3</td>
</tr>
<tr>
<td>16 to 17</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>0.00</td>
<td>100.00</td>
<td>58.88</td>
<td>0.1</td>
<td>58.88</td>
</tr>
</tbody>
</table>
thesis but it did not improve the degree of subsidence. The force acting across the trapeziometacarpal joint during pinch and grasp may reach 120 kg and it induces a lateral and dorsal shear force on the joint (Cooney and Chao 1977). Cutting the restraining ligaments to improve thumb mobility, as recommended by Ledoux, increases these forces further. Similar changes occur in osteoarthritis and lead to progressive subluxation (Lasserre, Pauzat and Derennes 1949). Although a satisfactory primary press-fit anchorage may be achieved, the cup, which is located in the subchondral bone, will therefore be subjected to micromotion with consequent migration and loosening. The design of the neck of the stem, which tends to medialise the first metacarpal, also increases the radial shear force and thus the process of loosening. Inadequate anchorage of the cup has been noted in short- and long-term follow-up of cemented models (August et al 1984; Sonderraad and Rechnagel 1991). The weak point of trapeziometacarpal arthroplasty, cemented or not, appears to be the anchorage of the cup in the trapezium.

The migration of the Ledoux cup is continuous and time-related. Since early migration has been clearly associated with late failure of a prosthesis (Freeman and Plante-Bordeneuve 1994), the rate of migration seen in our patients after only two years suggests that further loosening will occur and require more revisions.

At revision, we found a zone of depression on the border of the edge of the polyethylene cup. This is due to abutment against the neck of the stem during movement resulting in destabilisation of the cup anchorage and liberation of polyethylene, particles which induce a foreign-body reaction. The survival rate is such that we can no longer recommend the Ledoux prosthesis for the treatment of osteoarthritis of the trapeziometacarpal joint. The design of the prosthesis is inadequate and the anchorage insufficient. Loosening is inevitable. Prostheses are required which are unconstrained and retain the ligaments. Full evaluation is essential before they are made available for general use.

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


