The Wagner revision stem in alloarthroplasty of the hip

C.-H. Hartwig · P. Böhm · U. Czech · P. Reize
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Abstract Forty-one Wagner revision stems were implanted at the Orthopedic Department of the University of Tübingen between July 1990 and January 1993. We report the results of 37 patients at an average follow-up of 27 months (13–48 months) postoperatively. The main indication was stem loosening with considerable loss of bone. In addition, we used the implant 4 times in primary arthroplasty. At follow-up examination 33 patients (89%) were satisfied with the postoperative outcome. According to the Merle D’Aubigné score (12-point scale), 32 patients showed a poor functional result of less than 6 points postoperatively. Postoperatively, the results of 36 patients could be classified as very good to good. To categorise the radiological destruction of the implant bed, we used the femoral shaft defect classification of the DGOT (Deutsche Gesellschaft für Orthopädie und Traumatologie) in conjunction with the classification of Pak and Paproski [5, 11]. Twenty patients presented with trochanteric and calcar defects, and 11 patients with a combination of a calcar and shaft defect. We found a circular shaft defect in 2 patients. In 7 cases we assessed the bone remodelling postoperatively as very good, with strong newly formed bone structures, and in 25 cases as good, with remodelling of the old stem bed and bony structuring of the osteolyses. A secondary sinking in of the Wagner stem was seen in 7 cases. Only one stem had to be revised because of pain symptoms and loosening; in all other cases a secondary stabilisation of the revision-stem took place. With the Wagner revision stem, there is the possibility of achieving mechanical stability even in situations with massive bone loss. The evacuation of bone cement and granulation tissues is facilitated by the transfemoral approach, bone remodelling is accelerated, and bone grafting is often not necessary. As our short-term results show, the concept is a promising one. Nevertheless, we will be very careful in following these patients in the long term, as we have noticed stem sinking in a small percentage of cases.

Introduction

In spite of the great importance of hip endoprosthesis in the past years, the high rate of aseptic loosening remains an unsolved problem [8, 16, 22, 23, 27]. If loosening is present or if revision has been repeated — especially when cement has been used — considerable bony defects are no rarity, and the bone has sometimes become so thin that reliable anchoring of a prosthesis cannot be guaranteed [23, 24]. Different revision concepts were formulated as a solution to this dilemma. Many hip specialists use more voluminous implants to fill the bone cavities, either in the form of cementless revision stems or cemented long stems, or in some cases tumor stems [7, 9, 11, 13, 20, 21]. An application of forces on the distal side only and filling of the defects with prosthesis material leads in many cases to further atrophy and possible resorption of this valuable implant bed [6, 7, 17, 24].

In 1987, Wagner described the concept of a cementless revision stem with anchoring in the intact diaphyseal area of the femur for the first time [23]. The loosened stem is in most cases removed via a bone lid together with a muscle flap of the proximal femur. The cementless revision stem resembles the intramedullary nail principle and is stable in rotation due to its sharp ribs [23, 24]. There is generally regeneration of bone in the femoral stem interface, and this does not depend on the age of the patient [26].

Material and methods

Thirty-seven of the 41 Wagner revision stems which were implanted at the Department of Orthopedics in the University Clinic of Tübingen underwent follow-up examination at an average of 27 months (range 13–48 months). Two patients died unrelated to the arthroplasty, and 2 other patients could not be traced. There were 16 men and 21 women. Their age ranged from 39 to 85 (average 64) years.
The Wagner stem had been implanted 33 times because a revision had become necessary on account of considerable bone loss; in 2 cases the implant was used for the reversal of a girdlestone situation; once as a stabilising element in compound osteosynthesis; and once as a primary implant.

We used the transfemoral approach in the technique according to Wagner on 23 patients [24]. Fourteen stems were implanted via the transgluteal approach according to Bauer where no division of the femur takes place [1, 2]. In 21 cases, it was the first revision of a hip endoprosthesis; in 11 cases, the second; in 1 case, the fourth (Table 1).

In 5 patients we used additional bone grafts, either in the form of autogenic bone from the iliac crest or in the form of an allograft from the bone bank [9, 10]. In 18 cases the stems had been in place 2–9 years, and in 15 cases for more than 10 years, on average 10.5 years.

The assessment of function was made according to the Merle D’Aubigné score [4]. This facilitates the documentation of the ability to walk and also takes the subjective feeling of pain into account. Preoperatively, we used the femoral defect classification of the DGOT (Deutsche Gesellschaft für Orthopädie und Traumatologie) in conjunction with the classification of Pak and Paprosky to categorise the radiological destruction of the implant bed [5, 11] (Fig. 1).

The postoperative radiological assessment concentrated on the regeneration of bone at the stem interface, the healing of the ostectomy of the femur as well as the postoperative sinking-in of the stem. We assessed the bone regeneration as very good when we saw strong, newly formed bone structures, and as good when there was a remodelling of the old stem bed and bony structuring of the osteolyses.

To measure stem sinkage, we calculated the distances between the centre of the implant head and the greater (lesser) trochanter on the immediate postoperative X-ray as well as on the X-ray at the last follow-up.

Table 1. Reason for implantation

<table>
<thead>
<tr>
<th>Reason for Implantation</th>
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<tbody>
<tr>
<td>primary implantation</td>
<td>4</td>
</tr>
<tr>
<td>1st revision</td>
<td>21</td>
</tr>
<tr>
<td>2nd revision</td>
<td>11</td>
</tr>
<tr>
<td>4th revision</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
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</table>

Fig. 1. Femoral defect classification according to DGOT: I spongyosa defect; II trochanteric defect; III calcar defect; IV calcar defect + medial shaft defect; V calcar defect + lateral shaft defect; VI circular shaft defect.

Results

Function

Thirty-three patients (89%) considered the result of their operation as very good or good; four patients (11%) were moderately satisfied. The distribution of pain pre- and postoperatively is shown in Fig. 2.

Twenty-three patients were considerably limited as far as mobility was concerned before the operation and required two walking sticks. After implantation of the revision stem, 13 patients were able to walk without help and 13 with the help of one stick, whereas 11 patients needed the help of two canes, mostly because of other painful joints. Only 3 patients were able to climb stairs without difficulty preoperatively. At follow-up examination, 19 patients were able to climb stairs without complaint and without any support.

In the assessment of the hip arthroplasties according to the 12-point system of Merle D’Aubigné, preoperatively 32 patients (86%) achieved a maximum of only 6 points, whilst the functional result in 36 patients postoperatively was assessed as very good or good. Due to a loosened stem, one patient with pain and a restricted walking ability had to be classified as poor (Table 2).

Radiology

According to the femoral defect classification of the DGOT, 7 patients presented with a spongyosa and trochanteric defect (grades 1 and 2), 13 patients with calcar defects (grade 3), 11 patients with a combination of a calcar and medial or lateral shaft defect (grades 4 and 5). We found a circular shaft defect in 2 patients (grade 6) (Table 3).

Fig. 2. Distribution of pain scores before and after operation

Table 2. Merle D’Aubigné Score results based on pain and walking ability

<table>
<thead>
<tr>
<th>Results</th>
<th>Preoperative</th>
<th>Postoperative</th>
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<tr>
<td>very good (12–10 points)</td>
<td>n = 0</td>
<td>n = 21 (56%)</td>
</tr>
<tr>
<td>good (9–7 points)</td>
<td>n = 5 (14%)</td>
<td>n = 15 (41%)</td>
</tr>
<tr>
<td>unsatisfactory (6–0 points)</td>
<td>n = 32 (86%)</td>
<td>n = 1 (3%)</td>
</tr>
</tbody>
</table>
In 7 cases we assessed the bone remodelling as very good with strong, newly formed bone structures, and in 25 cases as good with remodelling of the old stem bed and bony structuring of the osteolyses (Figs. 3, 4).

Bone regeneration failed in only one case. All bone grafts were incorporated at the time of follow-up examination and showed no signs of resorption.

**Table 3** Defect of the femur shaft by DGOT classification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>n</th>
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<tbody>
<tr>
<td>I+II</td>
<td>Spongiosa and trochanteric defect</td>
<td>7</td>
</tr>
<tr>
<td>III</td>
<td>Calcar defect</td>
<td>13</td>
</tr>
<tr>
<td>IV</td>
<td>Calcar defect, medial shaft defect</td>
<td>3</td>
</tr>
<tr>
<td>V</td>
<td>Calcar defect, lateral shaft defect</td>
<td>8</td>
</tr>
<tr>
<td>VI</td>
<td>Circular shaft defect</td>
<td>2</td>
</tr>
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Table 4 Complications found

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<tr>
<td>Sinkage (1.0-2.0 cm)</td>
<td>7</td>
</tr>
<tr>
<td>Stem loosening</td>
<td>1</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>1</td>
</tr>
<tr>
<td>Sciatic nerve lesion</td>
<td>1</td>
</tr>
<tr>
<td>Infection (chronic)</td>
<td>1</td>
</tr>
</tbody>
</table>

Complications

In spite of a long period of non-weight-bearing (> 12 weeks), 7 patients out of the revision group presented with a postoperative sinking-in of the stem (1–2 cm). In 4 of them, the Wagner stem was implanted via a transfemoral approach, whereas in the remaining 3, we used the transgluteal approach. The preoperative bone loss of these cases differed from a simple trochanteric defect up to a combination of a calcar and a lateral shaft defect. Only one implant which had sunk in 2 cm in the first postoperative year, and which had distinctly loosened and was causing pain, had to be revised. In the remaining cases, there was a secondary consolidation of the implant without serious symptoms of pain.

In the peri- and postoperative phases, we experienced a lesion of the sciatic nerve, which was regressive at the time of follow-up examination, and one deep-vein thrombosis (primary disease was a non-Hodgkin’s lymphoma). A late infection with the formation of a fistula has not yet been revised because the patient has refused a further operation (Table 4).

Discussion

The aim of revision arthroplasty after loosening of the primary stem is to ensure stable implanting of a second femoral prosthesis. Large bone defects must be reconstructed so as to guarantee permanent anchoring of the implant [22, 27].

There are different methods at our disposal to achieve this goal. On the pelvic side, voluminous metal cups (Schneider-Burch Cup, Müller acetabular cup) and nets are recommended, if necessary combined with bone cement, whilst in the area of the femur large stems, partly cemented, partly cementless combined with a spongiosa graft are used [14, 15, 20, 21]. It is particularly a revision with cement which contradicts the principles of biological reconstruction. The use of cement usually worsens the problem of bone resorption and contributes to a renewed loosening of the implant [27]. There is no doubt that the biological reconstruction of a destroyed acetabulum or femur is superior to a replacement or a filling-in of the defect with PMMA [3, 6, 12–16].

Wagner’s concept guarantees stable wedging of the implant in the distal part of the femur on account of the anchoring ribs. The primary stability which is thus established in the intact implant interface offers the necessary mechanical rest, so that favorable conditions for the bony regeneration of the destroyed proximal part of the femur can be created [23–25].

Schenk and Wehrli presented histological findings on an autopsy specimen which was taken 5.5 months postoperatively in 1989, and after this short time were able to confirm the principles stated by Wagner:

- Distal rotation stability with the possibility of regeneration of the intramedullary vessels.
- Remodelling of bone in the proximal part of the prosthesis on account of the small distance between the osteoblasts and the implant surface [19].

This concept of a biological revision arthroplasty thus differs significantly from the usual concepts of cementless revision surgery.

Parhofer and Mönch in 1984 [13] as well as Morscher in 1987 [9] recommended a cementless stem which was as broad as possible after the loosened prosthesis and all the cement had been removed. They inserted autogenic spongiosa and bone grafts between the bone and the implant in order to guarantee a translation of forces which is as even as possible.

If we compare our clinical results with those of Parhofer and Mönch [13], who questioned 139 patients, 70.5% considered the result of their operation as either very good or good, 23% as satisfactory, and 6.5% as bad. Postoperatively, 72.2% had no pain. Morscher et al. [10] reported excellent or good results in 83% of 31 patients who had undergone revision arthroplasty in which a cementless long-stem prosthesis had been implanted. In our group of patients, 89% were satisfied with the outcome of the operation, 73% had no pain, and 19% had only slight pain not affecting their daily activities.

Only 1 patient exhibited an unsatisfactory result according to the Merle D’Aubigné score. This was due to a stem loosening after sinking-in of 2 cm. A few patients still had difficulty in walking at the time of follow-up examination because of osteoarthritis of the contralateral hip, reimplantation, or a development after several revisions of a hip endoprosthesis.

The Wagner revision stem is used in our clinic mainly for the revision of a total hip endoprosthesis after loosening in cases where there is destruction of the implant interface. Wagner himself reported his experience of impressive bony remodelling in the old implant interface [27]. In 32 out of 33 revision operations, we saw newly formed bone structures which led to a fast remodelling of the femoral shaft in 7 cases.

The complications which we observed in the perioperative and postoperative phases correspond to those of primary and revision arthroplasty, and their frequency has been documented in different reports [12, 16, 18]. A sinking-in of the revision stem has been described by Wagner and Wagner [26]. The reasons can be sought in the design of the prosthesis, which resembles an intramedullary nail, and also in the transfemoral approach to the loosened implant. The cortical bone of the distal femur typically parts to form a trumpet shape, which frequently cannot guaran-
tee a stable anchoring of the narrow prosthesis stem in the cortical bone, especially in the case when destruction of the bone stretches far distally. A stable distal wedging is only possible when the distal medullary cavity is made large enough by means of the appropriate rasp. In our experience, a temporary cerclage around the distal part of the femur is of great use in order to avoid a shaft fracture during rasping. The stem corresponding to the size of the rasp must then be driven in with light knocks, and it should safely anchor in the cortical bone on account of the sharp ribs. A too careful rasping and consequently the choice of an implant which is too small often lead to sinking-in because of insufficient primary stability, which in turn can lead to a revision.

Out of seven stems which had sunk in, only one had to be revised because of defined loosening and pain. In the remaining cases, a secondary stabilisation had taken place. The patients complained of no pain and were satisfied with the postoperative results. Beside the choice of the right size of implant, the period of non-weight-bearing (until a build-up of the implant bed can be seen radiographically) is also of decisive importance if a secondary sinking is to be prevented [19]. In our series, the median period of rest of the operated extremity was 15 weeks (8–52 weeks), whereby 8 weeks was the minimum.

We found no correlation between the operating technique (transfemoral or transglutural approach) and stem sinking. Nevertheless, we continue to regard a general osteoporosis as a contraindication for the use of this revision system.

In conclusion, the Wagner revision stem makes a primary stable anchoring of the stem possible in almost all cases, even after considerably loss of bone. Secondly, there is a good build-up of the implant bed in most cases. The function of the extremity concerned is preserved, and normal weight-bearing is possible after several months. The evacuation of bone cement and granulation tissue is considerably facilitated by the transfemoral approach. The Wagner concept of a cementless revision stem with anchoring in the intact distal femur diaphysis is a trend-setting principle. Our short-term results confirm this. Nevertheless, we will be very careful in following these patients in the long term, as we have noticed stem sinking in a small percentage of our cases.

References