Mid- to long-term results of endoprostheses for idiopathic osteonecrosis of the femoral head

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Abstract

The postoperative results of endoprostheses for idiopathic osteonecrosis of the femoral head were reviewed. The series included a total of 35 cases (44 hips) treated with endoprostheses from 1986 to 1996, and the follow-up period was between 5 to 15 years (average of 7 years 6 months). Among these cases, 23 hips were treated with bi-polar hip arthroplasty (BHA) and 21 hips with total hip arthroplasty (THA). In our department we perform BHA on cases in which the articular cartilage state is good, and perform THA on cases in which the articular cartilage state is bad. We reviewed the treatment results of the BHA cases and the THA cases performed in accordance with the above surgical indication.

The results were as follows:
1) Regarding the treatment results for the 23 hips in the BHA group, in the clinical evaluation based on the Evaluation Chart of Hip Joint Function (the JOA score), the preoperative JOA score of 48.2 points (total) improved to a postoperative JOA score of 88.6 points (total), no particular problem was found in the radiographic evaluation and thus the results were quite satisfactory.
2) Regarding the postoperative results of the THA group, the preoperative JOA score of 44.4 points (total) improved to a postoperative JOA score of 81.5 points (total) at the latest examination (post-revision results for revision cases), but 8 hips underwent revision (re-operation). Such poor results were thought to be due to specific problems in these cases. Proximal migration, wear of polyethylene, and osteolysis were found mainly in the 10 hips treated by 1992 using the titanium alloy inner head and the threaded cup, in which 7 hip procedures resulted in revision. Thus, in the treatment results of the 11 hips treated after 1993, from which time both of the above problems had been addressed by the manufacturers, no revision was performed besides the 1 case with postoperative infection, no radiographic problem was found and good results were obtained.

Therefore, leaving out of consideration the cases in which structurally defected prostheses were used, the treatment results of the BHA cases and the THA cases performed in accordance with the above mentioned surgical indication can be concluded as satisfactory.

Introduction

Idiopathic osteonecrosis of the femoral head (ION) is known to develop frequently in young and middle aged patients with a history of previous steroid treatment and habitual alcohol ingestion. In regard to the natural course of ION, progressive destruction of the hip joint may occur in more than half of the cases, resulting in
secondary osteoarthritis and causing serious functional disorders\textsuperscript{2-4}. Thus some kind of surgical treatment becomes necessary.

Surgery for ION is indicated in cases in which there is a wide necrotic area and collapse of the femoral head is expected. Endoprostheses, on the other hand, are inserted for cases in which joint preservation treatment is not appropriate. However, indications of bi-polar hip arthroplasty (BHA) and total hip arthroplasty (THA) slightly differ among hospitals, and there are many arguments as to which treatment result, either BHA or THA, is better. We choose BHA if the articular cartilage is preserved and perform it extensively if the articular cartilage state is good; and THA if the articular cartilage state is bad.

We evaluated the treatment results and the problems of ION cases in which surgery was performed based on the therapeutic strategy of our department.

**Patients and Methods**

1. **Patients**

   We surgically treated 93 cases (121 hips) with ION from 1982 to 1999: 104 hips were treated with endoprostheses and 17 hips with joint preservation treatment. We reviewed 35 cases (44 hips) of these 93 cases (121 hips), to which Biomet prostheses (Biomet, Inc. Warsaw, IN, USA) were inserted and which we were able to follow up for over 5 years. Of the 44 hips, 23 hips were treated with BHA and 21 hips with THA. We enrolled 22 men and 13 women ranging in age from 23 to 67 years old at the time of surgery (average 47.9 years old), and the follow-up period was 5 to 15 years (average 7 years 6 months).

   In our department, BHA is performed for stages II and III\textsuperscript{5} where articular cartilage is preserved, and extensively for stage IV\textsuperscript{5} if the articular cartilage state is good. It is to be noted that we did not perform manipulation, such as reaming the acetabulum, during BHA. THA is performed for stage IV\textsuperscript{6} and extensively for stages II and III\textsuperscript{6} if the cartilage state is bad (Table I).

   The classification proposed by the ION research subcommittee of bone and joint related working group of the Specific Disease Investigation Committee under the auspices of the Japanese Ministry of Health, Labor and Welfare\textsuperscript{6} was used for staging.

2. **Methods**

   Thirty-five cases were categorized into two groups: the BHA group and the THA group. The postoperative results of each group were reviewed to analyze the treatment effectiveness of the prosthetic surgery.

   The reviewed items were clinically evaluated based on the Evaluation Chart of Hip Joint Function (the JOA score)\textsuperscript{5} using Student's t-test. A p-value of less than 0.05 was taken to indicate a statistically significant difference.

<table>
<thead>
<tr>
<th>Stage II</th>
<th>Stage III</th>
<th>Stage IV</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BHA</td>
<td>3</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>THA</td>
<td>0</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3</td>
<td>17</td>
<td>24</td>
</tr>
</tbody>
</table>
   (number of hips)

![Biometric prosthesis](image)

**Fig. 1** Biometric prosthesis

Different models of Biomet prostheses were used in our series.
In the radiographic evaluation, incidence of proximal migration (migration), osteolysis, and wear of polyethylene (wear) were reviewed for the acetabular side, and sinking and osteolysis for the femoral side. Furthermore, the cases that required revision surgery were studied to analyze the causes.

It is to be noted that different models of Biomet prostheses were used in our series. With regard to the stem, PSN 28 made of titanium alloy and provided with an integrated inner head was used from 1986 to 1988; and Bi-Metric using a modular inner head was used after 1987. Both stems were proximally porous coated. As for the material of the modular inner head, titanium alloy was used from 1987 to 1992, and cobalt-chrome-molybdenum alloy after 1991. The outer head in the BHA group was made of cobalt-chrome alloy. All the cups used in the THA group were made of titanium alloy. Porous coated reinforced acetabular component (Cement cup) was used for cases requiring cement. For cases not requiring cement, a TTAP/ST reinforced acetabular component (Threaded cup) was used from 1986 to 1988, and a Mallory-Head 4 finned acetabular component (Finned porous cup) after 1988 (Figure 1).

Results

1. Postoperative results of the BHA group

BHA was performed in 19 cases (23 hips), in which the PSN 28 was used for the first 2 hips and the Bi-Metric model for the remaining hips, but none of the cases required the use of bone cement.

In the clinical evaluation, no cases resulted in revision, and the preoperative JOA scores of 13.3 points (pain), 15.8 points (range of motion [ROM]), 8.1 points (ability to walk [walk]), 11 points (activity of daily life [ADL]) or 48.2 points (total) improved to postoperative JOA scores of 37.2 points (pain), 18.1 points (ROM), 16.3 points (walk), 17.0 points (ADL), or 88.6 points (total) on average (Figure 2).

In the clinical results among stages II, III, and IV, the preoperative JOA score improved from total scores of 44.0, 54.0, and 40.0 to a postoperative JOA score of 83.0, 90.0 and 88.0 on average, respectively. Thus, no significant difference was seen in the stage-related clinical results (Figure 3).

In the radiographic evaluation, migration and osteolysis were not recognized on the acetabular side. Furthermore, wear was not identifiable since the outer head was not radiolucent, but only 1 hip showed narrowing of the joint space. On the femoral side, bone ingrowth was achieved in all cases without any problem. Thus, the treatment results of BHA performed in accordance with the surgical indications employed by our department, on cases in which the articular cartilage state was good were satisfactory.

2. Postoperative results of the THA group

THA was performed in 17 cases (21 hips), in which the PSN28 was used for the first 4 hips, and the Bi-Metric for the remaining 17 hips. On the femoral side, 8 of 21 hips required the use of bone cement, but 13 hips did not. On the acetabular side, the Cement cup was used in 9 cases, the Threaded cup in 3 hips, and the Finned porous cup in 9 hips.

In the clinical evaluation, problems arose in 8 hips (38.1%) and resulted in revision. Assuming the performance of revision as the end point, the 5- and 10-year survival rates of THA group obtained with the Kaplan-Meier method were 90.5% and 38.8%, respectively. It was found that the revision rate was more likely to increase rapidly 7 to 8 years after the operation (Figure 4).
The preoperative JOA scores of 11.4 points (pain), 14.7 points (ROM), 8.3 points (walk), and 10.0 points (ADL) or 44.4 points (total) improved to postoperative JOA scores at the latest examination (post-revision results for revision cases) of 33.6 points (pain), 15.8 points (ROM), 16.3 points (walk), and 15.8 points (ADL) or 81.5 points (total) on average. Nevertheless, the causal factors for high revision rates must be examined (Figure 5).

In the radiographic evaluation, 10 cases (11 hips) of 17 cases (21 hips) showed some kind of problem (Table 2). Migration of the cup was recognized in 6 hips on the acetabular side (28.6%). Of the 6 hips, 3 showed osteolysis, and 1 (case 10) was caused by infection. Moreover, wear of the cup was recognized in 4 hips. On the femoral side, sinking and osteolysis appeared in 1 hip, which hip also had problems on the acetabular side.

Bone ingrowth was obtained in 11 hips (52.4%) on the acetabular side and 19 hips (90.5%) on the femoral side. The overall results of the THA cases, including cases using the stem, the cup, and the inner head not presently in use, can be concluded as poor.

3. Review of revisions in the THA group

Revision was performed in 8 of 21 hips (38.1%) in the THA group. The period until revision was 1 year 5 months after the operation in the early series cases, and 4 years 3 months after the operation in infected cases. However, in most cases, revision was performed between 7 years 6 months and 10 years 8 months after the opera-
Fig. 5  Clinical results in the THA group (JOA score)
Preoperative JOA score improved from a total of 44.4 points to 81.5 points on average (post-revision results for revision cases). Nevertheless, causal factors of high revision rate must still be examined.

Table 2  X-ray evaluation of the problem cases in the THA group

<table>
<thead>
<tr>
<th>case</th>
<th>cup</th>
<th>stem</th>
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<tr>
<td></td>
<td>migration</td>
<td>wear</td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
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<td>10</td>
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Discussion

The therapeutic strategy for ION in our department is to first select joint preservation treatment for cases in which the stage has advanced and collapse is expected. However, endoprostheses, such as in the BHA and THA procedures, are inserted to treat a wide necrotic area where joint preservation treatment is not applicable. Most of the ION cases have a wide necrotic area, and thus insertion of endoprostheses is the most likely procedure. Due to the durability of endoprostheses, there are still many problems regarding the long-term results and regarding its use in young and middle-aged patients.

To maintain the effect of the artificial joint over a long period of time, satisfactory fixation between the implant, the bone and the cement is essential, as is an appropriate decision as to which endoprostheses (BHA or THA) to choose and at which stage to use them. Furthermore, the problem of how to use a wear-resistant material for the sliding surface acting as the joint must be considered.

Through our review of the treatment results of prostheses, it was found that satisfactory postoperative treatment results could be obtained in the BHA group. However, the long-term results of BHA are not necessarily satisfactory in other aspects, thus this procedure should be performed with caution in every stage. Nevertheless, it is not appropriate to completely deny the use of BHA for all different types of prosthesis are currently being used. We intend to continue applying BHA in preference to THA for cases in which articular cartilage is preserved.

In our review of the THA cases, the revision cases
were 8 hips (38%), and there were 2 hips (10%) of pre-revision cases with radiographic problems and thus the treatment results were more or less poor. To study the causes of such poor results, we compared the revision cases with non-revision cases (Table 3). The first cause is the problem of wear debris produced by the titanium alloy inner head used until 1992. The second cause is the easy loosening of the Threaded cup used until 1988. No significant difference was recognized between treatment results of cases requiring bone cement and those not requiring bone cement. Thus, in the treatment results after 1993, from which time both of the above problems had been addressed by the manufacturers, no problem has been recognized besides infection, excellent radiographic results were obtained, and a satisfactory postoperative JOA total score of 81.3 points was achieved. Thus, excluding the cases using the Threaded cup and titanium alloy inner head, the results for recent THA in cases in which the cartilage state is bad are satisfactory at the present time. We therefore intend to examine the long term results for these cases.

It can be seen from the above treatment results that implants made of titanium alloy and machined to give a porous surface are well fixed to the bone without any particular problem at the present time, and thus we intend to continuously use such implants in the future. It was also found that in terms of the sliding surface, the combination of polyethylene liner and titanium alloy gives high wear resistance. As a result, wear debris or wear powder are produced, osteolysis is caused, and
Finned porous titanium alloy inner head used until 1992. The second cause is the easy loosening of the Threaded cup used until 1988.

Revision was performed in 8 of 21 hips in the THA group. To study the causes of such poor results, we compared the revision cases with non-revision cases. The first cause is the problem of wear debris produced by the titanium alloy inner head used until 1992. The second cause is the easy loosening of the Threaded cup used until 1988.

Conclusions

1. The postoperative results of 35 cases (44 hips) with ION treated with endoprosthesis between 1986 and 1999 (23 hips were BHA cases and 21 hips were THA cases) were reviewed.

2. The treatment results of BHA performed in accordance with the surgical indications employed by our department, i.e. cases in which the articular cartilage state is good were satisfactory. No revision was performed and no radiographic problem was found.

3. The overall results of the THA cases, including cases using the stem, the cup, and the inner head not presently in use, can be concluded as poor and 8 hips had problems requiring revision. In the treatment results of the 11 hips treated with THA after 1993, excluding the cases using the Threaded cup and titanium alloy inner head, no revision was performed besides the 1 case with postoperative infection, no radiographic problem was found and thus satisfactory results were obtained.

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特発性大腿骨頭壊死症における人工関節置換術の中・長期成績

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【要旨】 特発性大腿骨頭壊死 (ION) 症例に対する人工関節の術後成績と問題点について検討した。
対象は、1986年～1996年までに人工関節が施行された35症例44股で、年齢は23～67（平均47.9）歳、経過観察期間は5～15（平均7.6）年であった。当科での術式の適応は、臼蓋軟骨の変性の少ない症例には人工骨頭置換術（以下BHA）、臼蓋軟骨の変性の強い症例には全人工股関節置換術（以下THA）としている。BHA症例は23股、THA症例は21股で、BHA群とTHA群それぞれの術後成績を検討した。
検討項目は、臨床成績は股関節症機能判定基準（JOA score）を用い、X線学的評価は、臼蓋側ではproximal migration、osteolysis、ポリエチレンの摩耗について検討し、大腿骨側ではstemのsinking、osteolysisの有無について検討した。又、revision症例についてもその原因について検討した。結果は、1）BHA症例23股の治療成績は、臨床成績は術前の平均JOA scoreはTotal48.2点が、術後Total88.6点と改善を認め、X線学的にも問題なく、適応を守れば良好な成績であった。2）THA群の術後成績は、臨床成績は、術前JOA scoreは平均44.4点が、最終調査時（再手術例は再手術後の成績を使用）の術後JOA scoreは81.5点と改善はしていたが、再手術症例が8股もあり問題であった。その原因としては1992年頃まで使用していたチタン合金製inner headの使用によるポリエチレンの高摩耗とosteolysisの発生、Threaded cupの使用によるcupの緩みの問題があげられる。従って、これらの問題を解決した1993年以降の11股の治療成績は、術後感染による1例を除き再手術例はなく、臨床成績、X線学的にも問題はなく、適応を守れば良好な成績であった。

(Key words) 特発性大腿骨頭壊死症、人工関節置換術、全人工股関節置換術、手術成績