A Radiographic Review of 135 Total Hip Charnley Arthroplasties followed between 15 and 35 Years

Rentgenologické zhodnocení 135 totálních náhrad kyčelního kloubu podle Charnleyho sledovaných 15 až 35 let

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ABSTRACT

The long-term radiologically interpreted results of low-friction Charnley hip arthroplasties have been previously suggested to be influenced by surgical details, such as orientation of the femoral component, degree of coverage of the plastic acetabulum and other features. We carefully analyzed the radiographs of 135 Charnley arthroplasties that had remained functional, had not been revised and had follow-ups between 15 and 35 years. Several common denominators were identified amongst these radiographs: 93.5% arthroplasties had 100% coverage of the acetabular component; 88% had acetabular inclination between 40–45°; 84.5% had a proximal/medial column of cement between 3 and 5 millimeters at the level of femoral head resection; 81% had a femoral canal/stem ratio more than 50%; and 84% had a column of cement that extended below the tip of the prosthesis. This study supports the importance of technical surgical details that enhance the chances of long-term survival of cemented total hip arthroplasties.

Key words: total hip, long-term follow up, Charnley.

Despite the fact that the field of total hip arthroplasty continuous to evolve and the use of acrylic cement as the means to stabilize the prosthetic components has significantly lost grounds to noncemented porous fixation the Charnley low-friction arthroplasty remains the gold-standard against which other arthroplasties are measured. Long-term results with the Charnley total hip arthroplasty have been reported by a number of investigators (1, 2, 3, 5, 16, 11, 12, 10, 19, 20). No clear reasons have been given to explain why the fate of the Charnley arthroplasty has withstood the test of time in such a superior manner despite major advances in the understanding of the chemical and mechanical behavior of foreign bodies implanted in the body. Upon completing a 35-year follow-up of our experience with the Charnley arthroplasty we undertook the task of studying the radiological condition of 135 arthroplasties with a minimum follow-up of 15 years and a maximum of 35 years in order to determine if common denominators could be identify that would shed light into the subject.

MATERIAL AND METHODS

From a group of 383 patients who had 470 Charnley arthroplasties (87 bilateral) performed by the senior author (A.S.) between July 1970 and July 1975, 39 (8.29%) joints were known to have been revised; their mean age was 62±13 years and their mean weight 67 kg. The mean follow-up until revision was 122±months with a maximum of 270 months. 244 (63.7%) patients were lost to follow-up prior to their reaching 15 years after surgery. It is assumed many of them had expired or that the loss to follow-up was due to other reasons, such as revision surgery performed elsewhere or simply patients’ unwillingness or inability to respond to our requests. Four (1%) patients were alive but their x-rays could not be obtained. Analysis of radiographs was conducted in the 135 hips of the 109 (28%) patients who were available for review between 15 and 35 ears after surgery. We had discontinued further gathering of follow-up data when the maximum follow-up of 25 years was reached. Subsequently we decided to increase the follow-up to the 35 years mark. The added data constitutes the material presented in this study.

The Charnley total hip replacements were performed through a lateral approach with trochanteric osteotomy. Non-pressurized finger packing of the cement was followed by insertion of the components. No medullary canal plugging was used in any instance. The original 50-mm acetabular cup was used in all patients. The femoral component consisted of the classical monoblock smooth, shiny 22 mm Charnley implant made of stainless steel (Zimmer). 368 (78%) arthroplasties had curved stems; 36 (7.6%) arthroplasties had straight stems; and 66 (14%) arthroplasties had the Cobra style stems. The Cobra prostheses had matted surfaces.

From the original total group of 383 patients, 287 (74%) had a primary diagnosis of osteoarthritis. In this subgroup, 299 (72.8%) patients had idiopathic osteoarthritis; 68 (23.6%) patients had osteoarthritis sec-
ondary to hip dysplasia, and 10 (3.4%) patients had osteoarthritis secondary to other conditions i.e. Perthes disease, slipped capital femoral epiphysis; 53 (13.8%) patients had rheumatoid arthritis; 10 (2.6%) patients had a painful endoprosthesis; 21 (5.4%) patients had idiopathic avascular necrosis of the femoral head; 9 (2.5%) patients had post-traumatic avascular necrosis of the femoral head, 2 (0.5%) patients suffered from ankylosing spondylitis; and one (0.2%) patient had an spontaneously fused hip secondary to head injury.

From the overall group of 383 patients who had 470 Charnley arthroplasties (87 bilateral) performed by the senior author (A.S.) between July 1970 and July 1975, 39 (8.29%) joints were known to have been revised; their mean age was 62±13 years and their mean weight 67 kg. The mean follow-up until revision was 122±months with a maximum of 270 months. 244 (63.7%) patients were lost to follow-up prior to their reaching 15 years after surgery. It is assumed many of them had expired or that the loss to follow-up was due to other reasons, such as revision surgery performed elsewhere or simply patients' unwillingness or inability to respond to our requests. Four (1%) patients were alive but their x-rays could not be obtained. The progression of various radiological changes was monitored on a yearly basis which at the 25-year mark had indicated the survival to be as shown in tables 1, 2 and 3.

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Weight bearing began within a few days after surgery, but full, unprotected weight bearing was postponed for six weeks. All patients were contacted on a yearly bases at which time they were either seen personally or were asked to obtain radiographs of their operate hips and to complete a simple questionnaire concerning the presence or absence of pain and the need and type of assisted ambulation.

The 109 patients available for long-term follow-up had 135 arthroplasties performed. Twenty-seven (24.7%) patients had bilateral replacements; 21 (77.7%) of these arthroplasties were performed at different times; and 6 (22.2%) arthroplasties were performed simultaneously. 115 (85%) stems were curved; 6 (4%) stems were straight; and 14 (10%) stems were of the cobra type. Forty-two (38.5%) patients were males and 67 (61.4%) patients were females. The mean weight of the patients who had curved stems was 67 kg; in the patients who had straight stems the mean weight was 65.5 kg;
The following are representative radiographs (Fig. 1, 2, 3).

The abnormal changes identified in the latest radiograph included among others acetabular migration, femoral/bone radiolucent lines and wear (Table 8).

**DISCUSSION**

Despite the plethora of different total hip prostheses brought into the market during the past three decades, it
is not possible at this time to state categorically that any one system or implant is significantly superior to all others. The non-cemented system of hip arthroplasty came into being on the belief that acrylic cement was associated with complications such as loosening and lysis (7, 8) However, for some time after the popularization of the original non-cemented arthroplasty, it became evident that bone lysis was more likely to develop with these implants. Modifications in the geometry of the implants and the distributions of the porous area seem to have significantly improved the results (2, 7, 8).

Reviews of clinical and radiological results with the Charnley implant have suggested that certain details influence the long-term outcome of the surgical replacement, for example, the degree of coverage and inclination of the acetabular component (3, 6, 13); the attitude of the stem in the medullary canal, i.e. varus, valgus, neutral (1, 4, 6, 14, 16, 20), the thickness of the column of cement at the level of the proximal/medial femoral cortex (2, 4, 6, 8, 10, 18) the ratio between the diameter of the femoral implant and that of the femoral component (4, 5, 17) the patients age at the time of surgery and the disease for which the surgery is performed (1, 3, 5, 12, 14).

Based on the above information we elected to review our Charnley arthroplasties that had survived between fifteen and thirty-three years to determine if the radiological and clinical features that have been previously identified were present in the long-surviving hips. We did not include in this study those patients who for a variety of reasons were not followed more than 15 years, since we were only interested in evaluating the radiological performance of implants followed longer than

**TABLE 8. Abnormal changes**

<table>
<thead>
<tr>
<th>Description of changes measured</th>
<th>Measure</th>
<th>% patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetabular migration</td>
<td>None</td>
<td>96.2 %</td>
</tr>
<tr>
<td></td>
<td>&lt;5 mm</td>
<td>2.9 %</td>
</tr>
<tr>
<td></td>
<td>&gt; 5 mm</td>
<td>0.7 %</td>
</tr>
<tr>
<td>Acetabular bone/cement radiolucent lines</td>
<td>None</td>
<td>94.1 %</td>
</tr>
<tr>
<td></td>
<td>&gt;1 mm</td>
<td>5.9 %</td>
</tr>
<tr>
<td>Femoral bone/cement radiolucent lines</td>
<td>None</td>
<td>95.5 %</td>
</tr>
<tr>
<td></td>
<td>&gt;1 mm</td>
<td>4.4 %</td>
</tr>
<tr>
<td>Femoral metal/cement radiolucent lines</td>
<td>None</td>
<td>97.7 %</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>2.3 %</td>
</tr>
<tr>
<td>Cement fracture</td>
<td>None</td>
<td>96.2 %</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>3.7 %</td>
</tr>
<tr>
<td>Polyethylene wear</td>
<td>None</td>
<td>30 (14.8 %)</td>
</tr>
<tr>
<td></td>
<td>1–3 mm</td>
<td>89 (66 %)</td>
</tr>
<tr>
<td></td>
<td>3–5 mm</td>
<td>13 (9.6 %)</td>
</tr>
<tr>
<td></td>
<td>&gt;5 mm</td>
<td>3 (2.2 %)</td>
</tr>
<tr>
<td>Broken wires</td>
<td>None</td>
<td>85.5 %</td>
</tr>
<tr>
<td></td>
<td>Broken</td>
<td>14.5 %</td>
</tr>
<tr>
<td>Acetabular Lysis</td>
<td>None</td>
<td>95.6 %</td>
</tr>
<tr>
<td></td>
<td>&lt; 5 mm</td>
<td>4.4 %</td>
</tr>
<tr>
<td>Femoral Lysis (Neck resorption)</td>
<td>None</td>
<td>95.6 %</td>
</tr>
<tr>
<td></td>
<td>&lt; 5 mm</td>
<td>4.4 %</td>
</tr>
</tbody>
</table>
fifteen years. It is well-known that virtually all different types of total hip implants seem to render good radiological results for a few years, only to demonstrate failure after fifteen years of clinical performance.

This review indicated that the vast majority of patients had met the previously identified observations. 1) 93.3% hips had 100 percent coverage of the acetabular component. 2) 88% hips had the acetabular component inclined between 40 and 45 degrees and 8.8% hips between 45 and 50 degrees. 3) 82.9% hips had the femoral component in a neutral attitude and 9.6% in a valgus attitude, while only 7.5% had the implants in varus. 4) 84.4% hips had a column of cement at the level of the transected femoral neck a thickness between 3 and 5 millimeters. 5) 81.4% hips had femoral stems that occupied more than 50% of the diameter of the medullary canal. 6) 84% hips had a column of cement that extended below the tip of the prosthesis.

Review of the radiographs of this group of patients with long-term follow-up demonstrated a low incidence of findings commonly known as being of an undesirable nature, some of which are generally considered to be signs of early failure. 1) Absence of measurable acetabular migration was documented in 96.2% hips. 2) 94.7% hips did not have continuous acetabular bone/cement radiolucent lines. 3) 95.5% hips did not show continuous cement/bone radiolucent lines. 4) 97.7% hips did not have femoral metal/cement radiolucent lines. 5) 96.2% hips did not have fractures of the femoral cement column. 6) Wear of the acetabular polyethylene component was found in most hips; only 14.8% hips did not have measurable wear. 7) Minimal femoral lysis was present in 4.4% radiographs; and acetabular lysis was documented in 2.5% patients. It is interesting to note that neither the age nor the weight of the patients at the time of surgery seem to correlate with acetabular wear, bone-cement or metal cement radiolucent lines. The small number of patients in the series and particularly in each category of „abnormal changes“ precluded the statistical analysis that is possible with larger series.

The data we gathered suggest that the patients’ weight may not be important in view of the fact since it was similar in analyzed parameters, such as disease categories, i.e. osteoarthritis, avascular necrosis, rheumatoid arthritis (Tables 4 and 5).

Clinical data was not reported in the current review despite the fact that attempts to gather pertinent information was made on a yearly basis. The patients’ clinical performance was not discussed because we considered the information obtained from questionnaires to be frequently unreliable, such as the use of external support or ability to walk long distances. We had long-realized that elderly people, for reasons frequently unrelated to the operated hips, use a cane or walker, not because of pain in the hip, but because associated degenerative conditions require their use. Often, elderly patients afflicted with multiple physical or mental problems do not appropriately respond to questions asked in written questionnaires, and frequently report the presence of pain. Subsequent telephone conversation with them makes it obvious that quite often the alleged symptoms are due to spine and other joints’ pathology rather than to hip disease. It is likely that patients whose radiographs do not show certain abnormal changes are likely to have asymptomatic hip joints.

It is not uncommon to see patients whose radiographs show significant abnormal changes who, nonetheless have minimal discomfort or are totally asymptomatic. Therefore, one may conclude that revision surgery is not an accurate end-point criterion in determining success or failure of total hip arthroplasties. There are also times when painful arthroplasties are never revised for a variety of reasons, such as the presence of medical conditions that preclude surgery or patients’ unwillingness of undergo additional surgery.

The data obtained from this study does not provide information regarding the impact that the described technical features may have had in the degree of wear of the polyethylene acetabular component.

This review does not intend to imply that long-term success of Charnley arthroplasties can be assured if the technical details identified in the text are carefully implemented. However, the information obtained strongly suggests that successful radiological long-term results from Charnley arthroplasty- and perhaps also from other types of cemented arthroplasties- may be significantly dependent on adherence to the details identified in this study. The identified common denominators strongly suggest that the following technical details are important in influencing a satisfactory long-term follow-up: complete coverage of the acetabular component, an angle of inclination of the acetabulum between 40° and 50°, a neutral attitude of the stem in the medullary canal, a ratio of stem/canal diameter greater than 50%, a column of cement proximally between 3-5 mm, and a column of cement that extends below the tip-end of the metallic stem (Tables 7 and 8).

ZÁVĚR

Již dříve bylo popsáno, že u totální náhrady s použitím komponenty s nízkým ošetřem podle Charnleyho jsou dlouhodobě, radiologicky hodnocené výsledky ovlivněny operačními faktory, jako jsou orientace femorální komponenty, stupeň pokrytí plastické jamky a další. Pečlivě jsme analyzovali rtg-snímky 135 totálních náhrad podle Charnleyho, které byly funkční, nebyly revidovány a doba sledování se pohybovala od 15 do 35 let. Na základě snímků byly zjištěny následující společné znaky: 93,5 % náhrad mělo stoprocentní zakrytí jamky; 88 % mělo sklon jamky 40°-45°; 84,5 % mělo proximálně mediálně sloupec cementu šíře mezi 3–5 mm u úrovni resekce hlavice femuru; u 81 % byl poměr femorálního kanálu ku dříku protezy více než 50 % a u 84 % zasahoval sloupec cementu pod šípku dříku protezy.

Výsledky této studie ukazují na význam technických detailů operačního výkonu, které zvyšují vyhledání na dlouhodobé přežití cementované totální náhrady kyčelního kloubu.
References