Evaluation Aseptic Loosening of Primary Hip Arthroplasty

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ABSTRACT

Background : The number of primary hip arthroplasty is growing with every passing year. At present this surgical operation has no equal in the rate of yielding good results. Despite the fact that in many cases in the long term after surgery radiolucent lines around the cup are observed, the clinical outcomes remain satisfactory.

Aim of the study : To study the clinical and radiological manifestations of the aseptic loosening of the endoprosthesis

Methods: This is a prospective study based on an analysis of diagnostic findings of 51 patients with aseptic loosening of hip joint components, aged 30 to 84 years. We depend for diagnosis of a septic losing by both clinical evaluation and X-ray assessment

Results: The majority of clinical and radiological evidence of aseptic loosening appear after three years (47%).All our patients had a pain syndrome of varying intensity, with (43.2%) used a walking-stick. Shortening limb from 1 to 7 cm was found in 43 patients 85.2%.

The aseptic losing are common in cementless hip prosthesis especially in femoral stem part of prosthesus 53.9% versus 25.6% in cemented type,

Revision surgery for primary hip prosthesis occur mainly for femoral stem involve 49% while other 25.5% involve both acetabular cup and femoral stem, while the rest of patient(25.5%) involve revision of acetabular cup only.

Discussion : At present this surgical operation has no equal in the rate of yielding good results. The lifetime of the majority of artificial joints does not exceed 15 years mainly due to aseptic loosening of one or both endoprosthetic components There are many causes of aseptic instability: substandard surgical technique, unwarranted extension of the indications for arthroplasty, inappropriate choice of the prosthesis dimension type, incorrect installation of components, reaction to the massive foreign body and the development of synovial-like membrane on the metal-bone interface .

As a rule, early instability within 1 year was associated with defects in the operative techniques, from 1 to 3 years mostly due to the wrong selection of the type of primary endoprosthesis while more than 3 years period, the instability was caused by two reasons: excessive load on the operated extremity or traumas and the rapid wear of plastic with large areas of osteolysis due to the high loads or inaccurate positioning of the prosthetic cup.

Conclusions: X-ray examination is the fundamental for diagnosing of aseptic loosening of hip endoprosthesis , and improved surgical techniques, the proper selection of the type of prosthesis are the keys for reduction of risk of aseptic loosening

Keywords: aseptic loosening, hip endoprosthesis .

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INTRODUCTION

The number of primary hip arthroplasty is growing with every passing year. At present this surgical operation has no equal in the rate of yielding good results. A pain syndrome disappears almost immediately or abates considerably, gait improves, patients become fully able to take care of themselves, they return to active and productive life. [(1)]

It is no coincidence that as the number of primary surgery is growing, the need for re-endoprosthesis is increasing. In big clinics and specialized centres a primary interventions-to-reinterventions ratio is 4:1-3:1 and in the future it is predicted to be 2:1 [(2)]. The reasons for revisions are as follows: loosening of the acetabular component - 14%; loosening of both endoprosthetic components – 36%; loosening of the femoral component – 44%; other reasons – 6% [(3)]. The longer the follow-up period lasts, the higher the value of aseptic loosening is.

Despite the fact that in many cases in the long term after surgery radiolucent lines around the cup are observed, the clinical outcomes remain satisfactory. As a result of discrepancy between X-ray findings and clinical outcomes there are disagreements in the orthopedic community about the indications for application of ultrahigh modular wear polyethylene acetabular components [4].

The osseointegration term is used to denote a bone-implant junction, where in the implant becomes part of the bone through the bone ingrowth into the porous structure and due to the bone adhering to the rough (in microscopic terms) implant surface [5]. The *bone ingrowth* term denotes osseointegration with bone tissue formation within the spongy porous structure and the connection of the latter with the surrounding bone. The effectiveness of osseointegration or biological (secondary) fixation of the implant depends on several factors, one of which is the primary fixation of the implant achieved during its implantation [6,7].

Total hip arthroplasty(THA) has a number of specific complications and outcomes after arthroplasty are worsening during the follow-up period. Aseptic loosening of the endoprosthetic components is the basic problem that determines the duration of the prosthesis functioning and, ultimately, the clinical outcome of the surgical operation. Despite the progress in engineering, metallurgy, scientific research in the field of osteointegration, the lifetime of the majority of artificial joints in the organism does not exceed 15 years [8]

There are many causes of aseptic instability: substandard surgical technique, unwarranted extension of the indications for arthroplasty, inappropriate choice of the prosthesis dimension type, incorrect installation of components, reaction to the massive foreign body and the development of synovial-like membrane on the metal-bone interface [9,10].

At present two hypotheses - biomechanical and inflammatory – are intensively studied. The proponents of the first approach consider the interaction of the rigid loaded construction with a living bone tissue to be the main reason for this complication (11).

The inflammatory theory of aseptic loosening of the endoprosthesis, as well as the biomechanical theory, is based on the enhanced bone resorption initiated by the wear particles of materials making up a friction assembly, and corrosion products [9,12].

Aim of study

To study the clinical and radiological manifestations of the aseptic loosening of the endoprosthesis

Methods

This is aprospective study based on an analysis of diagnostic findings of 51 patients with aseptic loosening of hip joint components, aged 30 to 84 years. In the period from January 2017 to July 2019 the patients were treated in the Orthopaedics unit in Ibin Sina hospital and Al-Kindy teaching hospital

We depend for diagnosis of a septic losing by both clinical evaluation and X-ray assessment

Clinically, all our patients assess for pain syndrome correlate to daily activity, Claudication, limping, the tonus of the gluteal muscles (the patient's ability to hold a pelvis while walking in a horizontal position) was assessed by using the Trendelenburg test and total extremity shortening.

Regarding X-Ray evaluation ,all our pateints subjected to standard radiography of the hip joint thus performed in the anterior-posterior and lateral views. X-ray pictures were analyzed, for acetabular and femoral component of the hip prosthesis

To determine the state of the acetabular component of the hip prosthesis we have analyzed the following linear and angular parameters: .

A. *Angulation of the acetabular component*. Was determined by the intersection angle of the horizontal axis of the pelvis at the lower edge of the "tear drop" and the line passing through the upper and lower lateral edges of the acetabular component. To ensure a balance of shearing and pressing loads in the hip joint, this angle should not exceed 45°.

B. *The angle of the acetabular component anteversion*. The numerical value of the deflection angle of the acetabular component on the sagittal plane can be determined only on the X-ray pictures made in the lateral projection. Anteversion angle corresponds to the angle between the line connecting the edge of the symphysis with the edge of the ischial tuberosity and a line passing through the plane of the entrance to the acetabular component. Normally, it amounts to 10- 20°.
C. *Determination of horizontal, vertical and rotational migration of the cup*. In case of loosening of the acetabular component, its proximal, medial or angular migration can be revealed. Displacement of the rotation center of the endoprosthesis from the line passing through the teardrop figure and relative to the teardrop figure, as well as change in the cetabular component angulation were determined.
D. *Cup coverage*. The difference between angulation of the acetabulum and the acetabular component was determined. Coverage of the acetabular with bone tissue should be not less than 70%.
For the objectification of evaluating of the bone tissue response to the prosthesis, the degree of osteolysis, migration of implants on the ground of X-ray pictures, projection zones of the endoprosthesis are singled out. To evaluate the acetabular component, we used J.G. DeLee - J. Charnley classification[13]

Figure1

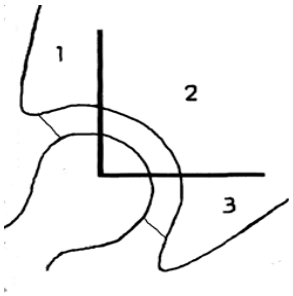
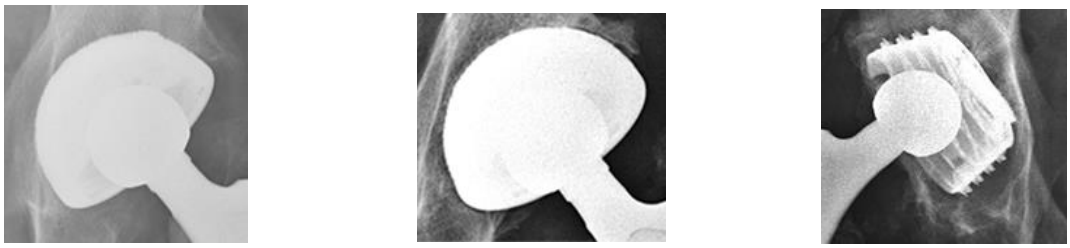


Fig. 1: Division of the acetabular component into zones according to J.G. DeLee and J. Charnley [13]

According to the X-ray findings the status of the implant osseointegration was described as good, satisfactory and unsatisfactory. Figure 2



A B C

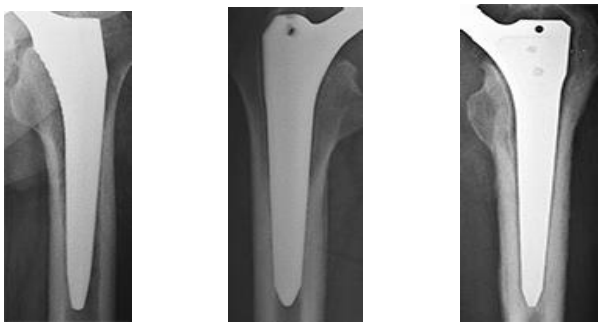
Figure 2 : Cup osseointegration A : good B: Ssatisfactory C:Unsatisfactory (unstable component)

Osseointegration of the femoral component of the endoprosthesis was regarded as
A. Good (a stable component with bone ingrowth) if rarefaction lines surrounded by thin sclerosis lines were not detected or were diagnosed in not more than 3 out of 7 zones in the frontal radiographic projections (or 4-5 out of 14 zones in the combined frontal and lateral projections) . Figure 3 A
B. Satisfactory with no or little migration of the component (less than 3 mm), with no or little change in the angle of the component

position (less than 5°). At the same time there were rarefaction lines surrounded by thin sclerosis lines in more than 4 out of 7 zones in the frontal radiographic projections (or more than 7 out of 14 with a combination of frontal and lateral projections) with a possible moderate hypertrophy of the cortical layer of the femur bone. Figure 3B

C. Unsatisfactory (unstable component) if its position has changed (migration by more than 3 mm, change in angulation - more than 5°). At the same time there were detected continuous circular lines of induration separated from the endoprosthesis by resorption lines of different thicknesses, different severity of hypertrophy of the cortical layer of the femur. Figure 3 C

To describe changes around the endoprosthesis stem, we used the T.A Gruen classification [14] .Figure4



A B C

Figure 3 : Stem osseointegration A: Good B: Satisfactory C: Unsatisfactory (unstable component)

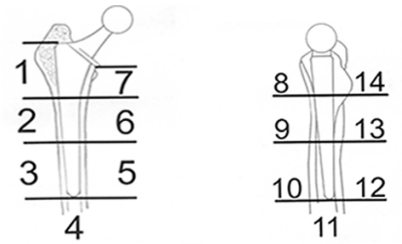
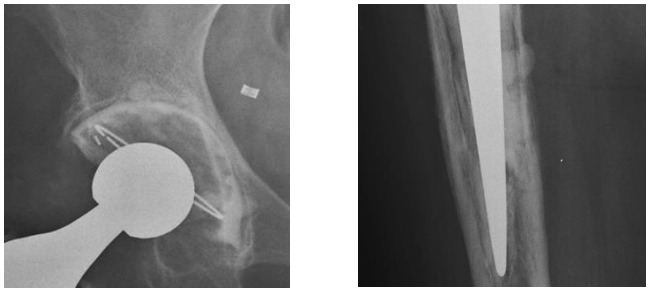


Figure 4 : Projection zones of the endoprosthesis stem on the X-ray picture in the frontal and lateral projections according to the T.A Gruen classification [14]

When evaluating the stability of the cement fixation prosthesis, it must be borne in mind that normally between the prosthesis and the cement mantle, as well as cement and the bone tissue there may be an osteolysis line of 1-2 mm width. It is conditioned by the minimum mobility of the implant in the cement and the whole block in the bone. This feature is not prognostically significant provided that the area of osteolysis does not cover the implant completely and does not progress during the follow-up. Osteolysis of more than 2 mm, change in the endprosthesis position, breakage of the cement mantle indicate the loosening of the prosthesis (figure 5).



A B

Figure 5 : Loosening of the cemented cup and stem A : Osteolysis of more than 2 mm width; B : breakage of the cement mantle

Result

This is aprospective study based on an analysis of diagnostic findings of 51 patients with aseptic loosening of hip joint components, aged 30 to 84 years. In the period from January 2017 to July 2019 the patients were treated in the Orthopaedics unit in Ibin Sina hospital and AL-Kindy teaching hospital Among them there were 21 men and 30 women, 62.7% were persons of the most active working age. (Table1).

Table 1 Age distribution of the patients as time of revision surgery

Age	No. of pat.	%
Young (under 45)	8	15.7
Middle (46-60)	24	47
Elderly (61-75)	14	27.5
Senium (after 76)	5	9.8

When analyzing the survival of the primary endoprosthesis until clinical and radiological evidence of aseptic loosening, the dominant causes that led to the loosening of the cup and the prosthesis stem were revealed. Distribution of the patients according to the time period from the primary surgery to the revision surgery are given in the table (Table.2).

Table 2 Distribution of patients according to the time period from the primary surgery to the revision surgery

Time after the original surgery	No. of pat.	%
Less than 1 year	8	16
1 -3 years	19	37
More than3 years	24	47

Clinical examination of patients with aseptic loosening was of great importance for the diagnosis,

All our patients had a pain syndrome of varying intensity. Only 3 patients (5.9%) retained the same motor activity as before the pain occurrence, taking painkillers from time to time - 2-3 times a week. Another 12 patients (23.5%) did not use mobility aids, having reduced the total daily load bearing on the lower extremities. 22 patients (43.2%) used a walking-stick, seven patients (13.7%) the others were able to walk only with crutches or a walker. In 7 cases (13.7%), severe pain dramatically reduced the patients' capability for self-care maintenance - they were either bedridden or could hardly move around in the apartment, getting out of bed with physical assistance. A pain syndrome in all cases increased with load bearing, and after a long walk did not pass for some time even at rest. In 45 patients (88.2%) pain was growing during active and passive movements in the horizontal position, in 9 of them - only with extreme degrees of movement or an attempt to overcome the existing contracture.

Accelerated axial load in the supine position caused a distinct occurrence or worsening of pain only in 12 cases (23.5%) Claudication was detected in all cases if the patient could make at least a few steps without mobility aids. Mild claudication was detected in 17 persons (33.3%), dropping claudication - in 8 persons (15.7%) , in 17 patients (33.3%) were limping because of sparing the shortened extremity (both mild

and dropping claudication). 9 patients (17.7%) could not move without crutches or a walker at all.
The tonus of the gluteal muscles (the patient's ability to hold a pelvis while walking in a horizontal position) was assessed by using the Trendelenburg test. A positive sign was detected in 37 cases (72.5%).
Total extremity shortening from 1 to 7 cm was found in 43 patients (84.3%). Relative shortening occurred in 17 cases (39.6%) , projection shortening (due to adduction and flexion contractures of the hip and knee joints) - in 5 cases (11.6%) , in the other cases 21 patients (48.8%) both relative and projection shortening .

Table 3. Distribution of the prosthesis stems and cup loosening depending on the type of fixation

Prosthesis components	Cementless fixation	Cemented fixation
Cup	14 (26.4%)	12 (23.5%)
Stem	27 (52.9%)	11 (21.6%)

As can be seen from the above, revision arthroplasty of the pelvic component was performed in 26 patients (50.9%) and revision arthroplasty of the femoral component was performed in 38 patients (74.5 %).
After clinical and radiographic examination, the availability of signs of loosening (Table 4).
Table- 4: Distribution of the patients according to the endoprosthesis components replaced during the revision surgery. Figures

	Right leg	Left leg	Total	%
Revision of the prosthesis cup only	6	7	13	25.5
Revision of the prosthesis stem only	14	11	25	49
Revision of the prosthesis cup and stem	7	6	13	25.5
Total	27	24	51	100

DISCUSSION

At present this surgical operation has no equal in the rate of yielding good results. A pain syndrome disappears almost immediately or abates considerably, gait improves, patients become fully able to take care of themselves, they return to active and productive life . Due to these facts hip arthroplasty can be attributed to the most prominent achievements in orthopaedics and medicine in general. Progress in the development and clinical use of the total hip arthroplasty achieved in the last 50 years is a great contribution to the development of plastic surgery .[1]
Aseptic loosening of the endoprosthetic components is the basic problem that determines the duration of the prosthesis functioning and, ultimately, the clinical outcome of the surgical operation. Despite the progress in engineering, metallurgy, scientific research in the field of osteointegration, the lifetime of the majority of artificial joints in the organism does not exceed 15 years .[8] The main reason for this phenomenon is the aseptic loosening of one or both endoprosthetic components. There are many causes of aseptic instability: substandard surgical technique, unwarranted extension of the indications for arthroplasty, inappropriate choice of the prosthesis dimension type, incorrect installation of components, reaction to the massive foreign body and the development of synovial-like membrane on the metal-bone interface .[9,10]
In our study about 2/3 of our patients are below 60 years old and this age group are active working age ,our result ar comparative with other studies ,Della Valle et al [15] and J.J. et al [16].
The aseptic losing are common in cementless hip prosthesis especially in femoral stem part of prosthesus 52.9% versus 21.6% in cemented type, this result are higher than result of Bardon [17] , Buttaro [18] and Hamilton et al [19] , and similar to result of T. Nishino [20], while aseptic losing in acetabular cup are nearly equal in both types of fixation cemenless and cemented types of fixation 26.4% versus 23.5% respectively and these results are higher than result obtain by P.R. et al [12] , Nishino et al

[20],and Harris et al [21] , and similar to result of R.H . et al [6].

Revision surgery for primary hip prosthesis occur mainly for femoral stem in our patient 49% only the femoral stem while other 25.5% involve both acetabular cup and femoral stem, while the rest of patient(25.5%) involve revision of acetabular cup only.

Our result were higher than result of Bardou [17] , Buttaro[18], Hamilton [19] and Nishino et al [20], the reasons for high percentage of revision may be substandard surgical technique , wrong patients selection or inappropriate selection of prosthesis dimension type and incorrect installation componants.

When analyzing the survival of the primary endoprosthesis until clinical and radiological evidence of aseptic loosening, the dominant causes that led to the loosening of the cup and the prosthesis stem were revealed. As a rule, early instability within 1 year was associated with defects in the operative techniques - excessively vertical or horizontal position of the prosthesis, contact between the cup and the cavity less than 70%, varus position of the prosthesis stem. Instability during the period from 1 to 3 years developed mostly due to the wrong selection of the type of primary endoprosthesis - mismatch between the design of the cementless stem and the structure of the proximal femur, implantation of cementless components in the patients with marked osteoporosis of the bones forming the hip joint, application of cementing technique in young patients. More than 3 year period , the instability was caused by two reasons: excessive load on the operated extremity or traumas (in particular, those resulting in splitting of the cement mantle) and the rapid wear of plastic with large areas of osteolysis due to the high loads or inaccurate positioning of the prosthetic cup. .

All our patients had a pain syndrome of varying intensity. Only 3 patients retained the same motor activity as before the pain occurrence, taking painkillers from time to time - 2-3 times a week. Another 12 patients did not use mobility aids, having reduced the total daily load bearing on the lower extremities. 22 patients used a walking-stick, the others were able to walk only with crutches or a walker. In 7 cases, severe pain dramatically reduced the patients' capability for self-care maintenance - they were either bedridden or could hardly move around in the apartment, getting out of bed with physical assistance.

As a rule, pain appeared in the groin, less often in the gluteal region, in cases of the femoral component loosening – in the middle or bottom third of the femur, sometimes in the knee joint. Irradiation of pain down the outer surface of the femur, shin and foot and up to the buttocks and lumbosacral area was typical. .

CONCLUSIONS

1. X-ray examination in the aseptic loosening of hip endoprosthesis components is fundamental for diagnosing,
determination of time and scope of the surgical intervention.
2. Reduction of risk of aseptic loosening of the hip prosthesis components is achieved by improved surgical techniques, the proper selection of the type of prosthesis, its design, restrictions of the patient's activity.

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