STUDIES ON EXPLANTED ORTHOPEDIC IMPLANTS

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Abstract. *One of the basic functions of the human body is mobility. When the mobile function can no longer be performed, a number of problems arise. Orthopaedic implants are medical devices made of one or more biocompatible materials that are placed inside the human body in order to replace the damaged parts and take over their biological functions. The purpose of this paper is to present a series of analyses on two bipolar prosthetic components made of high-density polyethylene recovered after revision surgery.*

Keywords: *implantruri, wear, biomaterials*

1. INTRODUCTION

Hip joint replacement surgery is done by replacing the upper part of the femur and the damaged hip bone. The damaged bone and cartilage are replaced with implants made of biocompatible materials.An orthopedic implant is a medical device made of one or more bio-materials, which is placed inside the human body for a period of time. Implants are designed to operate easily and ensure long term operation.

In time, due to the cyclic dynamic stresses and the complex movements performed in adverse biological environment, the optimal functionality of prostheses is lost, sometimes it is possible for an element to come off the supporting bone and, in the long run, there may appear a wear leading to a dysfunction of the mechanical components.

Among the causes leading to the implants' deterioration there are the result of the complex interactions between the construction, the patient characteristics and the medical factors related to the surgical act.

Articular surfaces are damaged mainly due to high pressure produced by the mechanical movements of the body on the joint surface. The movements performed by the legs in the coxofemoral joint are: flexion - extension, abduction - adduction and internal rotation - external rotation. (Figure.1) [1].

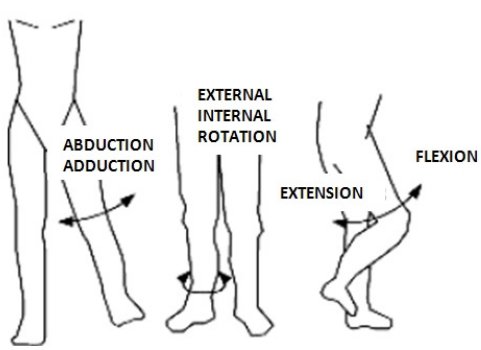

Figure 1. Hip joint movements [1]

The average values measured for the daily movements indicate a hip involvement of at least 120^0 in flexion, 20^0 in abduction and 20^0 in external rotation.

Flexion-extension and abduction-adduction movements are associated with rotation.

Joint movements may be active and / or passive; the amplitude of the movements in the coxofemoral joint is shown in Table 1 [2]. The amplitude of the passive movements in the joint is greater than that of the active movements.

Table 1. Normal mobility of the hip [2]

Type of movement	Flexion	Extension	Abduction-adduction	Internal-external rotation
Active	$90\text{-}120^0$	30^0	$60\text{-}70^0$	$35^0\text{-}15^0$
Passive	$110\text{-}150^0$	50^0	$70\text{-}80^0$	$40^0\text{-}20^0$
Difference	$20\text{-}30^0$	20^0	10^0	$5^0\text{-}5^0$

The relative movement allowed by the joint plays an important role in the transfer of loads from one bone segment to another. The load transfer mechanism is based on the contact between the joint surfaces, with all the features involved in this (friction, wear, etc..) [3].

2. HIP PROSTHESES CLASSIFICATION

The hip prosthesis are classified according to several criteria, by the type of joint receiving the prosthesis and by the type of fixation.

By the joint receiving the prosthesis there are: partial prostheses (also called cervico-cephalic prostheses) and total prostheses, which involve two primary components: the femoral component and the acetabular component. By the fixing method there are are: cemented prostheses and uncemented prostheses.

A partial hip prosthesis consists in the replacement of the femoral part of the hip joint only. The partial prosthetic intervention is called hip hemiarthroplasty and may be done in two ways: by replacing the femoral part with a cervico-cephalic prosthesis, figure 2 (a relatively less expensive method, with the inconvenience of having a shorter lifespan) or by replacing the femoral part with a bipolar prosthesis.

Figure 2. Cervico-cephalic prosthesis

A bipolar **cervico-cephalic** prosthesis (Figure 3) has a complex head which consists of an outer metallic cladding, which comes into contact with the acetabular cavity of the coxal bone, and an internal polyethylene component, which articulates with the proximal spherical end of the femoral stem.

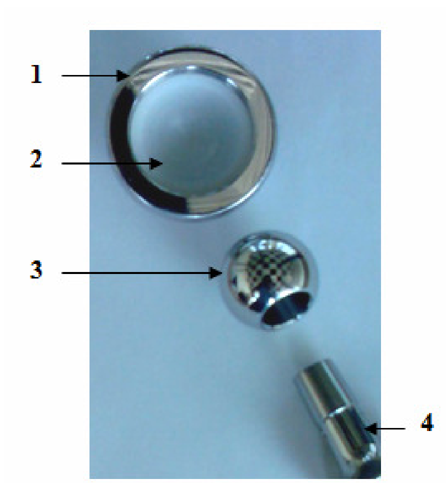

Figure 3. Cervico-cephalic bipolar prosthesis

A **cervico-cephalic** bipolar prosthesis (Figure 3) consists of:

1 - outer metal cladding;

2 - internal polyethylene component;

3 - proximal spherical end of the femoral stem.;

4 - femoral stem

A total hip prosthesis consists in the replacement of both parts of the joint (the acetabular and the femoral part). Figure 4 shows a total hip prosthesis produced by Zimmer company [4].

Figure 4. Total hip prosthesis [4]

By the fixing method, a prosthesis may be: uncemented, when performed by pressing (the implant comes into direct contact with the bone receiving the implant), generally used on younger patients, and cemented prostheses when acrylic cement is applied between the implant and the bone. Cemented prostheses are recommended for older patients, considering also the patient's general condition.

There are combinations of fixing methods too, when one of the components is fixed by pressing and the other component is fixed by cementing; these are hybrid prostheses.

3. MACROSCOPIC ANALYSES ON THE POLYETHYLENE SURFACE OF REMOVED IMPLANTS

Macroscopic analyses were made on two bipolar prosthetic components (Figure 5), recovered after the revision surgery.

Figure 5. The prosthetic components analyzed

The analyses were performed using a MARLIN - F131B video microscope (Figure 6) at a 45X zoom level.

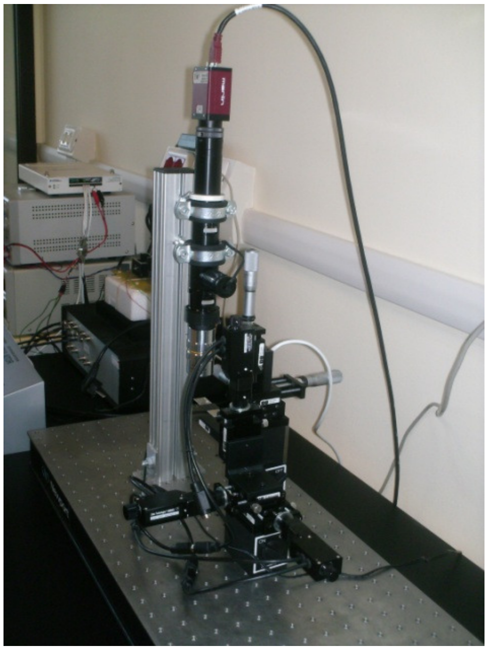

Figure 6. MARLIN – F131B Video microscope (45X zooming)

3.1 Analized Areas

During the macroscopic analysis performed by naked eye viewing of the UHMWPE internal component, a marked wear and tear was detected on certain areas.

Following to these observations, I divided the polyethylene component in four areas: 1 - pole area, 2 - medial area, 3 –border area 4 - the edge, as can be seen in (Figure 6) subsequently, each of the four areas was examined on the video microscope.

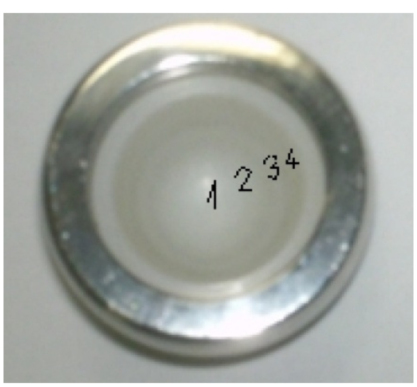

Figure 6. Wear areas
1 - polar area; 2 – medial area;
3 - border area; 4 - the edge

The wear areas coincide with those reported by Gonzalez-Mora V.A. et. Al. [5] in the study on the polyethylene acetabular cups of total hip prostheses [6].

3.2 Macroscopic analyses

The results of the macroscopic analyses on the two high-density polyethylene cup are shown in Figures 7 and 8.

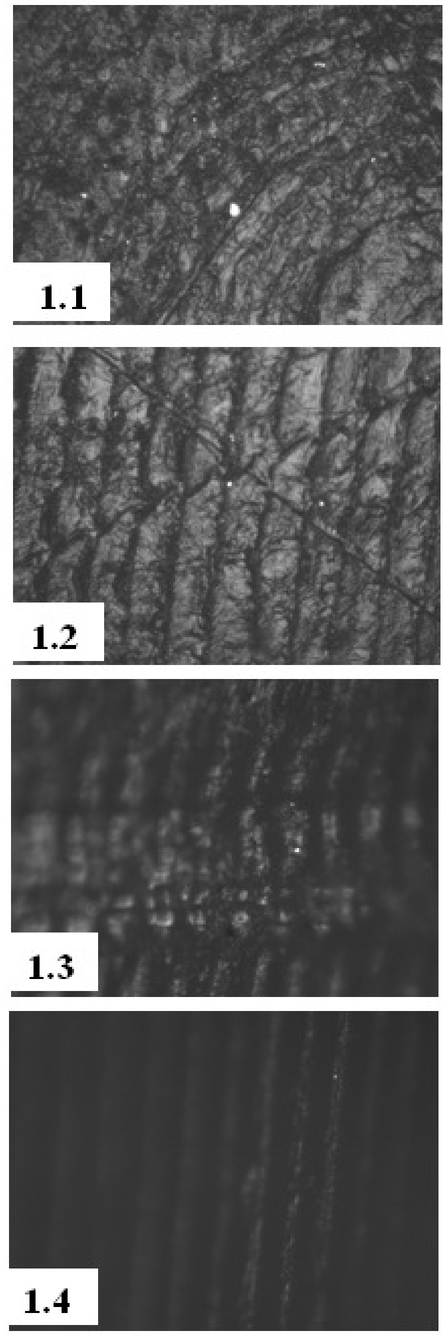

Figure 7. 1 Polyethylene cup no. 1 and the examined areas: 1.1- polar area; 1.2- medial area; 1.3- border area; 1.4- edge area

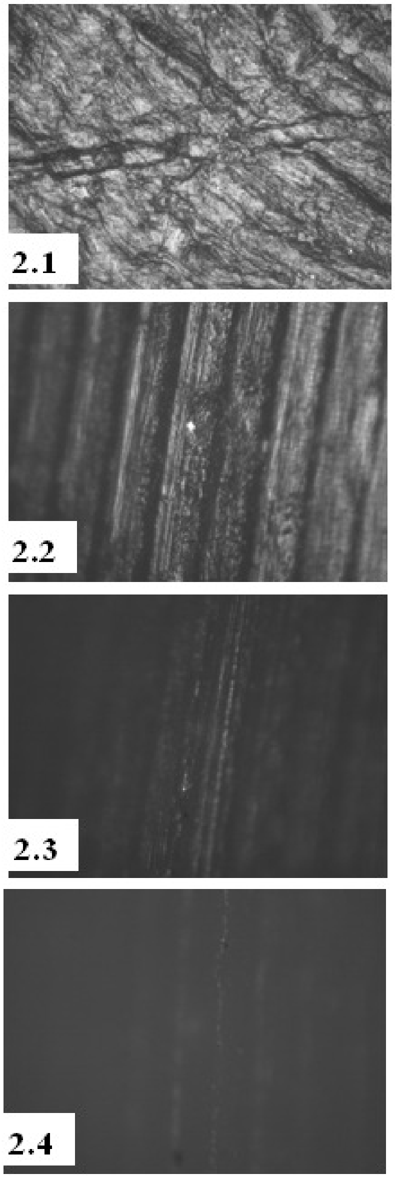

Figure 8. Polyethylene cup no. 2 and the examined areas: 2.1- polar area; 2.2- medial area; 2.3- border area; 2.4- edge area

The surface analysis performed on the removed implants' internal polyethylene components has led to the following conclusions: on the polar (1) and medial (2) areas the wear appears more pronouncedly, consisting in multidirectional scratches and isolated traces of foreign bodies embedded in the polyethylene cup.A lower wear degree can be seen in the border (3) and edge (4) areas.

The pictures of the relevant areas on the internal component's polyethylene surface show the damages on the explanted prosthetic components.

4. CONCLUSIONS

The macroscopic investigations of the two prosthetic components made of high density polyethylene indicate the presence of wear and particles of foreign bodies (acrylic cement, small metal particles detached from the worn surface of the femoral stem's proximal metal end or from surgical instruments) embedded in the polyethylene cup.

Generating polyethylene particles due to wear is associated with intense cellular reactions that lead to a shorter lifespan of the implant.

Although the scientific progress in the field of the hip implants has advanced greatly in the recent years, the lifespan of the hip implants is in reality lower than expected in theory, due to the multitude of causes and uncontrollable environmental factors surrounding the patient and causing the early wear of the implant.

5. FUTURE DIRECTIONS FOR RESEARCH

Our future research will focus on finding new structural concepts to improve hip prostheses.

The implants' constructive forms will be optimized.

There will be performed a comparative study of the results obtained, in terms of surface quality, friction and lifespan of the implant.

6. REFERENCES

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