

281. Catastrophic deformations of Weller endoprosthesis heads

Janusz CWANEK¹ and Andrzej Antoni CZAJKOWSKI²

¹ University of Rzeszow, Medical Department, Institute of Physiotherapy,

Warszawska 26a, 35-205 Rzeszow, tel.: (+4817) 872-19-20, e-mail: jpcwanek@o2.pl

² University of Szczecin, Mathematical and Physical Department, Institute of Mathematics,

Wielkopolska 15, 70-451 Szczecin, tel./fax: (+4891) 433-58-14,

E-mail: czajko2@o2.pl

(Received 15 April 2007, accepted 15 June 2007)

Abstract. Catastrophic deformations of Weller endoprosthesis metal heads, done on account of penetration of bone cement molecules, which forced to surface of polyethylene cup and head are described in the paper. The deep and continuous scratch was about fifty times deeper and not very deep and discontinuous was about four times deeper in compare with the biggest high of irregularities of head surface occurring without presented changes. Conclusion shows that bone cement molecules, which forced to surface of polyethylene cup and head, produce some scratches on the metal heads of Weller endoprosthesis. Observed scratches on the heads surface were considerably deeper in compare with the basic roughness of surface. The direction of scratches is coincident with the vector of displacements on the surfaces of polyethylene cup and head contact.

Keywords: Weller endoprosthesis, catastrophic wear of metal endoprosthesis heads

Introduction

On a surface of a few Weller endoprosthesis metal heads, removed on account of aseptic loosening, were observed some random defects like scratches, which were occurred in consequence of wear additional elements between co-operating surfaces of the cup and head.

The authors did not find in known Polish and world literature any reports presenting some structure changes on endoprosthesis metal heads of a hip joint, which are random damaged by some molecules of bone cement.

Aim of the paper

Some presentation of surface geometry of Weller endoprosthesis metal heads, damaged on account of penetration of bone cement molecules between co-operating surfaces of polyethylene cup and head is the main aim of the paper.

Analysed material and methods

Material consists two samples of surface metal heads of Weller endoprosthesis, removed on account of aseptic loosening, on which were observed some random damages in the shape of scratches.

Measurements of geometrical structure of the surface were realised in Faculty of Mechanical Engineering and

Aeronautics at the Rzeszow University of Technology by using *The Rank Taylor Hobson Talyskan 150* apparatus. The area of scanned head surface was 0,74mm × 0,71 mm, 0,372mm × 0,356 mm and 0,275mm × 0,282 mm with the scan velocity 500 μm/s. The obtained data were recorded and scientifically described by using the program *Talymap 3.0*.

Geometry of scratch surface in 3D system, their intersections and contour plot of deep scratch were presented in the considerations. The deep of scratches was described by the amplitude parameter *St*.

Results

In the paper were shown two most characteristic scratches: deep and continuous and not very deep and discontinuous on two different Weller endoprosthesis heads.

Deep and continuous scratch on the surface of Weller endoprosthesis head

The characteristic picture of deep and continuous scratch on the surface of Weller endoprosthesis head exploited by 12 years is shown on the contour plot (Fig. 1).

The picture of irregularities of metal head surface is presented on the figure 2.

The presented scratch is deep and has steep edge. The depth of the scratch has about 6 μm . Intersection of the scratch, in the pointed place visible on the figure 2, is

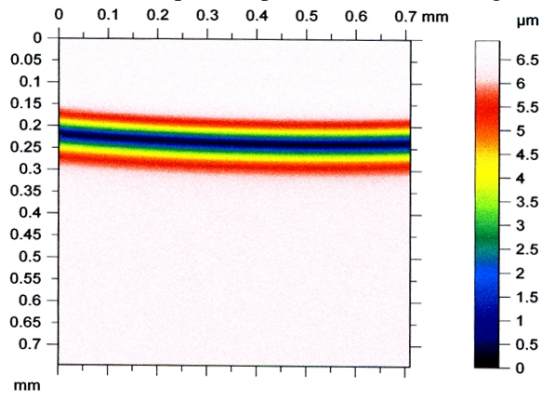


Fig. 1. Contour plot of a deep and thin scratch on the surface of Weller endoprosthesis head

illustrated on the figure 3.

The geometry of surface of exploited Weller endoprosthesis head, outside scratch limits, presents a picture of ideal smoothing surface. The parameter St has value about 120 nm.

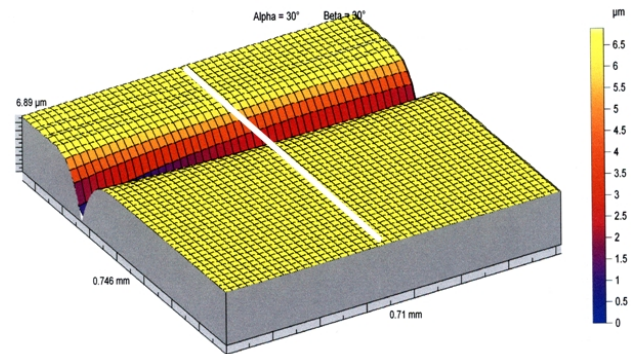


Fig. 2. Structure of a deep and continuous scratch on the surface of Weller endoprosthesis head with pointed place of intersection

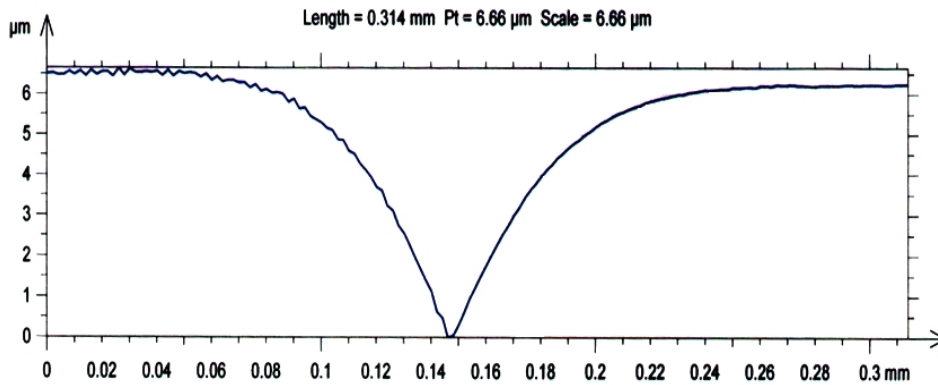


Fig. 3. Intersection of a deep and continuous scratch on the surface of Weller endoprosthesis head at the pointed place on figure 2

Not very deep and discontinuous scratch on the surface of Weller endoprosthesis head

The characteristic picture of not very deep and discontinuous scratch on the surface of Weller endoprosthesis head exploited for 8 years is shown on the figure 5. Moreover intersection of the scratch is illustrated on the figure 6. The presented scratch was a few times deep in compare with the biggest high of surface irregularities of Weller endoprosthesis head, but it was considerable shallower from the scratch shown on the figures 1-3.

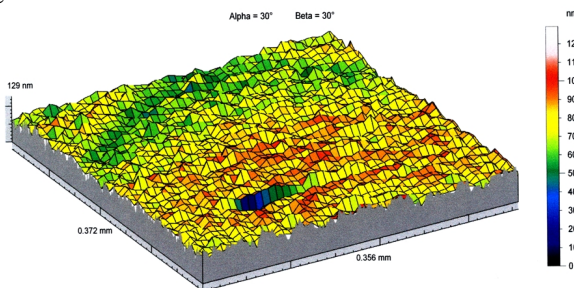


Fig. 4. Geometrical configuration of a surface of Weller endoprosthesis head outside scratch limits

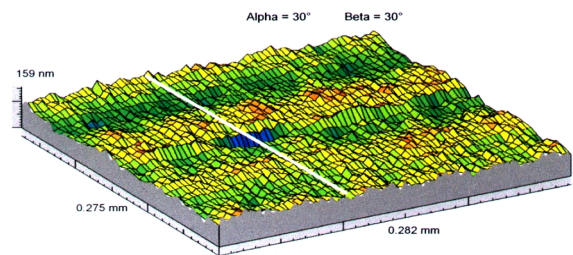


Fig. 5. Picture of not very deep and discontinuous scratch on a surface of Weller endoprosthesis head at the pointed place of intersection

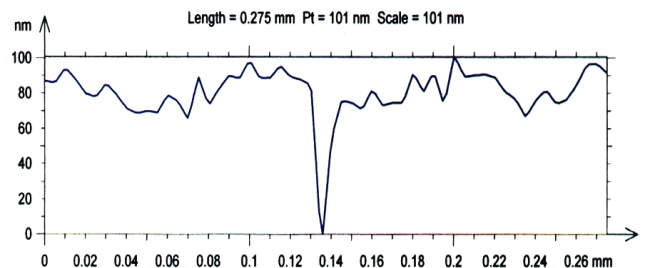


Fig. 6. Intersection of discontinuous and not very deep scratch on the surface of Weller endoprosthesis head at the pointed place on figure 5

Discussion

Unexploited surface of metal endoprosthesis heads have the mirror surface. The value of parameter Ra for Weller head surfaces is in the interval form 0,025 μm to 0,035 μm [1], for other models of joints is in the interval form 0,025 μm to 0,35 μm [2], [3], [4], [5].

From investigations implies that the parameter St for unexploited surfaces of Weller endoprosthesis heads was in the interval form 1,093 μm to 1,1397 μm , parameter Sz – from 0,8343 μm to 0,9362 μm , and parameter Sa – form 0,0532 μm to 0,0628 μm [6], [7]. Grujic at al. presents more less values for the parameter Rt of unexploited metal endoprosthesis heads, i.e. 220 μm [5].

Exploited surfaces of Weller endoprosthesis heads and other models of joints also had mirror surface and they had not any scratches [1], [6], [7], [8], [9]. The values of the parameter Ra were less and they are in the interval form 0,025 μm to 0,035 μm [1], [5], [6]. On the exploited surfaces of Weller heads form 17 to 20 years the values of the parameter are in the interval form 0,25636 μm to 0,32811 μm , for parameter Sz – form 0,16683 μm to 0,27147 μm , for parameter Sa – from 0,01176 μm to 0,0271 μm [5], [6].

Some authors observed on removed metal endoprosthesis heads of a hip joint micro-cracks and surface dulling [8], [9].

It was presented two most characteristic changes of surface structure of Weller endoprosthesis metal heads done on account of penetration of bone cement molecules, which forced to surface of polyethylene cup and head and made some catastrophic wear.

The deep and continuous scratch was about fifty times deeper and not very deep and discontinuous was about four times deeper in compare with the biggest high of irregularities of head surface occurring without presented changes. Independently from a high the direction of scratches was coincident with the vector of interaction displacements on the surfaces of polyethylene cup and head contact.

Conclusions

- Bone cement molecules, which forced to surface of polyethylene cup and head, produce some scratches on the metal heads of Weller endoprosthesis.
- Observed scratches on the heads surface were considerably deeper in compare with the basic roughness of surface.
- The direction of scratches is coincident with the vector of displacements on the surfaces of polyethylene cup and head contact.

References

- [1] **Sosnowski S., Kasprzak H. A., Romaniuk W.** at al. *The failure of hip joint plastic operation contemporary estimation*, Orthopaedic and Prosthetic Engineering, Białystok 1999, Vol. II, 395 (in Polish).
- [2] **Dzioch T.** *Kinematyczno - technologiczne aspekty kształtowania powierzchni kulistych w zastosowaniu do wytwarzania endoprotez*, Technical University of Rzeszow, Rzeszów 1982 (in Polish).
- [3] **ISO 7206 – 2** *Implants of surgery – Partial and total hip joint prosthesis, Part 2: Articulating surfaces made of metallic, ceramic and plastics materials.*
- [4] **Warunki techniczne, wymagania i badania endoprotez całkowitych stawu biodrowego przeznaczonych do implantacji z zastosowaniem cementu kostnego**, Medical Technique, WT - Z2/E - 1/89/R (in Polish).
- [5] **Grujic J., Sovlj B., Krklec V., Vukelec B.** *Analiza tribologicznych procesów wstawek zgloba kuka*, YUTRIB'91, Kragujevac 1991, 105.
- [6] **Cwanek J., Lubimow W.** *Amplitude surface parameters of heads of Weller endoprosthesis*, BIOMDLORE ' 2005, Vilnius 2005, Technique, No 52, 5 – 10.
- [7] **Czajkowski A. A., Cwanek J., Lubimow W., Wierzcholski K.** *Surface geometry of Weller endoprosthesis heads removed from the aseptic loosening*, Biomechanics. Customized endoprosthesis. Design manufacture and clinical applications. International Centre of Bio-cybernetics, PAS, Warsaw 2003, 105.
- [8] **Kreczko R., Małydk P., Orłoś Z.** *Some aspect of aseptic loosening of the total hip prosthesis*, Annales Academie Medicae Silesiensis, 2001, Supplement 32, 93 (in Polish).
- [9] **Streicher R.M., Semplitsch M., Oberholzer S., Rieker C.** *Metal - metal articulation for hip joints implants, Charlney Total Hip Arthroplasty, 33 years world - wide experience*, Groupe A.C.O.R.A, Lyon 1995, 299.
- [10] **Pytel A., Serafin J., Szulc W. i wsp.** *Ocena stopnia metalozy w obrazie histopatologicznym w przypadkach po endoprotezoplastyce stawu biodrowego*, Chirurgia Narządów Ruchu i Ortopedia Polska, 1996, Supplement 3A, 139.
- [11] **Wagner T.** *Powikłania po artroplastyce i zmiany polekowe, w Patomorfologia stawów*, (red. Małydk E., Wagner T.), PZWL, Warsaw 1991, 199.
- [12] **Willert H.G.** *Reaction of the articular capsule to wear products of artificial joint prosthesis*, Journal of Biomaterials Research, 1977, 11, 157.