CERAMIC-ON-CERAMIC TOTAL HIP ARTHROPLASTY IN YOUNG PATIENTS WITH FEMORAL-HEAD OSTEONECROSIS - SHORT-TERM RESULTS

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Abstract

Aim: the increasing number of total hip arthroplasties in case of young, physically active patients means an increasing number of revision surgeries as well. For these patients the use of ceramic bearings could be an appropriate solution because of its reduced wear and a predicted longer lifetime. In this paper we would like to present our short experiences with non-cemented, ceramic-on-ceramic total hip prosthesis, in case of young patients. **Materials and Methods:** between January 2011 and December 2012, 32 hip arthroplasties were performed in case of 31 young patients diagnosed with avascular necrosis of the femoral head. The clinical and radiological follow-up of these patients was carried out for an average of 1,5 year. The average age was 47 years (25-51) in the moment of the surgery. The clinical assessment of the patients were carried out by the Harris Hip Score and Visual Analog Scale, performed before and 3, 6, 12 month after surgery. The radiological evaluation was based on the anteroposterior and axial radiographs performed at the above mentioned time points. **Results:** in each cases the bony ingrowth of the prosthesis took place. No stress-shielding phenomenon was observed at the proximal part of the femur. In one case at six month control X-ray we noticed the damage of the ceramic insert and no further complications were observed. The patient refused the revision surgery for now. **Conclusions:** the fourth-generation ceramic component for non-cemented endoprosthesis used in case of young patients has very good early clinical and radiological results.

Keywords: Total hip arthroplasty, ceramic-on-ceramic, young patients

Introduction

The surgical procedure of artificial hip joint replacement nowadays is a routine intervention, used for several decades, it is one of the most spectacular and most successful orthopedic surgical procedures.

In Romania, 10000 primary hip prosthesis implantations are performed every year (Romanian Arthroplasty Register, 2014).

During total hip arthroplasty, both the femoral and acetabular bearing surfaces are surgically replaced with polyethylene (ultra-high-molecular-weight polyethylene (UHMWPE), or cross-linked UHMWPE (XLPE)), metallic or ceramic components. The different combinations of these materials being examined as bearing surfaces for total hip arthroplasty.

Total hip arthroplasty is increasingly used in case of young, physically active patients. In these cases we should take into account the occurrence of hip prosthesis loosening and revision surgeries. In the vast majority of loosening we talk about aseptic loosening.

There is a relation between the released amount of polyethylene and metal particles and the process of loosening. These particles causes the osteolysis, and in some cases we have to perform the revision surgery for several times in the lifetime of these young patients.

The solution to this problem could be to avoid using metal and polyethylene components as bearing surface, replacing them with much harder materials such as ceramic.

Boutin (1971) first introduced the Alumina ceramic in total hip replacement. However, the beginning of the ceramic-on-ceramic era was catastrophic because the poor quality of the used aluminum (inadequate particle size and other material properties).

Over the years the quality of the ceramic has greatly improved, especially the third and fourth generation ceramic bearings (Sedel, Kerboull, Christel, Meunier, & Witvoet, 1990), (Walter, 1992).

Nowadays the fourth-generation ceramic bearings are used, incorporating nanosized, yttriastabilized tetragonal zirconia particles producing an alumina matrix composite. Oxide additives produce platelet-like crystals that dissipate energy by deflecting cracks, by fusion of aluminum oxide and zirconium oxide microscopic particles a very smooth material is produced, with improved mechanical properties by preventing the initiation and propagation of cracks (Hannouche, Zaoui, Zadegan, Sedel, &

Nizard, 2011), (Gallo, Goodman, Lostak, & Janout, 2012).

Because of its reduced wear and a predicted longer lifetime, these ceramic bearings are the most appropriate for young and active patients.

The introduction of the new generation ceramic components has a short history in our teams' practices, so we do not have yet a report based on postoperative findings. However, sharing the clinical experience, as well as the possible complications, can be useful.

In this paper we would like to present our short experiences with non-cemented, ceramic-on-ceramic total hip prosthesis, in case of young patients.

Materials and methods

Between January 2011 and December 2012, 32 hip arthroplasties were performed, using ceramic-on-ceramic implants in case of 31 young patients. The clinical and radiological follow-up of these patients was carried out for an average of 1.5 years. The Ethical Committee of our institution approved this study, and all patients gave their written consent to participate.

28 male and 3 female patients were the subjects of the research. The average age was 47 years (25-51), in the moment of the surgery.

In all cases the preoperative diagnose was avascular necrosis of the femoral head. According to the Steinberg classification in all cases it was a IV-VI stage necrosis.

The etiology could not be determined in 8 cases, in 16 cases the cause was (most probably) chronic alcohol abuse, in 6 cases corticosteroid treatment, there was one registered case of cytostatic and corticosteroid treatment as main cause of the disease.

In all cases a non-cemented Pinnacle acetabular component (DePuy Orthopaedics, Warsaw, IN, USA) was used, both the liner and prosthetic head are made of BIOLOX delta ceramic material (CeramTec AG, Plochingen, Germany). In all cases we used 36 mm diameter head. The femoral component was CORAIL stem (DePuy Orthopaedics), a metaphyseal-fitting anatomical titanium femoral component with a fully hydroxiapatit coating.

The interventions were performed by two surgical teams. In every case a direct lateral incision was used. Both of the components were inserted with the press-fit technique.

At 24 hours after removing the drainage tubes, the patients were mobilized and they were allowed to walk with full weight bearing.

The patients were advised to avoid bending the hip more than 90 degrees in the first three months. The patients received thromboprophylaxis with low molecular heparin for 40 days after surgery.

The clinical assessment of the patients were made by the Harris Hip Score (HHS) and Visual Analog Scale (VAS) performed before and 3, 6, 12 month after surgery and then yearly.

The radiological evaluation was based on the anteroposterior (AP) and axial frogleg projection radiographs, performed at the above mentioned time points.

The acetabular and the femoral components were assessed according to DeLee, Charnley and Gruen (DeLee & Charnley, 1976), (Gruen, McNeice, & Amstutz, 1979).

We observed if there was any sign of mobilization of the components, radiolucent lines around the implants and the bony ingrowth, the orientation of the components as well as possible damages to the ceramic insert or prosthetic head.

The loosening criteria of the components were the following: for the acetabular component – more than 2 mm wide, continuous, radiolucent line or greater than 2 mm displacement of the component in any direction.

In case of the femoral component – if radiolucent lines was detected on the AP and axial images, on the entire length of the prosthesis.

The statistical calculations were performed using Statistical Package for Social Sciences (SPSS, version 20.0, Chicago, IL, USA).

A paired Student`s t test was employed pre- and postoperative, in order to compare the HHS and VAS, statistical significance was set at $p<0.05$.

Results

After the surgery a significant improvement, regarding pain, was reported by all patients.

The HHS showed statistically significant improvements in all cases. Before surgery the average HHS was 39.7 ± 6.7 (32-55) and after surgery 92.1 ± 7.9 (78-100) ($p=0.0001$), according to the last surveys. The average VAS decreased from 9.8 ± 0.9 to 1.3 ± 0.7 ($p=0.0001$).

There were no aseptic loosening, in each cases the bony ingrowth of the prosthesis took place. No stress-shielding phenomenon was observed on the proximal part of the femur (Figure 1.).

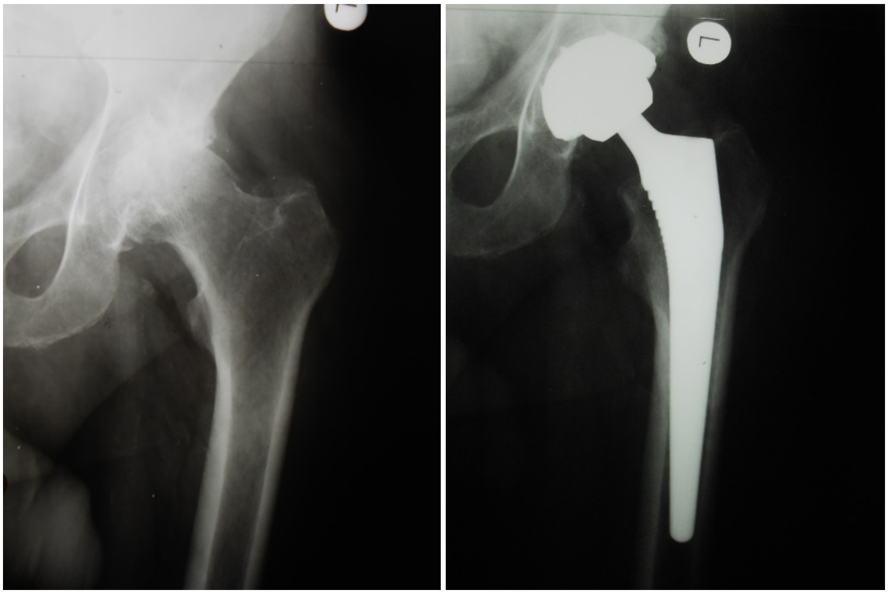

Figure 1. 46 year old male patient with osteonecrosis of the femoral head (Steinberg VI.) before operation and the control radiography at one year after the operation with the components in a correct position and bony ingrowth.

The abduction angle of the acetabular component had an average of 43.2˚ (38˚-47˚), while the inclination angle being approximately 13˚ (10˚-17˚).

There was one case of postoperative local hematoma and the patient was treated conservatively. The wound healed without further intervention or complication. In one case at the six month control X-ray we noticed the damage of the ceramic insert (breaking of the ceramic component edge), but no further complications were observed. The patient did not report any particular trauma. The X-rays revealed that all the components had a normal position.

The further radiographic control after 3 month showed no further damage at the level of the ceramic insert. The patient refused the revision surgery (replacement of the ceramic component).

Further complications in other cases were not observed for example luxation, damage of the ceramic head, infection or thrombosis.

Discussion

The growing number of hip arthroplasties worldwide, as well as the long-term survival of the implants of young patients is a particularly important issue today.

Despite it is an extremely successful surgical intervention, ostheolysis around the prosthesis caused by the polyethylene particles can lead to the loosening of the prosthesis (Savarino, Baldini, Ciapetti, Pellacani, & Giunti, 2009) . It is a major scientific challenge to eliminate or at least reduce this process.

Nowadays the tribology which is a branch of mechanical engineering and materials science is a major component in discovering and testing different materials in diverse biomechanical conditions (Vassiliou, Scholes, & Unsworth, 2007).

The used ceramic components at the beginning when there was a great number of revision arthroplasty contrary, in these days used and correctly implanted ceramic components works with a promising efficiency in terms of friction and wear values, in this regard we could read numerous studies (Brockett, Williams, Jin, Isaac, & Fisher, 2007).

The fourth generation Biolox delta ceramics which are extremely resistant were used in our study too.

Considering that we only had a short follow-up period, we cannot draw definitive conclusions regarding the survival of the prosthesis.

The postoperative clinical results are very good, and the bone ingrowth of the prosthesis was also successful, these results make us hopeful that our patients will be satisfied, and that the used implants will have a long lifetime.

Bascarevic et al., (2010) in his short-term study compares the ceramic-on-ceramic and metal-on-XLPE. They found great results in both cases, with two revision surgery in case of the polyethylene insert and no revision surgery in the case of ceramic insert.

Hernigou, Zilber, Filippini, & Poignard, (2009) using a CT scan, compared the osteolysis in cases of 20 years implanted different prostheses in the same patients (one side of ceramic-on-ceramic, while the other side ceramic-on-UHMWPE). The ceramic-on-ceramic component presented a much lighter level of osteolysis, even though these were first generation of ceramic components.

Amanatullah et al., (2011) performed a similar study, and he did not experience a significant difference between the two types of prosthesis, however, he pointed out an interesting audible squeaking phenomenon in case of ceramic components. This occurred in 3.1% of cases.

Nikolaou, Edwards, Bogoch, Schemitsch, & Waddell, (2012) compared metal-on-UHMWPE and metal-on-XLPE third generation ceramic component prostheses. They found that the ceramic prosthesis presented the lowest wear, while the wear degree of metal-on-XLPE was three times lower than the wear of metal-on-UHMWPE. The clinical results after five year did not find any differences; however, they found in 8.8% of cases a squeaking phenomenon.

The typical ceramics squeaking phenomenon can affects the patients’ quality of life. The detection and reporting of the phenomena varies widely, in different published studies, from 0.5 to 33%.

The cause of squeaking not known absolutely, some described in young, more active, heavier, taller patients (Molloy, Jack, Esposito, & Walter, 2012), as well as with time it occurs more and more often. Also interesting is that the squeaking can disappear by itself after a period of time. In some opinion the cause is that the separating liquid layer between the two bearing surfaces splits up and the surfaces begins to wear off (Kiyama, Kinsey, & Mahoney, 2013), (Brandt et al., 2013).

This phenomenon has also been observed with Biolox delta ceramic (Buttaro, Zanotti, Comba, & Piccaluga, 2012).

In our study, this particular phenomenon was not observed or recorded by the patient.

In case of hip replacement, another common complication is the dislocation. The occurrence of this complication might vary from 0% to 2.3% (Colwell et al., 2007) and (Bascarevic et al., 2010) found no significant difference between the dislocation of ceramic-on-ceramic and metal-on-polyethylene component.

Many studies demonstrated that the use of large prosthetic heads provide a greater stability and range of motion (Singh & Bhalodiya, 2013).

In our study there was no recorded dislocation.

We have to take into consideration the danger of breaking or damaging the ceramic head or insert, although the 3^{rd} and 4^{th} generation ceramics rarely present these phenomenon (Hannouche et al., 2003). If the damage of any component is noticed, immediate revision surgery is needed. Usually, any damage to the components occurs because of trauma or accident. Park et al., (2006) noticed 1.7% of damaged ceramic components with no history of trauma.

In our case, no trauma was present, according to the patient’s confess. At 6 month, after the broken ceramic insert was discovered, it shows no visible fragments or further damage. The break produced on the edge of ceramic insert. We have to mention that on the X-rays all the components had a normal position.

In case of ceramic component damage, the revision surgery can be complicated and have poor results. The surgery has to be performed as soon as possible, in order to reduce the risk of damaging the other component. It is important to completely remove all of the ceramic particles.

There is no accordance regarding to the best solution in case of revision, and the opinions are divided (Stafford, Islam, & Witt, 2011).

Our patient was informed about this and the other possible complications. However, the patient refused the revision surgery (replacement of the ceramic component). At this time we hold under observation this case.

Conclusion

The fourth-generation ceramic component for non-cemented endoprosthesis used in case of young patients has very good early clinical and radiological results, according to our research. Based on other studies covering longer periods of time, it can be clearly stated that this surgery may provide long-lasting solution for these patients.

It is a demanding surgical intervention, it is important that the components must have a proper orientation. Taking all these into consideration, the possible (above mentioned) complications should never be forgotten.

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