Favorable outcome of total hip arthroplasty with insufficient bone coverage of the roof reinforcement ring: a case report.

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SUMMARY

A 59-year-old male patient underwent a total hip arthroplasty for the treatment of end-stage dysplastic osteoarthritis. A roof reinforcement ring, a cemented polyethylene cup, and a cementless stem were used. Extensive superolateral portion of the ring was uncovered by host bone. Morsellized autogenous femoral-head graft was impacted to fill the space between superolateral border of the ring and superior part of the dysplastic acetabulum.

At the follow-up after 4-years, the patient had no complaints and was very satisfied with the operation result. The hip radiograph revealed no signs of instability of the acetabular component, and no bone graft resorption. Despite the suboptimal implantation of the ring compromising, apparently, mechanical stability of the prosthesis, the outcome was favorable. This result can be supported by the fixation of the metal ring with screws, the adequate orientation of the prosthesis, the position of hip´s center of rotation, and bone graft incorporation.

BACKGROUND

The outcomes of maltreated or neglected developmental dysplasia of the hip are highly detrimental. Degree of subluxation and time left untreated are the 2 main factors that contribute to severity of the sequelae of this disorder. Total hip arthroplasty (THA) performed for developmental dysplasia of the hip can be a demanding operation. The complexity of the reconstruction is influenced by the degree of anatomic abnormalities.[1]

Several systems of classification of developmental dysplasia of the hip in adults exist that are helpful for considering surgical treatment. The Hartofilakidis classification describes three characteristic types: dysplasia, low dislocation and high dislocation. In dysplasia the femoral head articulates with the original acetabulum, despite the degree of subluxation.[2]

Dysplastic hip presents deficiency of the superior segment of the acetabulum, and a secondary shallowing due to the formation of an osteophyte that covers the acetabulum fossa. Femoral anatomy can be distorted with excessive anteversion and coxa valga, and the diaphysis can be narrow. The femoral head can be elliptical and elongated, due to the formation of marginal osteophytes, and the greater trochanter small and located posteriorly. The abductor muscles can be poorly developed and oriented more transversely than normal, and the capsule elongated and redundant.[3-4]

Total hip arthroplasty is the procedure of choice for most patients with symptomatic end-stage osteoarthritis secondary to hip dysplasia.[5] When performed correctly, THA is an operation that can done with precision and reproducibility. Ideally, the acetabular cup is covered completely by host bone and should span the distance between the teardrop and the superolateral margin of the acetabulum.[6]

If the acetabulum is shallow, complete coverage of the acetabular cup will not be possible. In this scenario, structural bone graft augmentation, trabecular metal augmentation, and acetabular reconstruction with roof reinforcement rings may be indicated. The use of high hip center with a smaller acetabular component is another option. [7-8]

Standard cementless femoral stems with a rectangular cross-section can be difficult to use for the treatment of dysplastic osteoarthritis, due to the femoral proximal deformities. Several authors reported on the possibility of cemented stems. Another possibility is the use of modular implants or the use what is known as "custom-made prostheses", in combination with a corrective subtrochanteric, derotational

osteotomy to treat a pronounced femoral anteversion. A cementless stem with a conical shape can also be indicated. [9-11]

In this report a THA was performed for the treatment of a hip osteoarthritis secondary to developmental dysplasia. A roof reinforcement ring with a cemented polyethylene cup, and a conical stem were implanted. The superolateral portion of the metal ring was practically uncovered by host bone, due to an inadequate operative technique.

The purpose of this paper was to shown the unexpected outcome of the THA at 4-years follow-up, namely the mechanical behavior of the acetabular component.

Figure 1. Preoperative anteroposterior radiograph of the pelvis showing advanced right hip osteoarthritis, dysplasia of the acetabulum and coxa valga, and pelvic obliquity.

CASE PRESENTATION

A 59-year-old male patient underwent a total hip arthroplasty for the treatment of end-stage dysplastic osteoarthritis, in 2010. He presented a severe hip pain, functional impairment, the limb-length discrepancy was 30 mm, and was Thendelenburg-type gait. The pelvic radiograph revealed dysplasia of the right acetabulum according Hartofilakidis classification, right coxa valga, and pelvic obliquity (figure 1). The right femoral head presented marginal osteophytes and was large and flattened in shape. Using a standard posterior approach, a roof reinforcement ring and a cemented polyethylene cup were implanted. The femur was reconstructed with a cementless femoral stem with conical shape.

An appropriate size supporting ring was chosen and secured with screws in order to achieve satisfactory mechanical fixation to the pelvis. A polyethylene cup was then cemented in the correct orientation, independent of the ring orientation.
However, an extensive superolateral portion of the metal ring was uncovered by host bone compromising, apparently, mechanical stability of the prosthesis. Then, the removed femoral head was morsellized (using a rongeur) on table, and bone graft was carefully impacted to fill de space between the superolateral border of the metal ring and the superolateral margin of the native acetabulum. The conical stem was easily implanted with a correct femoral anteversion.

OUTCOME AND FOLLOW-UP

The postoperative course showed no problems with respect to the hip. Daily activity was quickly resumed. At 6-months after surgery the patient presented an asymptomatic hip with no limping, and approximation of equalization of limb-length. At 1-years follow-up the hip radiograph revealed a satisfactory orientation of the prosthesis, a small medialization of hip´s center of rotation, and some heterotopic ossifications. The bone autograft was incorporated (figure 2).

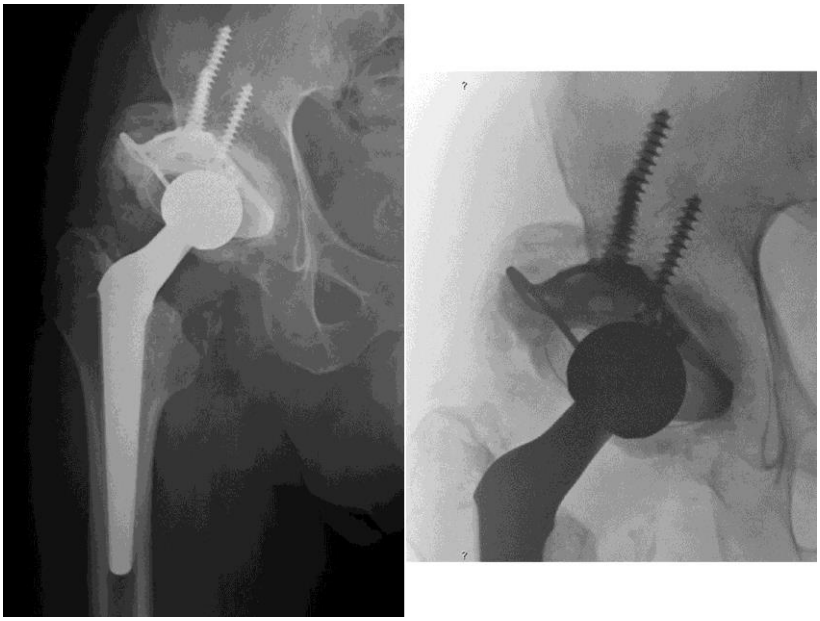

Figure 2. Postoperatively anteroposterior THA radiograph at follow-up period of 1-year. The superolateral portion of the roof reinforcement ring is not covered by the native acetabulum. It is possible to observe the incorporation of impacted morsellized autograft placed between the lateral border of the metal ring and the superior part of the dysplastic acetabulum. No signs of implant instability.

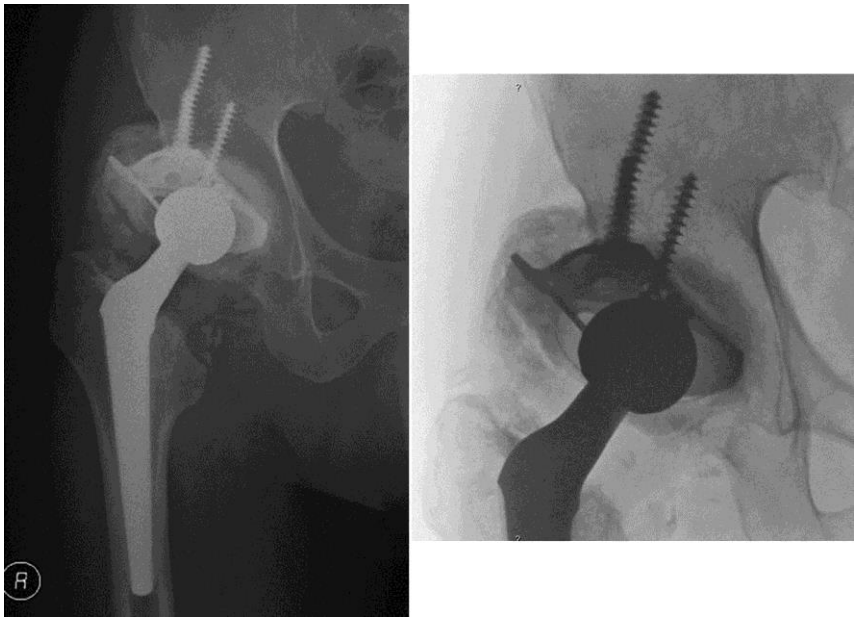

Figure 3. At follow-up period of 4-years, the THA radiograph showed stability of both components and no signs of bone graft resorption. Heterotopic ossifications with no functional impairment. The patient reported no pain and expressed high satisfaction with the surgery result.

At 4-years follow-up, the patient continued to present a stable and asymptomatic hip and expressed high degree of satisfaction with surgery result. The hip radiograph showed unchanged and stable seating of the acetabular component, and stable fixation of the femoral prosthesis by bone ingrowth, no measurable subsidence or radiolucent lines around the stem. Heterotopic ossifications can be observed and were classified as stage I according to the classification of Brooker.[12] The autograft presented no signs of bone resorption (figure 3).

DISCUSSION

Pain and severe functional impairment with limping in end-stage osteoarthritis of the hip, secondary to developmental dysplasia, are a clear indication for THA.[5] The outcomes for dysplastic hip are generally good, and are similar to results seen for THA in patients without dysplasia. Revision rates for THA in severely dysplastic hips, however, are significantly higher than revision rates for THA in non-dysplastic hips.[13]

Contrary to acetabular side, the reconstruction of the femur in dysplactic hip is similar to that of conventional cases.[3] It is not necessary to perform femoral

shortening for safe positioning into the anatomic hip center. Femoral reconstruction can be performed by both cemented and cementless femoral stems.

Due to femoral proximal deformities and excessive anteversion of the femur in hip dysplasia, we preferred the use of a cementless femoral stem with conical shape, and with a rounded cross-section. At 4-years of the follow-up period the hip radiograph revealed a stable fixation of the femoral stem.

The fixation of this stem is diaphyseal in nature and the prosthesis is made of tissue-compatible titanium-aluminium-niobium alloy with a grit-blasted surface that promotes osseointegration. The conical fixation of prosthesis ensure excellent primary stability. This is a simple, time-saving and cost-efficient implant.[14] It is possible to produce correct femoral anteversion with no technical difficulties. Another solution are modular components allow for easier control of anteversion. The conical prosthesis is indicated in cementless total hip replacement of cases with cylinder shaped femurs, deformed femurs, femurs with increased anteversion, and in conditions of intramedullary bony scar tissue after previous osteotomies.[15]

The main problem in joint replacement in developmental dysplasia of the hip is how to restore the normal anatomy and obtain a stable fixation of the acetabular prosthesis. Restoration of the hip´s center of rotation and the femoral lateral offset, and limb-length equality are important goals to achieve. In dysplastic hip the acetabular component can usually be placed in the true acetabulum.[3]

To obtain sufficient bony coverage and mechanical stability of the acetabular component, the socket can be medialized or elevated, or a lateral bone graft can be applied.[5] Medialization of the cup can generally provide adequate coverage. If at least 80% coverage of the periphery of the trial component can be obtained a cementless cup is implanted.[3] However, no clear guideline exists regarding the amount of adequate acetabular cup coverage.[16]

Despite cementless acetabular reconstruction without acetabular augmentation is now the standard of care in dysplastic hips, in this report acetabular reconstruction was done using a roof reinforcement ring with the polyethylene cup cemented to the ring. The metal ring can be optimally adapted to the shape of the acetabulum since the polyethylene cup is anchored using cement and, thus, may be freely positioned. Favorable results were described using metal rings in congenital dysplasia of the hip, and in complex primary or revision hip arthroplasty.[17-18]

In our case, a significant portion of the superolateral margin of the metal ring was uncovered by the host bone, due to an inadequate technique. The ring was not placed in an appropriate position just lateral to the teardrop. Osteophytes on the bottom of the acetabulum, the so-called double floor, were not sufficiently reamed

down to the depth of the original acetabular fossa. This condition led to incomplete bony coverage of the ring and suboptimal stability. According to the preoperative templating, controlled medialization of the implant could provide adequate coverage, avoiding this problem. Insufficient acetabular bone coverage may affect the durability of component fixation.[19]

In order to obtain augmentation of the acetabular component a biological technique was used. After the cementation of the polyethylene cup, morsellized cancellous bone autograft was impacted between the lateral border of the metal ring and the superior part of the dysplastic acetabulum. Augmentation by structural bone graft to supplement bone insufficiency coverage of the ring was another strategy. However, the incorporation process of solid bone grafts is unpredictable and may result in final resorption of the graft.[20-21]

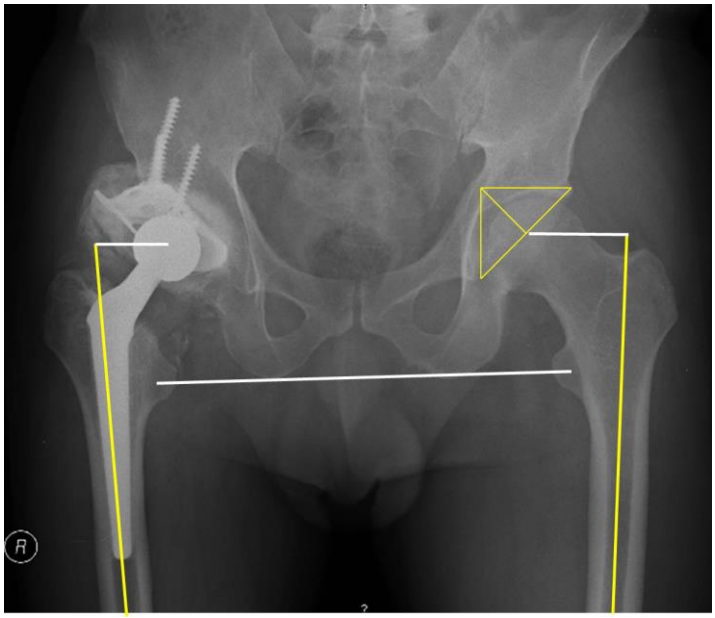

Figure 4. Postoperative THA radiograph at follow-up period of 4-years showing an acceptable position of the hip´s center of rotation and the lateral and vertical offsets, a correct inclination of the cemented polyethylene cup, and approximation of the leg lengths equality.

The outcome of the acetabular bone reconstruction was very satisfactory. Incorporation and remodeling of the impacted morsellized bone graft was found. At 1-years of follow-up, the hip radiograph showed continuation of the trabecular lines from the host bone into the graft. Complete revascularization and incorporation of morsellized bone grafts was reported both in animal studies and in retrieval biopsies.[22-23] The value of this technique was demonstrated in dysplastic hip.[24] An important advantage is the reconstitution of the acetabular bone stock.

At the follow-up after 4-years, the patient had no complaints regarding the right hip and regarded the outcome of the operation as very satisfactory. The hip radiograph showed no signs of instability of the roof reinforcement ring and of the femoral stem, and no signs of resorption of autograft.

In this report, bone insufficiency coverage of the roof reinforcement ring was well tolerated. However, the outcome could be different if others adverse factors were presented, including a painful hip and an early mechanical failure of the arthroplasty.

A high or posterior hip center is associated with increased joint reaction forces. These increased forces carry an increased risk of accelerated polyethylene wear and component loosening.[6] An excessive medialization of the acetabular component can result in failure to restore offset with associated bone loss, impingement, and laxity of hip abductors causing weakness and difficulty ambulating. Likewise, excess lateralization can increase joint reactive forces and muscle tension causing postoperative pain and bursitis.[25]

We believe that the favorable outcome of our case can be supported by the sufficient fixation of the metal ring with screws, the correct inclination angle of the cemented acetabular cup, the correct orientation of femoral stem, the position of the hip´s center of rotation with an acceptable medicalization (figure 4), and the bone graft incorporation. It is possible that the autograft has played some role in mechanical stability of the acetabular prosthesis.

Nevertheless, further follow-up is required to determine the mechanical behavior of the implants in medium- and long-term. Despite this favorable outcome, we agree that cementless acetabular reconstruction without acetabular augmentation is the standard of care in dysplastic hips.

Learning points

- THA in patients with developmental dysplasia of the hip can be a complex procedure due to acetabular and proximal femoral deformities.
- Preoperative templating is useful to determine the final position of the implants.
- In the dysplastic hip the acetabular component should be completely covered by host bone and the hip´s center of rotation restored whenever possible.
- The conical femoral stem is a simples and an efficient implant. It is possible to produce correct femoral anteversion with no technical difficulties.

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