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Original Article

Acetabular Reconstruction with Reinforcement Ring and Morsellised Graft: Technique and Medium-term Result
以髖臼加強環及切碎骨來重建髖臼 - 技術及中期結果

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A R T I C L E I N F O

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A B S T R A C T

Background: Acetabular bone defects are commonly seen in both primary and secondary total hip arthroplasty, creating difficulties in restoring anatomical hip centres, which results in high mechanical failure rate.
Methods: Total hip arthroplasty with acetabular reinforcement rings were performed in 18 hips in 18 patients from 1996 to 2011 in United Christian Hospital. Both clinical and radiographical assessment were performed during follow-up.
Results: Eight patients died of unrelated diseases with average follow-up of 30.5 months. At the latest follow-up, none of them showed radiographic signs of loosening or migration of implants and none of them required revision surgery. The remaining 10 patients with mean age of 77.9 years (range, 65–88) at the time of operation were followed-up for an average of 67.4 months (range, 11–121). The average Harris hip score was 78.3 (range, 58.5–87). The average vertical and horizontal difference of hip centres was 1.5 mm superiorly ($p = 0.431$) and 0.4 mm medially ($p = 0.619$) respectively when postoperative hip centres were compared to their contralateral hips. The average inclination of the polyethylene cup was 47.8 degrees (range, 42–58). There was no evidence of radiographic loosening during our follow-up and none of them required revision surgery.
Conclusion: Acetabular reconstruction with the use of acetabular reinforcement rings and morsellised bone grafts showed satisfactory clinical and radiographic results at a medium-term follow-up.

中 文 摘 要

背景: 髖臼骨缺損常見於初次及翻修全髖關節置換術，使重建髖關節中心困難，導致較高的機械性失敗率。
方法: 在1996 年至2011 年間，基督教聯合醫院共進行了18 例使用髖臼加強環的全髖關節置換術。隨訪期間我們以臨床和X 光片進行評估。
結果: 共8 例死於無關的疾病，其平均隨訪時間為30.5 個月。他們沒有表現出鬆動或遷移的跡象，亦沒有需要進行翻修手術。其餘10 例隨訪時間平均67.4 個月（範圍11-121），平均年齡為77.9 歲（範圍65-88）。 Harris 評分平均為78.3（範圍58.5–87）。相對於對側的髖關節，術後的髖關節中心的平均垂直和水平的差異分別為上方1.5 毫米（$p = 0.431$）和內側0.4 毫米（$p = 0.619$）。聚乙烯杯中的平均傾角為47.8 度（範圍42–58）。隨訪期間他們沒有表現出鬆動的跡象，亦沒有需要進行翻修手術。
結論: 於全髖關節置換術使用髖臼加強環和切碎骨來重建髖骨在這中期研究中展現出滿意的臨床和影像學結果。

Introduction

Acetabular bone deficiency often increases the technical difficulty in performing total hip arthroplasty. It can occur in primary total hip arthroplasty such as that for acetabular protrusio. In

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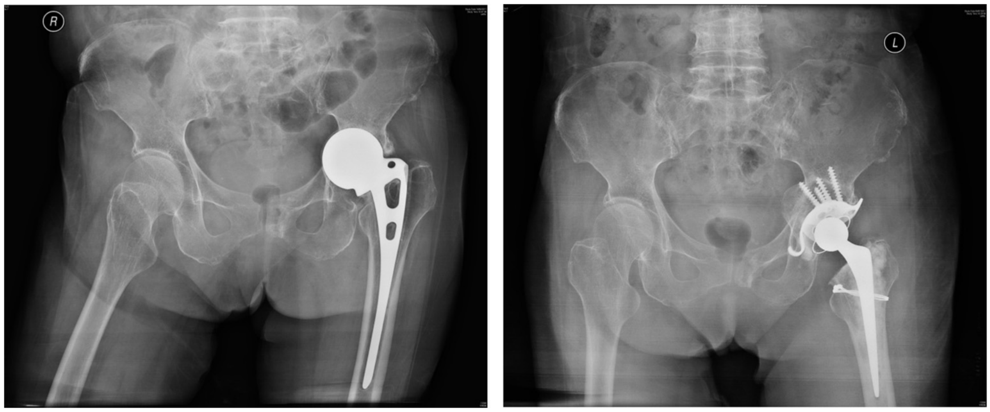

Figure 1. Austin–Moore prosthesis protrusio with acetabular American Academy of Orthopaedic Surgeons type II defect treated with Ganz ring.

revision arthroplasty, bone deficiency can be caused by loosening or migration of old implants. Bone deficiency can result in difficulty in restoring the anatomical hip centre. Failure to do so is associated with higher mechanical failure rate. Bone deficiency also poses additional difficulty to achieving a stable implant fixation.

Various methods have been proposed to deal with this situation. Acetabular revision with cement alone was not desirable. By contrast, uncemented acetabular revision has been very successful. Uncemented revision relies on the intimate contact between the bone and the implant to achieve a stable biological fixation. High hip centre and oversized jumbo cups were some of the ways that could increase the host bone contact in the presence of acetabular bone defect. The disadvantage of these two techniques is that additional bone loss would be created during the reaming process, making future revisions even more difficult. Moreover, when there is < 50% host bone contact, alternatives have to be considered.

Acetabular reinforcement rings have been used for acetabular reconstruction in the presence of bone deficiency. There are two types of ring. The Müller ring is without hook while the Ganz ring has a hook. Previous studies showed that the use of acetabular reinforcement rings was successful in restoration of hip centre and hip biomechanics.[1–4] Moreover, they can protect the bone graft during graft incorporation and thus help to restore bone stock. The results of the acetabular reinforcement rings have been reported to be satisfactory by some authors. However, other authors have reported less satisfactory results.[5] The difference in results may be due to a number of factors. However, technique of using these rings may be a crucial factor. The aim of our study was to evaluate the clinical and radiographic results of acetabular reconstruction with acetabular reinforcement rings and morsellised graft and highlight some of the technical details when using the acetabular reinforcement ring.

Materials and methods

Total hip arthroplasty with acetabular reinforcement rings were performed in 18 hips in 18 patients from 1996 to 2011 in our hospital. The indications of total hip arthroplasty include protrusio of Austin–Moore arthroplasty (11 patients), avascular necrosis (4 patients), protrusio of cemented Thompson arthroplasty (1 patient), osteoarthritis (1 patient), and revision total hip arthroplasty (1 patient). All operations were performed by the same specialist in joint reconstruction in our hospital. Eight patients died of unrelated diseases with average follow-up of 30.5 months. At the latest follow-up, none of them showed radiographic signs of loosening or migration of implants and none required revision surgery. Three of them were stick walkers, two were frame walkers, and three were wheelchair bound. The remaining 10 patients (all female) with mean age of 77.9 years (range, 65–88 years) at the time of operation were followed-up for an average of 67.4 months (range, 11–121 months). This group of 10 patients was the focus of this study.

Acetabular deficiency was classified according to the American Academy of Orthopaedic Surgeons classification system based on the radiographic analysis and intraoperative findings. In our study, they were graded as type II (cavitary deficiency) with volumetric bone loss with intact rim in 17 hips (Figure 1) and type III (combined segmental and cavitary deficiencies) in one hip (Figure 2).

Surgical technique

Preoperative templating was performed in all patients. The size of the ring, the host bone contact of the ring, and the bony deficiency were estimated. If the ring with hook was to be used, the change in the hip centre was estimated. If this caused lateralization of the hip centre, the junction of the hook and the ring was bent to decrease the amount of lateralization.

All patients underwent surgery in the lateral position using the posterior approach. Membrane was removed from the acetabulum and the acetabulum was reamed with hemispherical reamers. Reaming was kept to a minimum and the aim was to create a spherical rim for the reinforcement ring to seat properly.

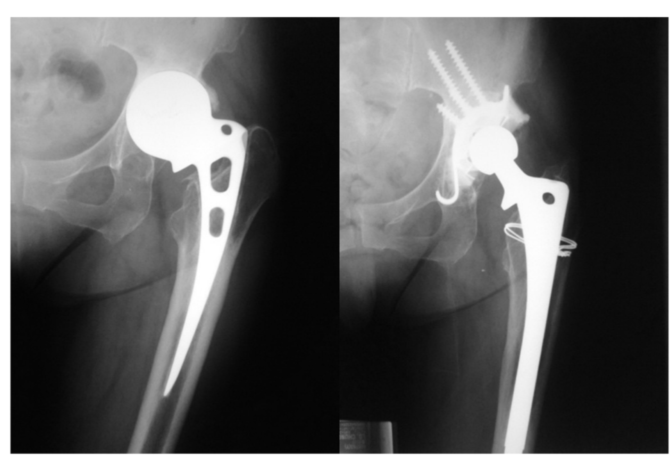

Figure 2. Austin–Moore prosthesis protrusio with acetabular American Academy of Orthopaedic Surgeons type III defect treated with Ganz ring.

A Müller reinforcement ring was used if there was good contact inferomedially. Otherwise, a Ganz reinforcement ring with a hook would be used. When using the Ganz ring, the teardrop was exposed with a blunt retractor and the hook of the ring was placed under the teardrop.[6] A Müller reinforcement ring was used in five patients and Ganz reinforcement ring was used in 13 patients. The size of the reinforcement ring was chosen if primary stability was achieved. Usually, the size of the ring would be 2–4 mm smaller than the last acetabular reamer used. The hook of the ring might be bent to increase the amount of the host bone contact and decrease the amount of the lateralization of the hip centre. The orientation of the ring was guided by the area of best bone stock available. The ring should be an appropriate version so that it would not overhang excessively anteriorly or posteriorly and cause impingement. The appropriately sized reinforcement ring was then inserted and impacted with primary stability. After the ring was positioned in place, the extent of the bony deficiency assessed. The ring was then removed and nonstructural morsellised bone graft used to reconstitute the acetabular defects. Two patients received autografts and 16 patients received allografts. The autografts were prepared from the femoral head removed. No graft was taken from the iliac crest. Allografts were prepared from our bone bank system in which the femoral heads were harvested during hemiarthroplasty for femoral neck fracture and stored at -70°C under sterile condition. The graft was prepared by either reverse reaming with hemispherical reamer or metal impactors. Reverse reaming was performed with a reamer 2 mm smaller than the hemispherical reamer used to ream the acetabulum. A metal impactor used for the impaction bone grafting technique proposed by Sloff was used in the remaining patients. One must be cautious not to overfill the acetabular defect with bone grafts because this could otherwise affect the position of the ring and lateralize the hip centre of rotation.[7]

The ring was repositioned and impacted. The stability was enhanced with a minimum of three fully threaded 6.5-mm cancellous screws passing the cephalad portion of the ring into the acetabular dome. The screws must be directed cephalad and medially approximately in line with the resultant forces about the hip at 20° to the longitudinal axis of the body. The first screw should never be introduced through the outer holes of the ring since this screw would tilt the ring outward and the ring would lose contact from the acetabular floor.[7] Inserting the first screw centrally would prevent the outward tilting of the ring and allow firm seating of the ring into the dome. The anterior screws would then be inserted. The posterior screws were inserted last because too early insertion of the posterior screws would cause the retroversion of the ring. The number of screws inserted depended on the intraoperative stability achieved. Usually more than three screws were required to provide adequate stability. To ensure good stability, bicortical screws were used with care. The polyethylene cups were usually 2–4 mm smaller than the ring used. Polyethylene cups were fixed with cement within the rings at 40° of abduction and 20° anteversion with the assistance of anteversion guide rods. The polyethylene cups should be oriented to the patient's axis and not to the reinforcement rings. The whole acetabular component was considered as a noncemented type of fixation. All patients received antibiotics prophylaxis on induction of anaesthesia. Touch down walking was started after the operation. Full weight bearing walking was allowed 8–12 weeks after the operation.

We defined clinical failure as revision surgery for any reasons. Clinical result was evaluated with Harris hip score postoperatively. Radiographic assessment was made in each follow-up visit and included an anteroposterior radiograph of the pelvis and a true lateral radiograph of the operated hip. The M.E. Müller acetate template was used in pre- and postoperative anteroposterior radiographs to detect the position of hip centre. Hip centre was measured in two dimensions and was compared to the contralateral side. The vertical distance was the distance between the inferior border of the teardrop and the centre of rotation. The horizontal distance was the distance between the medial border of the teardrop and the centre of rotation.

Radiographs within 2 weeks postoperatively were used as a reference for the initial position of the implant. Radiographs in the most recent visit were then compared to decide whether there was any loosening and migration. Statistical analysis was performed using SPSS version 19 (SPSS Inc., Chicago, IL, USA). The paired *t* test was used to assess the changes of the vertical and horizontal distances at the preoperative, postoperative, and latest follow-up. Radiolucent lines were measured in the three zones according to the technique of DeLee and Charnley.[8] Migration was defined as: (1) > 2 mm horizontal or vertical displacement of the hip centre; or (2) change of inclination of polyethylene cup $> 3^{\circ}$. Incorporation of bone graft was also assessed and was considered present if bridging trabecular bone was visible on plain radiographs. Radiographic failure was defined as any loosening, migration, or implant failures, such as breakage of stems, hooks, or screws.

Results

Clinical results

There was no revision surgery in our patients during the whole follow-up period. The average Harris hip score was 78.3 (range, 58.5–87) in the latest follow-up evaluation. Seven patients could walk with a stick, two patients could walk unaided, and one patient could walk with a frame.

Radiographic results

Comparison between preoperative hip centres and contralateral hip centres

All hip centres were found to be migrated superiorly and medially to their contralateral hip preoperatively. The average vertical migration of hip centres was 14.3 mm (range, 3–22 mm) superiorly ($p < 0.001$). The average horizontal migration of hip centres was 13.8 mm (range, 0–20 mm) medially ($p < 0.001$).

Comparison between postoperative hip centres and contralateral hip centres

The average vertical difference of hip centres was 1.5 mm superiorly when the postoperative hip centres were compared to their contralateral hips (range, 4 mm inferiorly to 15 mm superiorly; $p = 0.431$). The average horizontal difference of hip centres was 0.4 mm medially when postoperative hip centres were compared to their contralateral hips (range, 4 mm laterally to 4 mm medially; $p = 0.619$). After reconstruction, both vertical and horizontal differences of hip centres had been corrected significantly with vertical displacement from 14.3 mm to 1.5 mm superiorly ($p = 0.001$) and horizontal displacement from 13.8 mm medially to 0.4 mm medially ($p < 0.001$).

Comparison between postoperative hip centres and preoperative hip centres

The average vertical distance was 29.2 mm (range, 19–42 mm) preoperatively and 16.4 mm (range, 13–24 mm) immediately postoperation ($p = 0.001$). The average horizontal distance was 17.4 mm (range, 4–30 mm) preoperatively and 30.8 mm (range, 20–35 mm) immediately postoperation.

Comparison of postoperative hip centres between immediate postoperation and recent follow-up

The immediate postoperative and the most recent radiographs both showed correct position of the rings in all hips. The average inclination of the polyethylene cup was 47.8° (range, 42–58°). There was no evidence of radiographic loosening during our follow-up. The average migration of hip centres was 0.7 mm in the vertical direction ($p = 0.191$) and 0.5 mm in the horizontal direction ($p = 0.299$). There was an average change of 0.6° of inclination of polyethylene cup noted during the most recent follow-up ($p = 0.217$). All grafts showed optimal incorporation and no graft resorption. There was no implant failure or screw breakage. There was no case of dissociation between the polyethylene socket and the reconstruction ring.

Comparison of reinforcement ring inclination

The average inclination of reinforcement ring was 39.7° (range, 25–48°). There was an average change of 1.3° of inclination ($p = 0.638$) of the reinforcement ring noted in the most recent follow-up. There was no evidence of radiographic loosening of rings during our follow-up.

Complications

Four patients had intraoperative complications. In a patient with loosening of total hip arthroplasty, the cortex over the proximal femur was very thin due to marked osteolysis. Extended trochanteric osteotomy was performed for removal of femoral prosthesis and cement. However, a crack developed over the medial cortex of proximal femur and the distal part of the greater trochanter. A long hydroxyapatite coated stem was used and the greater trochanter was reattached with trochanteric grip. This patient developed nonunion of the trochanteric fragment. Since the nonunion was asymptomatic, no further intervention was required. The other three intraoperative complications occurred in patients suffering from acetabular protrusio of Austin–Moore arthroplasty. A minor longitudinal crack was noted at calcar region during preparation of the femoral canal and cerclage wires were applied for protection. The fractures healed uneventfully. No infection or dislocation was identified postoperatively and all patients underwent uneventful postoperative rehabilitation.

Discussion

Total hip arthroplasty in the presence of the acetabular bone deficiency is complex and often technically demanding. The aim of treatment is to restore the normal hip biomechanics by restoring the anatomical centre of rotations and leg lengths. Moreover, bone stock should be restored as far as possible to make future revision easier.

There are several ways to reconstruct the acetabular side in the presence of bone deficiency. The mode of reconstruction should be individualised according to the mechanical and biological problems encountered. No single technique is likely to provide a solution to all acetabular problems. Among these techniques, the use of cemented implant alone has been associated with high failure rates in previous studies.[9] Trancik et al[10] reviewed the cases of cemented cups with solid grafts at an average follow up period of 3.5 years and found one revision and four radiographic impending failures, yielding a 24% failure rate. Jasty and Harris[11] found that the failure rate of cemented cups with solid grafts was 32% at 5.9 years.

Uncemented implant derives its permanent stability from biological fixation by bone ingrowth into the host bone. At least 50% of host bone contact is required to provide adequate stability. In press-fit implant, there should be a precise contact between the metal shell and the bone as well as the peripheral rim of the acetabulum so that the shell is well fixed and not movable by manual means. The immediate postoperative stability can be further augmented by cancellous screw fixation to the ilium. However, with the presence of a bone defect, it has to be overcome by putting the hip centres higher than normal or over-reaming of the acetabulum. Both high hip centre and oversize jumbo cup can increase the mechanical stability by increasing the bone contact and thus bone coverage of an uncemented implant. With these techniques, the reported failure rate varies from 0% to 11% at 41–98 months. However, the disadvantage of these two techniques is that they produce additional bone loss during over-reaming and make future revisions more difficult. Furthermore, when < 50% of the host bone contact can be achieved, there will not be adequate stability and other alternatives have to be considered. Impacted morsellised allograft is another effective and widely accepted method to restore bone stock, which has shown good clinical and radiological results. Comba et al[12] reported a 95.8% survival rate in 51.7 months after impaction grafting with cemented acetabular component. However, it is technically demanding and high failure rate of impaction bone grafting has been observed in acetabular revision with severe bone defects.[13]

Acetabular reinforcement ring is one of the possible ways to deal with the difficulty in acetabular reconstruction in the presence of bone deficiency. The reinforcement ring not only provides immediate stability to the acetabular reconstruction, but also prevents motion between the implanted bone graft and the acetabular component. As a result, the bone graft can be protected from high stress during healing and osteointegration will be more likely to take place in a stable environment. Furthermore, with the morsellised bone graft reconstituting the bone stock, the ring can help to restore the centre of rotation of the hip.

There are two types of acetabular reinforcement ring. Without the hook, the stability of the Müller ring relies on the contact with the host pelvic bone cranially, posteriorly and inferomedially. The Ganz ring is an acetabular reinforcement ring with a hook. This ring can help to restore the hip centre by anchoring the hook at the acetabular notch, which usually remains constant even when there is severe bony destruction. Therefore, it is useful in cases with relatively severe bone deficiency. Moreover, with the hook is inserted beneath the teardrop, the device is put under tension and the device provides sufficient buttress in patients with moderate-to-severe bone loss around the acetabular implant. Furthermore, when the ring is placed in the acetabulum, it helps to show the size, shape, and location of the acetabular defects and allograft can be used to fill the defect.

In the literature, the results of the acetabular reinforcement ring are variable. Udomkiat et al[5] reported clinical and radiographic short-term results of three different acetabular reconstruction devices (Burch–Schneider, Ganz, and Müller) in treating type II and III defects. The overall mechanical failure rate, at an average of 4.6 years, was 17%.There was no difference in the mechanical failure rate between the three devices.

By contrast, in other studies, it was shown that the successful rates were 96% in 5 years,[14] and 91% in 10 years[15] and therefore spoke in favour of their continued use. In our study, we found that the use of acetabular reinforcement rings had a good result clinically and radiographically during our average follow-up period of 67.4 months. There was no clinical failure and no revision surgery was required.

We felt that our satisfactory result relies on the proper use of the acetabular reinforcement device. As pointed out by Korovessis et al,[16] poor surgical technique in the ring implantation was the reason for the 7% reported revision rate at 5–10 years after surgery and, that in their series, the rate of aseptic loosening of the ring

7–12 years after surgery was 10% and was primarily attributable to trauma or infection and poor technique in the implantation of the ring.

We think that the principles of the use of the rings are as follows:

(1) Proper restoration of hip centre

With preoperative templating, size of the ring, host bone contact, and bone defect can be estimated. In our series, with careful preoperative planning, acetabulum was reconstructed with morsellised bone graft and appropriate ring. In this way, hip centre could be satisfactorily corrected. When compared to their contralateral side, the vertical displacement of involved hip centres, corrected from 14.3 mm superiorly to 1.5 mm superiorly and the horizontal displacement corrected from 13.8 mm medially to 0.4 mm laterally. Thus, the hip centre was restored close to their anatomical position. Restoration of hip centre to normal is important since it can lower the forces exerting on the prosthetic components, and thus the rate of mechanical failure can be reduced. We attributed our satisfactory result to the successful restoration of hip centre. By contrast, in Udomkiat et al's[5] series, their ring was put in less satisfactory position. The Müller ring had an abduction angle of $53.2 \pm 15.2^\circ$ and elevated hip centre of 5.9 ± 12.5 mm. The Ganz ring had abduction angle of $61.9 \pm 10.5^\circ$ and elevated hip centre of 12.6 ± 15.2 mm.

(2) Proper use of the Ganz ring

The use of acetabular reinforcement ring with hook has been controversial. Proponents suggested that, with proper placement of the hook below teardrop, the hook can help in proper position of the ring. However, Schatzker and Wong[17] found that the Ganz ring tended to lateralize the polyethylene cup because it made the acetabulum shallow. This had been associated with an early failure in their series with a loosening of a vertically implanted polyethylene cup and dislocation causing a catastrophic failure. We agreed with Schatzker and Wong[17] that the Ganz ring will tend to lateralize the hip centre as seen when we did the preoperative templating in most of our cases. However, when we noticed this before the operation, the junction of the hook with the ring will be bent during the operation to decrease the amount of the lateralization (Figure 3). With this technical trick, we avoid the lateralization of the hip centre with the use of a Ganz reinforcement ring. In our study, among those who received reinforcement ring with a hook, the postoperative hip centres, when compared to contralateral hips, were on average 1.8 mm inferiorly and 0 mm medially. For reinforcement rings without hook, the postoperative hip centres were on average 0 mm superior and 2 mm medial to their contralateral hips.

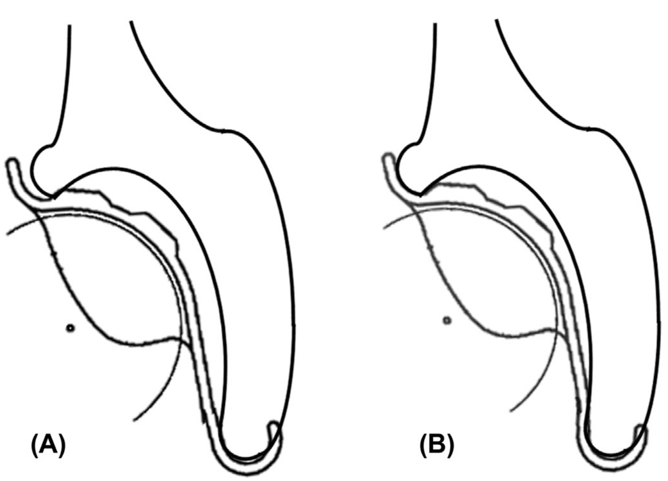

Figure 3. Junction of the hook with the ring was bent during the operation to decrease the amount of the lateralisation. (A) Before bending of hook; (B) after bending of hook.

(3) Reconstruction of bone defect with morsellised graft

Morsellised femoral heads were used for bone grafting in all of our cases. The use of morsellised graft has a few advantages. Firstly, morsellised bone chips can be tightly packed to replace the bone loss and this results in a complete layer with no gaps. During the revascularization phase, the open structure of the cancellous bone allows more rapid blood vessel invasion. This is better than the more solid cortical bone used in bulk or structural allografts. Another advantage is that the bone is replaced without significant structural weakening. This is because apposition of new bone precedes osteoclastic function in cancellous graft.

(4) Ring stability

The stability of the ring at the time of surgery is essential for satisfactory result. Zehntner and Ganz[18] reviewed their results of acetabular reconstructions with the Müller ring and defined reconstructions as adequate if an appropriately sized ring had been used with good contact on host pelvic bone cranially, posteriorly, and inferomedially. They found that the incidence of migration in adequate reconstruction was less. Gerber et al[6] showed that inadequate fixation of implant at the time of surgery was the only significant predictor of implant failure. With adequate primary stability, the osteointegration of the bone graft could take place during the first 12 months. Implant loosening without primary stability was always associated with resorption of the graft. In all our cases, reinforcement rings demonstrated primary stability at the time of operation. The immediate stability was enhanced by two to four screws with adequate purchase to ilium. All patients received bone grafts, either allografts or autografts from the femoral head removed. All bone grafts showed successful incorporation with trabecular bone observed and no graft resorption was demonstrated radiographically.

Various means can be used to improve the ring stability. If host bone contact is not satisfactory, it can be improved with reaming. Any irregularities within the acetabulum should be reamed. However, one should not ream excessively the already deficient acetabulum. The stability can also be improved with the use of acetabular ring with hook in case there is poor inferomedial contact. Of course, screw augmentation is important. However, screw fixation should be aimed at temporary fixation only. Although they are strong mechanically, they can still break in the long term because of fatigue failure if there is poor graft incorporation or graft resorption with repeated motions between the bone and prosthesis. Long-term support and stability of the prosthesis should be provided by successful incorporation and revascularization of bone grafts.

(5) Proper placement of the ring and the cemented cup

When positioning the acetabular reinforcement ring, the proper version is important. Otherwise, the metal ring will overhang anteriorly or posteriorly causing impingement and dislocation of the hip. The ring should be at an appropriate abduction angle. Although it should be adequately abducted to give good host bone contact, too much abduction will cause inadequate support for the polyethylene cup and early failure.

When positioning the polyethylene liner in the ring, the abduction angle of the polyethylene liner should be similar to that in the primary total hip arthroplasty. Since the liner is fixed to the outer metal shell by bone cement, the abduction angle of the polyethylene liner could be easily adjusted. In the presence of bone deficiency, the abduction angle of the reinforcement ring is usually larger. In that case, the polyethylene liner should not follow the orientation of the metal ring.

(6) Proper indication

When using acetabular reinforcement ring with or without hook, adequate support of the ring cranially by host bone is important. If the roof side of the ring cannot be placed on the cortical part of the host bone, other methods of reconstruction should be considered. One way is to use structural graft to reconstruct the superior bone and use an acetabular reinforcement ring for reconstruction. Other possible methods include a ring with flap, Burch–Schneider cage, graft augmentation prosthesis cup, trabecular metal acetabular shell with augments and whole acetabular allograft with cemented cup. Extensive bone loss is considered as a contraindication for the use of acetabular reinforcement ring.[17,19]

Limitations

As pointed out by Zehntner and Ganz,[18] the type of deficiency to be addressed plays an important role. The cavitory defects do not seem to impose special problem under the condition that the acetabular component have good support by host bone. Of special concern are segmental deficiencies of the roof or either one or two of the acetabular pillars or a medial wall deficiency. In these cases, the extent of the deficiency may exceed the minimal required host-bone support of the reinforcement device. Most of our patients had cavitory defect that could be filled with morsellised graft. We have only one case of combined segmental and cavitory defect. This was a patient with segmental medial wall defect, which was filled with wafer graft. Reconstruction of major segmental and combined segmental and cavitory deficiencies probably requires more elaborate techniques.

Moreover, our results are medium term. Longer follow-up is required. However, with restoration of bone stock and restoration of the hip centre, good longevity can probably be achieved.

Conclusion

Acetabular reconstruction with the use of acetabular reinforcement rings and morsellised bone grafts has shown satisfactory clinical and radiographic results at a medium-term follow-up. This early result suggests the technique is useful to reconstruct the acetabular bone defects and restore the hip centre of rotations so that the mechanical outcome can be improved.

Conflicts of interest

All authors declare no conflicts of interest.

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