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Midterm Follow Up of Acetabular Reconstruction of Dysplastic Hips using Structural and/or Morselized Bone Graft in Primary Total Hip Arthroplasty

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ABSTRACT

Background: Acetabular fixation is a dysplastic hip challenge, and many approaches for primary total hip arthroplasty (THA) have been shown. Even though each surgical procedure was discussed, combining bulk graft with impaction of morselized graft is promising. To confirm long-term outcomes, additional research into the clinical outcomes of a combined set of procedures may be necessary.

Objective : The aim of the current study is to report the midterm results of using structural and/or morselized autografts for acetabular reconstruction in a series of patients with developmental dysplasia of the hip (DDH).

Patients and methods: A total of 44 patients with 44 hips were included in the study. They were followed prospectively for an average period of 2-3 years. Preoperative planning was done including laboratory and radiological investigations. Harris Hip Score (HHS) was applied pre- and post-operatively.

Results: HHS was raised from 41.24 before surgery to 83.4 at the latest follow-up. The limb-length was restored to within 0.5 cm in 38 cases (86.4%). Only 4 patients (9.09%) had radiological signs of structural graft resorption. Two (4.5%) patients developed complete radiolucent lines and were revised for loosening. Infection complicated the post-operative course of 3 (6.8%) patients in this study.

Conclusion: The technique of biological acetabular reconstruction using structural and/or morselized bone graft in primary THA for cases of acetabular dysplasia is reliable, and it not only simplifies the attainment of initial stability, but also strengthens the mid-term to long-term stability during THA in DDH.

Keywords: Acetabulum, Dysplasia, Morselized Bone Graft, Harris Hip Score.

INTRODUCTION

Acetabular deficit frequently results from actabular dysplasia. Prevalence ranges from 5.4 to 12.8% in the Danish population, 1.8% in the Korean population, 2.4% in the Turkish population, and 7.3% in the Singaporean population [(1)]. Genetic and intrauterine environmental variables are also part of the multifactorial etiology. Patients, who have one or more of the following risk factors, including female gender, firstborn, favorable family history or ethnic origin, breech birth, oligohydramnios, torticollis, and lower-limb deformity, are considered to be at risk [(2)].

Because dysplastic hips have changed architecture, total hip arthroplasty (THA) in these patients is a technically challenging treatment. When performing THA on patients with acetabular deficit, the distorted anatomy of the acetabulum and proximal femur combined with the leg length disparity create significant complications. Additionally, since the majority of patients are younger, it is crucial to maintain the continuity of the abductors and balance the soft tissues to maximize the functional outcome of the operation. The following procedures for acetabular reconstruction are described: Standard metal implants, specially made acetabular implants, pedicled or autologous iliac grafts, homologous or auto/homologous bone grafts, reinforcement rings with hooks combined with autologous graft augmentation, cranial positioning of the acetabulum, medial protrusion cotyloplasty technique with chisel or reaming, and cotyloplasty without spongioplasty are some of the procedures available [(3)].

Postoperative infections, bone graft failure, fractures around or through prosthetic devices, dislocations, vascular injuries, and nerve injuries are among the complications [(4)]. Bulk bone grafting has benefits, including allowing the cup to be positioned in an anatomically correct location as opposed to a high one, supporting the acetabular component, and, if used, providing useful bone stock for any upcoming revision surgery. Although it is widely acknowledged that covering and initial stability of the socket are crucial, many authors have documented significant rates of autograft resorption, bone graft collapse, and loosening of the socket [(5)].

In the present study, we report the midterm results of using structural and/or morselized autografts for acetabular reconstruction in a series of patients with developmental dysplasia of the hip (DDH).

PATIENTS AND METHODS

This case series included 44 dysplastic hips of 44 patients (38 females and 6 males) during the period from May 2016 to August 2020.

Inclusion criteria: Patients older than 18 years with developmental type of acetabular dysplasia.

Exclusion criteria: Patients younger than 18 years or with acetabular degenerative changes secondary to post-traumatic fracture acetabulum, degenerative joint disease, healed inflammatory disease as rheumatoid

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disease and neurological disease as cerebral palsy were excluded from this study**.**

Pre-operative regular lab testing, a thorough clinical examination, and a full history taking were all completed. Patients were assessed radiologically. The patients' clinical examination was done using the Harris hip score [(6)]. According to Crowe, the classification system was employed [(7)]. Anteroposterior pelvic view, pelvic inlet and outflow views, Judet external and internal oblique views are all included in a plain X-ray. An isosceles right triangle, the Ranawat triangle is used to identify the hip rotation centre [(8,9)]. Femoral head extrusion index in acetabular dysplastic patients is shown in **Figure 1**.

Computerised tomography with 3D reconstruction was used for preoperative evaluation in all patients. the vertical height of equals to 20% of the pelvic height according to A.P view of the pelvis, it is 5 mm lateral to intersection of kohler line and shenton line and the horizontal side of triangle equal to its vertical side.

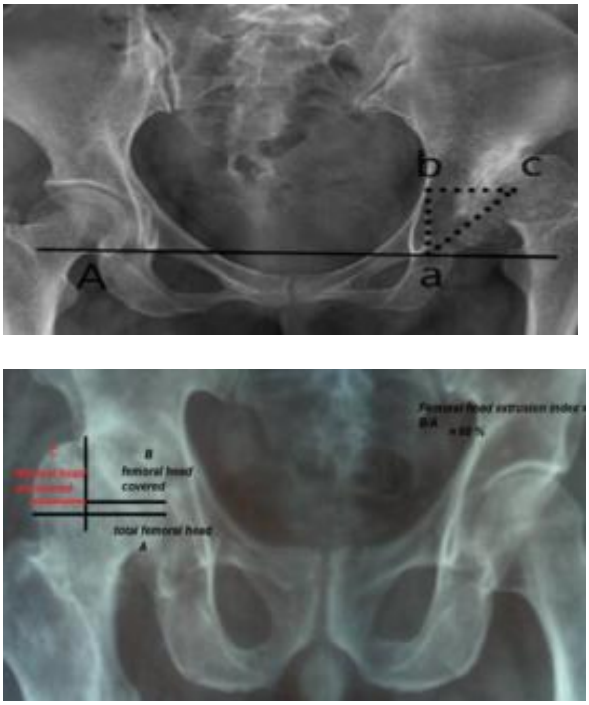

Figure (1): Ranawat's triangle on an anteroposterior pelvic radiograph. Line A is the inter-teardrop line. Point (a) is located 5 mm to the same side tear drop. Triangle abc, the length of ab and bc is equal to 20% of the pelvic height. Femoral head extrusion index in patient with acetabular dysplasia.

Surgical Technique:

Thirty cases were operated under spinal anesthesia, 10 cases under epidural anesthesia and 4 cases under combined spinal epidural anesthesia. All cases were operated in lateral decubitus position after well padding of the bony prominences. Routine scrubbing and draping and prophylactic third generation cephalosporins was administrated 1 hour prior to surgery. Lateral approach was used in all cases.

After reaching the acetabulum, the labrum is incised at the proximal extent of the flap to aid in dislocation of the hip joint. A bone hook is placed around the femoral neck anteriorly and the femoral head is dislocated by traction on the bone hook while externally rotating the leg. A standard femoral neck osteotomy is performed, it is typically a line made from the medial neck one finger breadth above the lesser trochanter to the saddle of the lateral neck, and the femoral head is then removed. Three retractors were used to gain adequate exposure.

First: sharp Hohmann is utilized to develop the plane between the anterior wall of the acetabulum and the anterior overlying capsule, once the plane is developed sharp Hohman is replaced by blunt one. Second: superior to the acetabulum, a sharp cobra retractor is utilized to retract the gluteus medius away from the surgical field. Third: placed infero-posteriorly, is placed against the ishium. The labrum was excised, the fat within the cotyloid notch was removed to find the true floor of the acetabulum, the transverse acetabular ligament surgically and the tear drop radiologically is signs to find the anatomical hip center. Osteophytes should be removed, with an osteotome, a rongeur, or both, to provide accurate anatomic landmarks for prosthetic positioning and to avoid impingement on the prosthesis during insertion or during motion after implantation. Acetabular reamers may be helpful in removing medial osteophytes seated in the acetabular fossa. Initial reaming is done with an instrument several millimeters smaller than the prosthesis size selected preoperatively and is directed more medially to deepen the acetabulum. Subsequent reaming is done in 30 to 40 degrees abduction and 10-20 degrees anteversion. The need for a graft can be assessed by placing a trial acetabular component after the initial reaming. If the cup is covered by bone superiorly and posteriorly to its widest diameter, the cup will likely be stable. Structural grafts will then be needed for bone stock restoration and not for stability. The planned cup must have greater than 50% host bone contact. If there is inadequate posterior or superior coverage, structural grafting will be needed.

Cancelous bone, biconave disks of cancellous bone and blocks of bone fashioned from femoral heads were used. Cancellous bone graft consisted of morselized chips that are pressed into defects and contoured with reverse acetabular reaming. Defective superolateral acetabular rim was augmented with hangover bone grafts that surround the acetabular wall. In patients with extremely severe dysplasia, the excised femoral heads were used for augmentation. These grafts were fixed by 2 cancellous screws after temporary Kirschner wire fixation. The edge of the grafted bone was trimmed, and the acetabulum was reamed gradually and carefully from a diameter of 40 mm to the optimal diameter. Care was taken with the center of the new acetabulum because the center may move downward because of the hard eburnated femoral head. Finally, a

conical reamer was used and morselized bone grafts are placed into the dead space of the structural bone graft. The socket is fixed in the same orientation.

In some cases, the sockets were unstable, so 2 or 3 screws were placed in the acetabular socket to obtain better stability. A cup insert was placed in the socket. The favored diameter of the socket was 46mm (range, 22-52mm). Following acetabular cup placement, cementless femoral stem was inserted in all cases.

The wound and the hip joint are irrigated thoroughly, a deep suction drain can be utilized, the anterior flap is returned to its anatomic position at the greater trochanter by heavy absorbable suture, then the fascia of gluteus maximus and the fascia lata are closed interrupted heavy with absorbable suture. Then the subcutaneous tissue is closed with absorbable suture and the skin is closed with skin staples. The affected limb is placed in abducted and neutral position.

Post-operative care and follow up:

Rehabilitation of active flexion and extension of the hip joint started 1 week postoperatively; patients are encouraged to walk initially with crutches as fast as possible after surgery and eventually to give up the stick 12 weeks after surgery. Follow up in the outpatient clinic depends on evaluation by Harris hip score and serial x-ray evaluation after 2 weeks, 1 month, 3 months and 1 year.

Ethical approval:

This study was ethically approved by the Ethical Committee of the Faculty of Medicine, Zagazig University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical analysis

The collected data were introduced on Microsoft Excel software and statistically analysed by utilizing the Statistical Package for Social Sciences (SPSS) version 20 for windows. Qualitative data were defined as numbers and percentages. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as means and standard deviation (SD).

RESULTS

A total 44 patients (38 females and 6 males) were included in this study. The right hip was involved in 18 patients, while the left hip was involved in 26 patients. Patients mean age at time of surgery was 32 years ranging from 18 years to 60 years. The mean patients' body mass index at time of total hip arthroplasty was 29.9 ranging from 27.3 to 34.

At time of total hip arthroplasty 3 patients were diabetic (**Type II**) and 2 patients were cardiac (hypertension and coronary insufficiency). The mean preoperative Harris score was 41.24 ranging from 26.35 to 47.9 (**Table 1**).

Table (1): Demographic data of the studied patients

Number of patients	44
Gender	6 males 38 females
Mean time at Total hip arthroplasty **Range**	32 years (18 - 60 y)
Mean body mass index at time of arthroplasty **Range**	29.9 (27.3 - 34)
Mean preoperative Harris score **Range**	41.24 (26.35 - 47.9

A total of 25 patients were Crowe grade I, 17 patients were Crowe grade II and 2 patients were Crowe grade III **(Table 2)**.

Table (2): Crowe classification among the studied patients

Grade	Proximal migration	Femoral head subluxation
I	<10% vertical height of the pelvis	Proximal migration of head neck junction from inter-teardrop line <50% of femoral head vertical diameter
II	10-15%	50-75%
III	15-20%	75-100%
IV	>20%	>100%

The studied patients had a minimum of 3 years follow up (range 3-5 years). The remaining 4 patients; 3 had early removal of the implants due to deep wound infection and the fourth patient died of pulmonary embolism. The average post-operative Harris hip score was 83.4 (range 35-95) at the latest follow up.

A total of 33 (75%) patients had good or excellent Harris hip scores at their latest follow-up, 4 (9.1%) patients had fair scores, and 3 (6.8%) patients had poor scores **(Table 3)**.

Table (3): Postoperative Harris hip scores among the studied patients

Harris hip scores	Number	Percentage
Excellent	5	15%
Good	28	60%
Fair	4	9.1%
Poor	3	6.8%

The remaining 4 patients had no score calculated, 3 had early removal of the implants due to deep wound infection and the fourth patient died of pulmonary embolism. From the 3 patients with poor Harris hip score, 2 patients were doing fine and their scores were 83 and 78 but their scores deteriorated due to acetabular loosening (1 septic and 1 aseptic). The third patient had another road traffic accident 2.5 months after the surgery and the patient suffered from skeletal and non-skeletal injuries led to the poor function and the low hip score of 40. The center of the hip was restored to within 10 mm in 43 patients. In only 1 (2.3%) patient the hip center was displaced vertically by 18 mm and laterally by 5 mm. A cementless cup with 2 screws was used and the cup was stable both clinically and radiologically at 2.5 years follow up with no lucent zones. The post-operative limb-length varied from +1 cm to −1 cm with a mean of +0.3 mm. The limb-length was restored to within 0.5 cm in 38 (86.4%) cases.

The limb was shorter by 1 cm in 3 cases (Crowe II and III). This included the one with high hip center despite the use of a long neck length. In the other 2 cases, the reduction was tight which forced the use of a short neck length. The limb was longer by 1 cm in 3 cases had some sort of increased soft tissue laxity after release and lengthening of the limb was done to achieve good tension in the abductors to augment stability. Periacetabular radiolucencies 2 mm wide or more were seen in 9 (20.5%) patients. Only 2 patients demonstrated evidence of change of the cup position. These 2 cases were loose and had revision **(Figure 2)**.

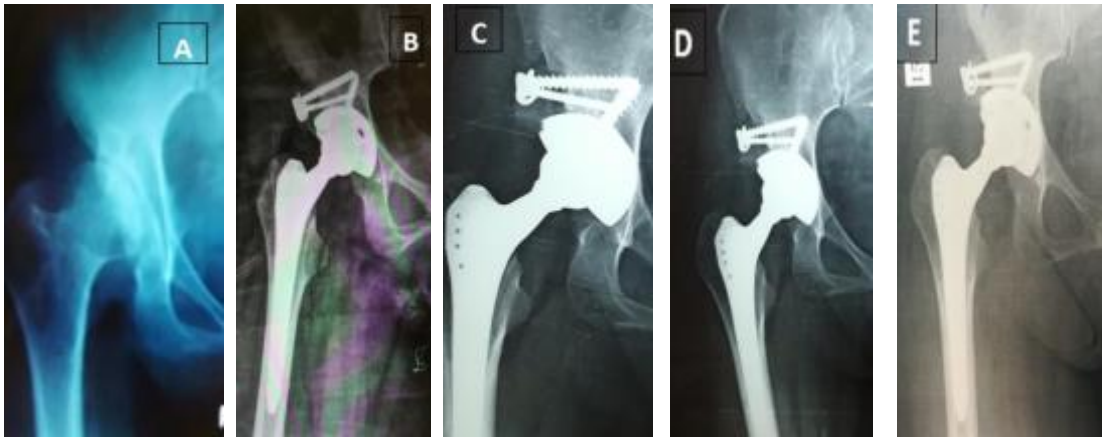

Figure (2): Female case, 43 years old with left acetabular dysplasia, (A) Preoperative x-ray, (B) Immediate postoperative x-ray, (C) Radiological follow up after 2 weeks, (D) after 3 months and (E) after a year.

Four (9.09%) patients had radiological signs of structural graft resorbtion. Complications were encountered in 11 of studied cases. Only 2 (4.5%) patients had displaced acetabular components and complete radiolucent lines and were revised for loosening. The 7 remaining acetabular components with some degree of radiolucency were stable by both clinical examination and radiographic review, with fair or good Harris Hip scores (average 79.7 points) at the time of the latest follow-up. Infection complicated the post-operative course of 3 (6.8%) patients **(Figure 3)**.

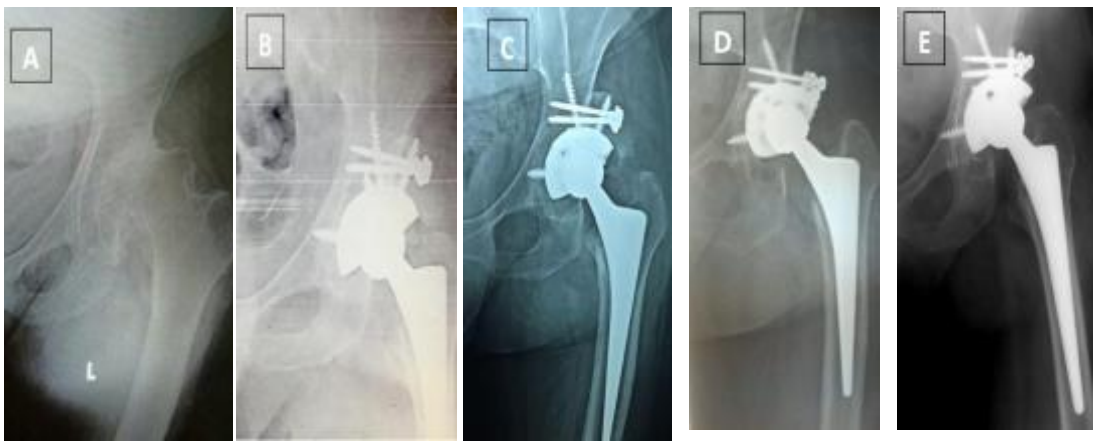

Figure (3): Female case, 65 years old with left acetabular dysplasia (A) Preoperative x-ray examination, (B) Immediate postoperative x-ray, (C) Radiological follow up after 2 weeks, (D) after 3 months and (E) after a year.

DISCUSSION

When THA is necessary for a patient with developmental dysplasia of the hip (DDH), acetabular roof bone insufficiency frequently prevents the use of standard techniques for socket implantation [(10)]. The following methods for acetabular reconstruction are described: cotyloplasty for shallow acetabuli; higher hip centers for steep acetabuli; specialized acetabular augments; acetabular roof reconstruction with autologous bone grafting; and graft augmentation by rim mesh or hooked reinforcement ring devices with impaction morselized bone grafting [(11-15)]. However, the acetabular bone stock is not retained in the first three methods, and the original hip center may be shifted. However, if revision is intended, tremendous care must be taken to not only preserve but also increase bone stock in primary THA, overcoming the major issue of bone insufficiency.

In this study the use of biological reconstruction of the dysplastic deficient acetabulum with morselised and/or structural bone grafts was done. Minor difficulties were encountered in dysplastic hips Crowe`s grade I and II. In dysplastic hip Crowe`s grade III major soft tissue release were done but actually we have only two cases crowe's III included in our study. In our study we had 4 cases of graft absorption (9.09%).

On the other hand, **Kim and Kadowaki [(16)]** studied 83 hips from 70 patients with a mean follow-up of 11 years and found no evidence of graft collapse. They also noticed that the host-graft interface vanished and that radiodense bands began to appear between the graft and the ilium and the cup, indicating incorporation of the graft. The fact that graft integration is a time-dependent process may help to explain this.

In a study of 102 hips, **Knight *et al.* [(17)]** found that remodeling appeared at 9 months (range, 2-30 months), reorientation was recognized at 16 months (range 6-42 months), and bridging trabeculation was noticed at 5 months postoperatively. In this study, the mean Harris Hip Score at the last follow-up was 83.4 (interquartile range: 35-95).

A total 52 patients were investigated by **Song *et al.* [(18)],** with a mean postoperative HHS of 92.9 (range 63-100). With two cases of recurring dislocation that required revision, we had one partial sciatic damage case that healed within a year. We had one case of DVT and pulmonary embolism and these results were comparable with Maruyama *et al.* who studied the additional bulk bone grafting method on 102 THAs with shallow acetabulum (31% for DDH). One of them replaced only the polyethelene component and the other had revision with the use of a mesh. They only experienced one postoperative dislocation (1%), which was treated with a closed reduction.

In finally, using a biological technique to rebuild a deficient acetabulum in cases of adult hip dysplasia is a solid alternative in terms of stability and longevity. If the acetabular covering of the cup is less than 70% and the host bone to cup contact is greater than 50%, a structural and/or morselized graft may be employed. According to **Kim and Kadowaki [(16)]**, 94% of 83 dysplastic hips underwent bulk femoral head repair survived for 10 years without acetabular revision for any cause.

The inter-observer variability, relatively short follow-up term, and relatively small study group are just a few of the limitations of our study, hence we advise extending the follow-up duration in order to more properly assess the effectiveness of the employed technique on the longevity of THR.

CONCLUSION

The technique of biological acetabular reconstruction using structural and/or morselized bone graft in primary total hip arthroplasty for cases of acetabular dysplasia is reliable, and it not only simplifies the attainment of initial stability, but also strengthens the mid-term to long-term stability during THA in DDH.

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REFERENCES

1. **Jacobsen S, Sonne-Holm S (2005):** Hip dysplasia: a significant risk factor for the development of hip osteoarthritis. A cross-sectional survey. Rheumatology (Oxford), 44(2):211-8.
2. **Dezateux C, Rosendahl K (2007):** Developmental dysplasia of the hip. Lancet, 369(9572):1541-52.
3. **Bicanic G, Barbaric K, Bohacek I *et al.* (2014):** Current concept in dysplastic hip arthroplasty: Techniques for acetabular and femoral reconstruction. World J Orthop., 5(4):412-24.
4. **Nunley R, Prather H, Hunt D *et al.* (2011):** Clinical presentation of symptomatic acetabular dysplasia in skeletally mature patients. J Bone Joint Surg Am., 2:17-21.
5. **Papachristou G, Hatzigrigoris P, Panousis K *et al.* (2006):** Total hip arthroplasty for developmental hip dysplasia. Int Orthop., 30(1):21-5.
6. **Harris W (1969):** Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am., 51(4):737-55.
7. **Crowe J, Mani V, Ranawat C (1979):** Total hip replacement in congenital dislocation and dysplasia of the hip. J Bone Joint Surg Am., 61(1):15-23.
8. **Ranawat C, Dorr L, Inglis A (1980):** Total hip arthroplasty in protrusio acetabuli of rheumatoid arthritis. J Bone Joint Surg Am., 62(7):1059-65.
9. **Holzapfel B, Greimel F, Prodinger P *et al.* (2012):** Total hip replacement in developmental dysplasia using an oval-shaped cementless press-fit cup. Int Orthop., 36(7):1355-61.
10. **Pagnano W, Hanssen A, Lewallen D *et al.* (1996):** The effect of superior placement of the acetabular component on the rate of loosening after total hip arthroplasty. J Bone Joint Surg Am., 78(7):1004-14.

11. **Kaneuji A, Sugimori T, Ichiseki T *et al.* (2009):** Minimum ten-year results of a porous acetabular component for Crowe I to III hip dysplasia using an elevated hip center. J Arthroplasty, 24(2):187-94.
12. **Dorr L, Tawakkol S, Moorthy M *et al.* (1999):** Medial protrusio technique for placement of a porous-coated, hemispherical acetabular component without cement in a total hip arthroplasty in patients who have acetabular dysplasia. J Bone Joint Surg Am., 81(1):83-92.
13. **Bicanic G, Barbaric K, Bohacek I *et al.* (2014):** Current concept in dysplastic hip arthroplasty: Techniques for acetabular and femoral reconstruction. World J Orthop., 5(4):412-24.
14. **Schreurs B, Busch V, Welten M *et al.* (2004):** Acetabular reconstruction with impaction bone-grafting and a cemented cup in patients younger than fifty years old. J Bone Joint Surg Am., 86(11):2385-92.
15. **Akiyama H, Yamamoto K, Tsukanaka M *et al.* (2011):** Revision total hip arthroplasty using a Kerboull-type acetabular reinforcement device with bone allograft: minimum 4.5-year follow-up results and mechanical analysis. J Bone Joint Surg Br., 93(9):1194-200.
16. **Kim M, Kadowaki T (2010):** High Long-term Survival of Bulk Femoral Head Autograft for Acetabular Reconstruction in Cementless THA for Developmental Hip Dysplasia. Clin Orthop Relat Res., 468(6):1611-20.
17. **Knight J, Fujii K, Atwater R *et al.* (1993):** Bone-grafting for acetabular deficiency during primary and revision total hip arthroplasty. A radiographic and clinical analysis. J Arthroplasty, 8(4):371-82.
18. **Song J, Ahn T, Yoon P *et al.* (2017):** Reliability of the acetabular reconstruction technique using autogenous bone graft from resected femoral head in hip dysplasia: Influence of the change of hip joint center on clinical outcome. J Orthop., 14(4):438-44.