

ORIGINAL RESEARCH

Total hip arthroplasty with bulk femoral head autograft for acetabular reconstruction in developmental dysplasia of the hip

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ABSTRACT

Introduction: The long-term outcome of the total hip arthroplasty which is performed with cement and with the use of a bulk autograft for acetabular reconstruction in patients reported with developmental dysplasia involving hip have considerably varied. The focus on achieving union and stability of the autogenous graft has been keenly identified as key determinants of a successful outcome with this procedure.

Materials and Methodology: The proposed study period was estimated to be around October 2019 to March 2021, 16 patients who were reported to be managed with autologous bone graft in combination with an iliac osteotomy at the Department of Orthopaedics, IGIMS, Patna. Patients who were maintaining a minimum of 12 months were eligible to be included in the study.

Results: All grafts were united by one year on follow-up radiographs. At latest follow-up, all hips were functioning well with no clinical signs of loosening and no revisions had been performed. There was no discernible graft resorption or collapse and no patient had acetabular loosening according to our criteria.

Conclusion: This study has represented that this technical variation which combines an iliac osteotomy with the bulk autograft in the cases of developmental hip dysplasia has enabled early stability and reliable graft incorporation which when combined together with satisfactory clinical and radiological outcomes in the relatively short term.

Keywords: hip arthroplasty, acetabular reconstruction, developmental dysplasia, femoral autograft

INTRODUCTION

In order to obtain a successful osseous coverage and stability of the socket at the time of total hip arthroplasty surgery in patients with severe bone deficiency of the acetabular roof secondary to developmental dysplasia of the hip, placement of the socket in the true acetabulum and augmentation of the superolateral aspect of the ilium with bulk femoral head autograft has been effectively used. *Harris* and *Crothers*¹ postulated that this technique and their early outcomes were seems to be encouraging.² Therefore, the reported prevalence of such acetabular failure was found to increase substantially with longer follow-up duration.³⁻⁵ Also, all of the grafts that had been applied in their patients had already united to the ilium where loosening of the socket was the principle long-term complication, with sixteen of fifty-six hips requiring revision at the time of follow-up, at a mean of 16.8 years.⁵ Nowadays, more favourable long-term results of this surgical technique have been well documented. Rates of radiographic loosening and of revision of cemented sockets have been

analysed to be around 25% and 4% respectively, at fifteen years at a mean age range of 13.1 years,⁷ and 12% and 0% (five and none of forty-three hips) at a mean age of eleven years.⁸ Long-term results of this technique in combination with the use of a cement less socket have not been documented yet as seen in literature.⁹ Since the long-term results of total hip arthroplasty were conducted with cement and the use of a bulk autograft for acetabular reconstruction in patients with developmental dysplasia of the hip have varied relatively and analysing the results of Charnley total hip arthroplasties were performed with this augmentation procedures to identify factors that could actually influence the results of those procedures. Because the deficiencies of short-term data which were documented in the series reported by *Harris et al.*¹⁻⁵

The focus on achieving union and stability of the autogenous graft have been keenly identified as key determinants of a successful outcome with this procedure.¹⁰ Bulk autogenous grafts are great to incorporate gradually and often incompletely¹¹ and limiting their ability to respond to stresses under cyclic loading. The major factors that might possibly affect the incorporation of the graft are mostly stability of the construct and host-graft bone contact.¹³ In this current study, it has been described a novel technique in combining the use of bulk autograft with an iliac osteotomy which provides primary stability and eventually optimises direct cancellous bone contact interface.

MATERIALS AND METHODOLOGY

The proposed study period was estimated to be around October 2019 to March 2021, 16 patients who were reported to be managed with autologous bone graft in combination with an iliac osteotomy at the Department of Orthopaedics, IGIMS, Patna. Patients who were maintaining a minimum of 12 months were eligible to be included in the study. There were 4 men and 12 women who were basically comprised the study group and the average age at the time of surgery was found to be around 50.1 years (range 26– 77). The probable diagnosis in all patients was Developmental Dysplasia of Hip with a defective acetabular roof which would result in the uncovering of the acetabular component when placed in the desired position without any augmentation procedure. Pre-operative radiographic planning with the use of transparent overlays and socket templates has reported to be performed in order to assess the position of the socket and autograft and potential coverage. Posterior approach was used effectively with the relative short external rotators which are divided at their insertion and reflected to protect the sciatic nerve. The femoral head was effectively resected and the acetabulum was exposed. A full capsulectomy was conducted and a pin was inserted just above the acetabulum and the distance to a fixed point on the greater trochanter was measured to provide an estimate of leg lengthening once the trial components were placed. The acetabulum was consequently reamed with the focus on the positioning of the socket at the level of the true acetabulum.

Radiographs taken preoperatively and post-operatively at 1, 4, 8 and 12 months were evaluated by two observers (SWY and FC). Pre-operative radiographs were classified as per the system formulated by *Crowe et al.*¹² and the acetabular angle of *Sharp*¹³ was equally measured. Post-operatively, the inclination angle of the socket was eventually measured in relation to Kohler's line and the amount of coverage of the socket was expressed in terms of percentage with the horizontal distance between the most medial point and the most lateral edge of the socket. Graft union was equally evaluated by observing the disappearance of the graft-host bone interface and the appearance of bridging trabeculae.

Heterotopic ossification was relatively classified based on the system postulated by *Brooker et al.*¹⁴ The horizontal (distance from the inferior point of the teardrop) and vertical (distance from the inter-teardrop line) locations of the cup were measured as described by *Russotti et al.*¹⁵ Resorption of the graft was eventually evaluated at each follow-up interval and the cup-

bone interface was evaluated based on the zones of *DeLee* and *Charnley*.¹⁶ Cup loosening was measured according to the criteria hypothesized by *Mulroy* and *Harris*,¹⁷ with a vertical or horizontal migration more than 2 mm or cement fracture, with an inclination change more than 4 degrees or with a reported continuous radiolucent line of more than 1 mm or noncontinuous radiolucency more than 2 mm at the acetabular cement-bone interface considered the evidence of loosening.

RESULTS

The preoperative radiographic classification was Crowe type I in 8 hips (50%), type II in 4 hips (25%), and type III in 3 hips (19%) and the mean Sharp angle was 49.8° (range 43–61°). The mean duration of follow-up was 8.3 years (range 6–10.2 years). No patients were lost to follow-up. Immediate postoperative radiographs showed a mean acetabular inclination angle of 44° (range 28–63°), and the average coverage of the component by graft was 40.3% (range 25–61%). The mean horizontal location of the hip centre was 35 mm (range 22–42 mm) lateral to the teardrop. The mean height of the hip centre was 31 mm (range 20–56 mm) vertically from the inter-teardrop line. *Russotti* and *Harris*¹⁵ defined proximal placement of the socket as ≥ 35 mm of vertical displacement, and according to these criteria six patients had proximal placement of the socket.

All grafts were united by one year on follow-up radiographs. At latest follow-up, all hips were functioning well with no clinical signs of loosening and no revisions had been performed. There was no discernible graft resorption or collapse and no patient had acetabular loosening according to our criteria. No patient had vertical or horizontal migration >2 mm or a change in the inclination angle >3°. Postoperative complications included transient neuropraxias in 3 patients, an episode of dislocation in one patient which was treated with closed reduction. Two patients showed evidence of heterotopic ossification, one Brooker stage I and one Brooker stage II. There were no infective complications.

DISCUSSION

There is a reported combination of a higher local incidence of DDH could possibly associated with both genetic and environmental factors which include swaddling of infants, together with the bounded primary care facilities in their childhood which could result in a higher proportion of patients who were presenting in their 3rd or 4th decade of life with the incidence of degenerative hip disease. Developmental dysplasia of the hip usually reported with the considerable difficulties in the restoration of acetabular anatomy and helps in achieving utmost coverage of the acetabular component especially in the superolateral region. Various protocols have been formulated to elaborate this difficulty that include proximal positioning of a smaller cup^{15,18} penetration of the medial wall that is the protrusio technique,^{19,20} an iliac sliding graft²¹ and lateral bulk grafting^{2,6,7} with either autogenous or allogenic bone materials. All of the above discussed techniques have already reported satisfactory medium-term results, bulk autogenous grafting that has been possibly favoured by various authors as it permits more anatomic cup placement and enhances early structural support to the acetabular component and the ready availability of autogenous graft in the form of the resected femoral head. Added advantage is that the augmentation of pelvic bone stock in case of subsequent revision²² which is considered as an important principle which has given the early age of onset to the secondary degenerative change in this study group that has been constituted in this study.

The results that had been documented in the literature with regard to bulk autograft in DDH have been changing constantly which could probably attributed because of the observable differences in the selection of patients, severity of dysplasia, bone quality and the technique of bone grafting and various components that had been in use.²² *Harris* et al formulated that

good early results in 27 hips in 22 patients² but consequently reported a combined clinical and radiographic success rate of 60% at 16 years with the failures because of graft resorption and its collapse.⁵ On the contrary, *Kobayashi et al*⁶ in their study observed that 37 hips at a mean age range of about 19 years after performing the cemented arthroplasty with 100% survival of the socket and have also reported favourable outcomes.^{7, 21–23,24}

Earlier studies have recognised that the two of the most important factors that have been involved in the graft incorporation are the host & graft bone contact and further stability of the graft.^{2, 10, 11, 21} *Harris* originally elaborated “scoring” criteria of the lateral cortex of the ileum before directly bolting the curvature of the femoral head against the ileum. Followed which various other authors have discussed that using a cut surface of the femoral head²³ as a graft to enhance the cancellous bone in contact with the ileum. Additionally, *Kobayashi* possibly elaborated that the preparation of the ileum with multiple drill holes²⁴ in order to result in a bleeding bone bed which effectively facilitates graft incorporation.

In this current study, we had described a technique of graft and iliac preparation which enhances the area of cancellous bone contact between the graft and host bone. Moreover, the bevelled edge created by the osteotomy procedure that effectively allows impaction of the graft and achieves primary stability meaning that the screws provide supplementary fixation only. This enables the biological situation for efficient revascularisation and incorporation of the graft which in the end resulted in an increase in the bone stock and reduced resorption and failure rates in the longer term follow up period. *Ikeuchi et al*²¹ elaborated the use of a sliding iliac graft for acetabular reconstruction in DDH patients which used a similar osteotomy to the one that had been followed in this study. They obtained an excellent short-term outcome almost in 19 patients and noted quick incorporation of the graft secondary to the intimate host to graft contact stability followed by a lower rate of resorption. Therefore, the maximum thickness of the iliac graft was 14 mm, bounding the technique in more severe cases of dysplasia. This method that had been followed in this study retains the advantages of host-graft contact and stability without the possible limitation in available graft size. This study is basically not without any limitations. Firstly, we recommended and followed the use of cemented implants only due to the possible availability and expense. Secondly, this study lacks pre and postoperative clinical outcome scores which are partly due to the lack of cultural and language appropriate validated scoring instruments.

CONCLUSION

It is to be concluded that the current study has represented that this technical variation which combines an iliac osteotomy with the bulk autograft in the cases of developmental hip dysplasia has enabled early stability and reliable graft incorporation which when combined together with satisfactory clinical and radiological outcomes in the relatively short term. Longer term follow-up is in utmost necessity to reiterate the clinical success rate of this procedure.

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