Total hip arthroplasty with acetabular reconstruction using a bulk autograft for patients with developmental dysplasia of the hip results in high loosening rates at mid-term follow-up

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Abstract

Purpose Managing a deficient acetabulum in patients with developmental dysplasia of the hip (DDH) can be challenging. The purpose of the study was to determine the mid-term results of total hip arthroplasty (THA) using a bulk structural autograft for reconstruction of the acetabular roof in patients with DDH.

Methods Between 1982 and 1999, 112 patients underwent THA with acetabular roof-plasty using a bulk structural autograft for secondary osteoarthritis related to DDH. A total of 106 patients (115 hips) met inclusion criteria and were followed for an average of 11.6 years (seven to 24 years). The mean age was 52.5 years at the index operation. Clinical and radiological evaluations were performed according to the methods of Merle d'Aubigné and Postel, Johnston et al. and DeLee and Charnley.

Results The overall Merle d'Aubigné hip score significantly improved (3.7 vs 10.4, $p < 0.01$). The limb length discrepancy decreased from 30 to 6 mm ($p < 0.01$). The average distance that the hip centre was distalised was 22.3 mm (0–56 mm). However, radiolucent lines were observed in 27 % of patients at final follow-up, and the overall rate of revision for aseptic loosening was 16 %. Further, Kaplan-Meier survivorship curves predicted a rapid increase in the failure rate at 15 years.

Conclusions The mid-term functional outcome of THA with an acetabular roof-plasty using a bulk autograft is satisfactory; however, the long-term results are questionable.

Keywords Acetabular reconstruction · Total hip replacement · Acetabular dysplasia · Aseptic loosening · Structural bone graft

Introduction

The bony coverage of the acetabular component and location of the hip centre are important determinants of the long-term survivorship following total hip arthroplasty (THA) [1, 10]. In dysplastic hips, the craniocaudal diameter of the true acetabulum is enlarged, and the acetabulum becomes oval and shallow. Thus, when the acetabular component is implanted within the true acetabulum with an inclination of 45° and an anteversion of ~10°, the component may be undercovered. To solve the problem of a deficient acetabular roof, authors [7, 9, 10] have recommended: (1) increasing bony coverage using a bulk structural graft, (2) using tantalum metal augments or (3) placing the cup in a high hip centre position. Thus, the aim of this retrospective study was to determine the mid-term clinical and radiographic results of patients undergoing THA with reconstruction of the acetabular roof using a bulk structural autograft for treatment of developmental dysplasia of the hip (DDH). We hypothesised that, in accordance with the literature, the short-term outcomes of bulk autograft for acetabular reconstruction will be satisfactory; however, the long-term aseptic loosening rate would be high.

Patients and methods

The study was approved by the Ethics Committee at our institution. Between 1982 and 1999, 5,016 consecutive total hip arthroplasties were performed in our department. Of these, 112 consecutive patients underwent a THA with a concomitant reconstruction of the acetabular roof using a bulk structural

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autograft for management of a deficient acetabulum secondary to DDH. Of the 112 patients, 107 (96 %) were available for the study. Of the 107 consecutive patients (76 women and 30 men), 106 (115 hips) met inclusion criteria. One hip was excluded from this study due to septic loosening of the implants. The mean age at the time of index operation 52.5 years (range 34–80 years). The average follow-up time was 11.6 years (range seven to 24 years). All 115 hips displayed signs of DDH and were classified according to Hartofilakidis et al. [11]. Thirty-eight hips were dysplastic, but the femoral head articulated with the true acetabulum (group A). Sixty-nine (69) hips had a low dislocation (group B), while eight hips had a high dislocation (group C).

A bulk structural autograft that was contoured from the resected femoral head (after removal of the cartilage, if any) was placed in the prepared superolateral portion of the shallow acetabulum, fixed by two to three cancellous or cortical bone screws, according to the original paper by Harris et al. [10] (which was recommended first in Hungary by Udvarhelyi [23]) (Fig. 1). Once the deficient acetabulum was reconstructed, then a cemented or cementless acetabular component was implanted depending on the patient's bone quality, amount of native acetabular bone stock and surgeon preference.

During the post-operative physical examinations, the range of motion, walking ability and the presence/absence of a Trendelenburg gait was determined. Pain was determined according to the criteria of Merle d'Aubigné and Postel [3]. The limb length discrepancy (LLD) was measured both clinically and radiographically. All perioperative complications were recorded.

The radiographic evaluation was performed according to Johnston et al. [14] and Gruen et al. [9]. The pre-operative radiograph, the immediate post-operative radiograph (control) and the most recent X-ray were compared and evaluated. The degree of radiological loosening was measured in different zones (e.g. zones 1, 2 and 3) of the acetabulum according to

the method of DeLee and Charnley [4]. A decrease in the craniocaudal dimension of the graft on successive radiographs (aka graft collapse) and increasing thickness of the radiolucent layer in zone 3 were considered signs of a proximal migration of the cup.

Statistical analysis

The pre-operative to post-operative changes in outcome measures were statistically compared with a Student's *t* test. In addition, a Kaplan-Meier survival analysis was performed. Significance was set at $p < 0.05$ (Fig. 2).

Results

The mean overall Merle d'Aubigné hip score statistically improved from 3.7 (range 2–8) pre-operatively to 10.4 (range 3–12) post-operatively at final follow-up ($p < 0.01$); further, 68 patients had a good or excellent result. The mean walking ability score increased from a mean of 2.9 (range 1–4) pre-operatively to an average of 5.0 (range 2–6) post-operatively; the amount of pain decreased to 0.8 (0–5) post-operatively from 5.4 (1–6) pre-operatively. When examining the range of motion, the mean flexion range was 61° (range 0–125°) preoperatively and 86° (range 40–120°) at the follow-up. Abduction increased from 13° (range 0–40°) to 30° (range 10–45°).

In 83 % of cases, no perioperative complication(s) occurred. While 17 % of patients developed a minor or major complication, 11 % developed major complications including: a transient femoral or sciatic nerve palsy (4), deep venous thrombosis (4), non-fatal pulmonary embolus (2), femur fracture intra-operatively due to intra-operative manipulations (1) and deep infection (1).

A negative Trendelenburg gait pattern was seen post-operatively in 69 hips. In 21 patients, the Trendelenburg gait was negative both pre-operatively and at final follow-up; however, in 48 hips the pre-operative positive Trendelenburg gait became negative post-operatively.

The mean LLD was 30 mm (range 0–70 mm) preoperatively; however, post-operatively, the mean LLD was only 6 mm (range 0–30 mm) at the time of follow-up ($p < 0.01$). Further, radiographically, the mean distance that the hip centre was distalised was 22 mm (range 0–56).

The overall survivorship in terms of aseptic loosening was 84 %. Ten per cent of the hips demonstrated a radiolucent zone that was larger than 5 mm; all of these cups needed to be revised due to aseptic loosening. An additional 6 % of the cups required revision arthroplasty for aseptic loosening in the setting of smaller radiolucent zones (1–5 mm) with symptoms consistent with loosening (Fig. 3).

While 16 % of acetabular components required revision THA for aseptic loosening, an additional 11 % of hips had a

Fig. 1 Characteristic anteroposterior (AP) pelvic radiograph showing fixation of the femoral head autograft with two screws and washers with a cemented acetabular component

Fig. 2 Kaplan-Meier survival curve for all-cause revision

radiolucent line between 1 and 5 mm thick around the acetabular component; thus, only 73 % had no evidence of radiolucencies on their final follow-up radiograph.

Using Kaplan-Meier survivorship analysis for all-cause revision, THA with a bulk allograft for acetabular reconstruction has a predicted 80 % survival at 14 years; however, survival appears to dramatically decrease after 15 years post-operatively (Fig. 2).

Discussion

Managing a deficient acetabulum can be difficult, especially in DDH; a common option for reconstructing the acetabular

roof in cases of DDH is to use a bulk structural autograft with a cemented or cementless acetabular component. The purpose of this retrospective study was to determine functional and radiographic outcomes at mid-term follow-up of patients with DDH who underwent THA with acetabular roof reconstruction using a bulk autograft. Based on the results of our study, mid-term outcomes are satisfactory with overall survivorship of 84 % at 11 years; however, the loosening rates are high, and thus the survivorship between ten and 20 years will potentially dramatically decrease.

There are a number of limitations to this study. First, it is a retrospective study and thus inherently has some selection bias. However, this is minimised given we had >90 % clinical follow-up. Further, only eight patients in our cohort had high

Fig. 3 AP hip radiograph showing an example of a failed left cemented THA with bulk autograft reconstruction of the roof. A radiolucency is seen in zone 1–3, along with evidence of hardware failure, in the setting of symptomatic groin pain**Table 1** Published survival of THA with a bulk graft for acetabular reconstruction

Author	Follow-up (years)	No. of cases	Cup loosening (%)	Revision (%)
Gerber & Harris [8]	7.1	47	19	10
Mulroy & Harris [17]	11.8	46	46	20
MacKenzie et al. [16]	16.0	59	35	7
Numair et al. [18]	9.9	182	14 ^a /28 ^b	10 ^a /17 ^b
Shinar & Harris [20]	16.5	70	61	36
Sochart & Porter [21]	20.3	60	37	37
Bobak et al. [2]	11.0	45	12	0
Inao & Matsuno [13]	12.9	20	15	0
Tsukada & Wakui [22]	8.4	22	0	0
Saito et al. [19]	18.5	37	0	6
Kim & Kadowaki [15]	11.0	83	3	6
Hendrich et al. [12]	10.2	56	11	8

^a Low dislocation

^b High dislocation

dislocations pre-operatively. High hip dislocations have traditionally been regarded as the most difficult cases to treat; thus, our acceptable mid-term survivorship may be related to the patients in the cohort, and our failure rate would likely have been higher if more cases were high dislocations. Still, our cohort can be considered a “best-case” scenario for this particular procedure. In addition, while the survivorship is 84 % for all-cause revision, the failure rate will likely be significantly higher in the near future; in particular, 11 % of patients had radiolucent lines without clinical failure at the time of the study. Thus, we anticipate that some or all of those patients will eventually fail; however, because they had not been revised at the time of the manuscript, we cannot call them a failure at this time, and thus they are not reflected in the Kaplan-Meier survivorship curve. Finally, the study was underpowered to determine if there was a difference in between the non-cemented and cemented groups in terms of survival; thus, survival based on fixation was not assessed.

Still in our large cohort of patients, approximately two thirds of our patients had a good or excellent functional result. Further, two thirds of the patients had a negative Trendelenburg gait at final follow-up; the improved gait is likely related to the fact that the hip centre was distalised an average of 22 mm, thus restoring tension in the gluteals. However, we also had four patients who developed incomplete sciatic or femoral nerve palsies from lengthening; thus, while placing the acetabular component in the true acetabulum is often desired, the risk of nerve palsy does exist.

Finally, we had a survivorship that is similar to the published literature (Table 1). While a survivorship of 84 % at 11.6 years is promising, approximately 27 % of patients did have some degree of radiological loosening at final follow-up. This finding, in addition to the concerning Kaplan-Meier survivorship plot, suggests that survivorship may dramatically decrease between ten and 20 years post-operatively. Similar to our experience, Gerber and Harris [8 and Mulroy and Harris [17] initially published good results using a bulk graft for acetabular reconstruction at 7.1 years of follow-up; however, the revision rate was approximately doubled after an additional five years [8, 17]. As a result of this literature, some authors have begun using pedicled iliac graft with improved success [5, 6], while others have begun using tantalum metals when reconstructing the deficient acetabulum; however, long-term results on tantalum metals is lacking.

In conclusion, THA in addition to structural bulk autografting of the deficient acetabulum is an acceptable treatment option for patients with DDH and a deficient acetabulum. While the mid-term results are promising, caution should be used until long-term follow-up is obtained, given the high rates of radiographic loosening and the concerning survivorship plots between ten and 20 years post-operatively.

Conflict of interest The authors declare that they have no conflict of interest.

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