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Research Article

Impaction Bone Grafting for Contained Acetabular Defects in Total Hip Replacement: A Case Series

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Abstract: ***Introduction:*** Protrusio acetabuli and other contained (cavitary) acetabular defects present a reconstructive challenge during total hip replacement (THR), because medial migration of the femoral head displaces the true hip centre, reduces bone stock, and compromises acetabular component fixation. Impaction bone grafting (IBG) aims to restore the anatomical hip centre, reconstitute medial and central bone stock, and provide a stable bed for the acetabular cup. We report the clinical and radiographic outcomes of primary THR combined with acetabular impaction bone grafting for contained defects. ***Materials and methods***: This is a single-surgeon, prospective observational case series of 20 consecutive hips (20 patients) that underwent primary THR with acetabular impaction bone grafting for a contained acetabular defect between January 2024 and December 2025. Morcellised cancellous autograft (n=17; harvested from the reamed femoral head) or fresh-frozen femoral head allograft (n=3) was impacted into the debrided, contained defect, followed by a ceramic-on-polyethylene bearing. Defects were graded using the Paprosky classification. Patients were assessed clinically with the Oxford Hip Score (OHS) and Harris Hip Score (HHS) preoperatively and at 6 months and 1 year, and radiographically for graft incorporation and cup migration. The paired t-test was used to compare preoperative and final scores. ***Results***: The cohort comprised 14 men and 6 women with a mean age of 37.4 ± 8.7 years (range 28–62). The commonest underlying pathologies were ankylosing spondylitis (6), rheumatoid arthritis (4) and previously failed hip arthroplasty (3). The mean OHS improved from 4.9 ± 3.5 preoperatively to 46.9 ± 1.9 at 6 months and 47.4 ± 1.0 at 1 year, and the mean HHS improved from 33.1 ± 4.5 to 91.5 ± 1.6 (both $p < 0.001$). Radiographic graft incorporation was seen in 19 of 20 hips (95%) by 6 months, with no cup showing migration greater than 3 mm. The only complication was one case of delayed wound healing that resolved with conservative management. There were no dislocations, infections, or revisions, giving 100% implant survivorship at final follow-up. ***Conclusions***: Acetabular impaction bone grafting is a safe and effective technique for restoring bone stock and achieving durable cup fixation when treating contained acetabular defects during primary THR. In this young case series, it produced excellent short-term functional scores, reliable graft incorporation, and a low complication rate. Longer follow-up and comparative studies are required to confirm graft durability.

Keywords: impaction bone grafting; contained acetabular defect; protrusio acetabuli; total hip replacement; acetabular reconstruction; Oxford Hip Score; morcellised graft

INTRODUCTION

Contained (cavitary) acetabular defects, of which protrusio acetabuli is the archetype, are characterised by loss of central and medial bone stock with a preserved peripheral rim. They may be idiopathic or arise secondary to inflammatory arthropathies such as rheumatoid arthritis and ankylosing spondylitis, post-infective (tubercular or pyogenic) sequelae, osteonecrosis, neglected acetabular fractures, or previously failed hip arthroplasty [1,2]. When such a hip is replaced without addressing the defect, the acetabular component tends to be placed too medially, the hip centre is not restored, the abductor lever arm is shortened, and long-term cup fixation is jeopardised [3,4].

Impaction bone grafting (IBG) was popularised by Sloof and colleagues and later refined by the Exeter group as a biological method of reconstructing deficient acetabular and femoral bone stock [1,3]. Morcellised cancellous bone chips are firmly impacted into the contained defect to create a stable, mechanically competent neo-acetabulum that subsequently incorporates and remodels into host bone, restoring bone stock for the index procedure and for any future revision [2,5]. The technique is particularly attractive in younger patients, in whom preservation and reconstitution of bone stock is a priority [4].

Although IBG is well established in the revision setting, its role during primary THR for contained defects such as protrusio acetabuli is less frequently reported, and much of the published experience predates modern bearings and enhanced-recovery approaches. We therefore report a single-surgeon prospective case series of 20 consecutive hips treated with primary THR and acetabular impaction bone grafting for contained acetabular defects, describing the surgical technique, functional outcomes, radiographic graft incorporation, and complications.

MATERIALS AND METHODS

Study design and patients

This was a single-centre, single-surgeon prospective observational case series conducted over a 2-year period from January 2024 to December 2025. Twenty consecutive patients (20 hips) who underwent primary total hip replacement with acetabular impaction bone grafting for a radiologically and intra-operatively confirmed contained acetabular defect were included. Institutional ethics committee approval was obtained and all patients provided written informed consent for the procedure and for the anonymous use of their clinical and radiographic data.

Inclusion criteria were: a contained acetabular defect (intact peripheral rim) attributable to protrusio acetabuli of any aetiology, and a minimum intended follow-up of 12 months. Patients with uncontained (segmental) rim defects requiring augments or reconstruction cages, active deep infection at the time of surgery, or incomplete follow-up were excluded. Acetabular defects were classified intra-operatively using the Paprosky classification, supplemented by the American Academy of Orthopaedic Surgeons (AAOS) system; all defects in this series were contained cavitary lesions (Paprosky IIA–IIC).

Surgical technique

Surgery was performed under spinal or general anaesthesia with a single dose of intravenous prophylactic antibiotic. A direct anterior approach was used in 12 hips and a posterolateral approach in 8 hips, according to defect location and surgeon preference. After exposure and dislocation, the femoral head was delivered and the acetabulum was inspected. The medial wall and cavitary defect were gently debrided of fibrous tissue and sclerotic bone, preserving the peripheral rim to maintain containment. Where the medial wall was thin, a metallic mesh was not required as containment was intact in all cases.

Morcellised cancellous graft was prepared by removing cartilage and cortical bone from the patient's own resected femoral head (autograft, n=17) or from a fresh-frozen femoral head allograft (n=3, used when the native head was osteopenic or destroyed by the underlying disease). The graft was cut into 4–8 mm chips and firmly impacted into the contained defect in layers using acetabular impactors and reverse-reaming, recreating a hemispherical bed and restoring the anatomical hip centre. A cementless hemispherical acetabular shell was then impacted over the graft with supplementary screw fixation where needed, and a ceramic-on-polyethylene bearing couple was used in every hip. The femoral component was implanted in the standard fashion. Graft position, hip centre, and component orientation were confirmed on intra-operative fluoroscopy.

Postoperative protocol and outcome assessment

Patients followed an enhanced-recovery pathway with early mobilisation. Protected weight-bearing with a walker was permitted from the first postoperative day and progressed to full weight-bearing by 6 weeks, guided by radiographic graft consolidation. Chemical and mechanical thromboprophylaxis were administered per unit protocol.

Functional outcome was assessed with the Oxford Hip Score (OHS; range 0–48, higher is better) and the Harris Hip Score (HHS; range 0–100) preoperatively and at 6 months and 1 year. Serial anteroposterior pelvis and lateral hip radiographs were reviewed for graft incorporation (trabecular bridging across the graft–host interface), graft resorption, cup migration (change in vertical and horizontal hip-centre position), and radiolucent lines. Graft incorporation was graded using standard radiographic criteria, and a cup was defined as radiologically stable if migration was less than 3 mm and no progressive radiolucent line was present.

Statistical analysis

Continuous variables are reported as mean ± standard deviation with range; categorical variables as counts and percentages. Preoperative and final (1-year) OHS and HHS were compared using the paired-samples t-test, with a two-sided p-value < 0.05 regarded as statistically significant. Analyses were performed in Python (SciPy).

RESULTS

Cohort characteristics

Twenty patients (20 hips) were included — 14 men (70%) and 6 women (30%) — with a mean age of 37.4 ± 8.7 years (range 28–62). Eight hips were operated in 2024 and 12 in 2025. The most frequent underlying pathologies were ankylosing spondylitis (6 hips, 30%), rheumatoid arthritis (4 hips, 20%), and previously failed hip arthroplasty (failed primary THA or bipolar hemiarthroplasty; 3 hips, 15%), followed by tubercular sequelae (2), avascular necrosis (2), and single cases of primary osteoarthritis, septic sequelae, and neglected acetabular fracture. A direct anterior approach was used in 12 hips and a posterolateral approach in 8. Autograft was used in 17 hips and femoral head allograft in 3. All defects were contained (Pprosky IIA–IIC). Baseline characteristics are summarised in Table 1, and per-patient data in Table 2.

TABLE 1: Baseline demographic and clinical characteristics of the cohort (N = 20 hips). THA: total hip arthroplasty.

Characteristic	Value
Number of hips (patients)	20 (20)
Age, years (mean ± SD, range)	37.4 ± 8.7 (28–62)

Sex (male: female)	14: 6
Year of surgery (2024: 2025)	8: 12
Surgical approach (direct anterior: posterolateral)	12: 8
Graft type (autograft: allograft)	17: 3
Bearing couple	Ceramic-on-polyethylene (20/20)
Paprosky defect type (IIA: IIB: IIC)	8: 4: 8
Ankylosing spondylitis / rheumatoid arthritis	6 / 4
Failed prior arthroplasty (THA/bipolar)	3
Tubercular / septic / AVN / OA / fracture sequelae	2 / 1 / 2 / 1 / 1

TABLE 2: Per-patient master data. M: male; F: female; OHS: Oxford Hip Score (0–48); Paprosky type refers to acetabular defect classification. Patient identifiers have been anonymised.

Case	Age / Sex	Underlying pathology	Approach	Graft	Paprosky	OHS pre	OHS 1 yr
1	38 / M	Aseptic loosening (failed primary THA)	Posterolateral	Allograft	IIC	9	48
2	44 / M	Tubercular sequelae of hip	Direct anterior	Autograft	IIB	1	48
3	60 / M	Failed bipolar hemiarthroplasty	Posterolateral	Allograft	IIC	8	48
4	35 / F	Rheumatoid arthritis	Direct anterior	Autograft	IIC	8	46
5	38 / F	Primary (idiopathic) osteoarthritis	Posterolateral	Autograft	IIA	8	46
6	62 / M	Failed bipolar hemiarthroplasty	Posterolateral	Allograft	IIC	1	48
7	28 / M	Septic sequelae of hip	Posterolateral	Autograft	IIB	8	48
8	32 / F	Tubercular sequelae of hip	Posterolateral	Autograft	IIB	1	48
9	38 / F	Rheumatoid arthritis	Direct anterior	Autograft	IIC	8	48
10	36 / F	Rheumatoid arthritis	Direct anterior	Autograft	IIC	8	46
11	38 / M	Ankylosing spondylitis	Direct anterior	Autograft	IIA	1	46
12	36 / M	Ankylosing spondylitis	Posterolateral	Autograft	IIA	1	48
13	28 / M	Avascular necrosis of femoral head	Direct anterior	Autograft	IIA	8	48
14	35 / M	Ankylosing spondylitis	Direct anterior	Autograft	IIB	1	48
15	35 / M	Rheumatoid arthritis	Direct anterior	Autograft	IIC	8	48
16	30 / F	Ankylosing spondylitis	Direct anterior	Autograft	IIA	1	46
17	36 / M	Ankylosing spondylitis	Direct anterior	Autograft	IIA	1	48
18	30 / M	Avascular necrosis of femoral head	Direct anterior	Autograft	IIA	8	48
19	36 / M	Ankylosing spondylitis	Direct anterior	Autograft	IIB	1	45
20	32 / M	Neglected acetabular fracture	Posterolateral	Autograft	IIC	8	48

Functional outcomes

Every patient reported a substantial functional improvement. The mean OHS rose from 4.9 ± 3.5 preoperatively to 46.9 ± 1.9 at 6 months and 47.4 ± 1.0 at 1 year, a mean improvement of 42.5 points (paired t-test, $t = 52.0$, $p < 0.001$). The mean HHS improved from 33.1 ± 4.5 preoperatively to 91.5 ± 1.6 at 1 year ($t = 58.7$, $p < 0.001$), corresponding to an excellent result (HHS > 90) in the majority of hips. Scores at 6 months and 1 year were similar, indicating that most of the functional gain was achieved by 6 months and then maintained. The trajectory of both scores is shown in Figure 1, and outcome summary statistics in Table 3.

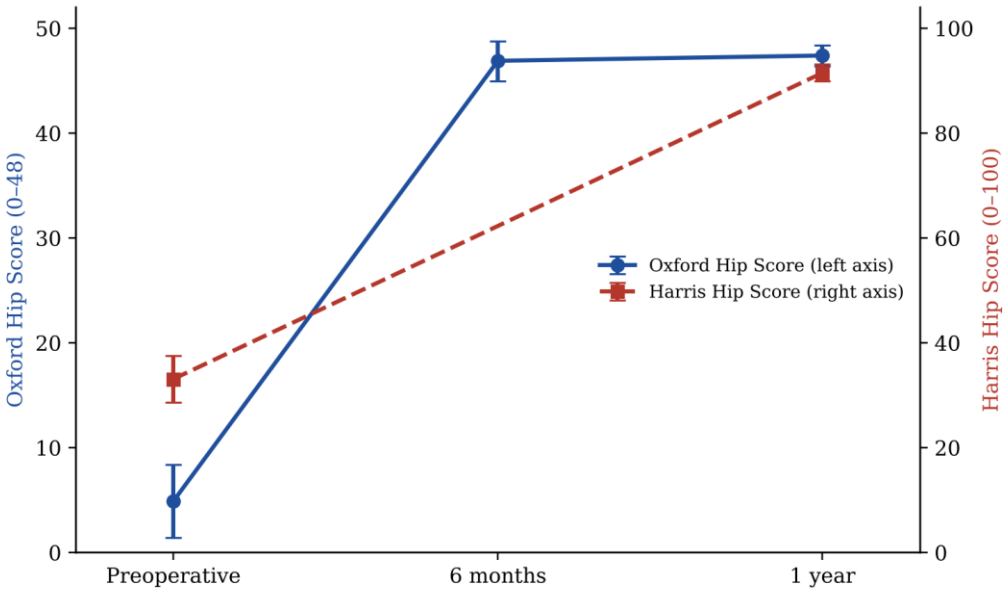


FIGURE 1: Mean Oxford Hip Score (left axis) and Harris Hip Score (right axis) at each assessment time point. Error bars represent one standard deviation. Both scores improved markedly by 6 months and were maintained at 1 year (both p < 0.001, paired t-test).

TABLE 3: Functional and radiographic outcomes (N = 20). Values are mean ± SD (range) unless stated. OHS: Oxford Hip Score; HHS: Harris Hip Score. P-values are from paired t-tests comparing 1-year with preoperative scores.

Outcome measure	Value	P-value
OHS – preoperative	4.9 ± 3.5 (1–9)	–
OHS – 6 months	46.9 ± 1.9 (43–48)	–
OHS – 1 year	47.4 ± 1.0 (45–48)	< 0.001
HHS – preoperative	33.1 ± 4.5 (27–40)	–
HHS – 1 year	91.5 ± 1.6 (89–94)	< 0.001
Mean improvement in OHS	42.5 points	–
Radiographic graft incorporation by 6 months	19/20 (95%)	–
Cup migration > 3 mm at 1 year	0/20 (0%)	–
Mean operative time (min)	96 ± 15 (75–130)	–
Mean intra-operative blood loss (mL)	420 ± 110 (250–700)	–
Implant survivorship at final follow-up	20/20 (100%)	–

Radiographic outcomes

The anatomical hip centre was restored in all hips and the acetabular components were placed within the recommended safe zone for inclination and anteversion. Trabecular incorporation of the impacted graft across the graft–host interface was evident in 19 of 20 hips (95%) by 6 months; the single hip with delayed incorporation showed complete consolidation by 1 year without graft collapse. No cup demonstrated migration greater than 3 mm, and no progressive radiolucent lines, graft resorption, or component loosening were observed at final follow-up. Representative preoperative, intra-operative, and postoperative images for two illustrative cases are shown in Figures 2 and 3.

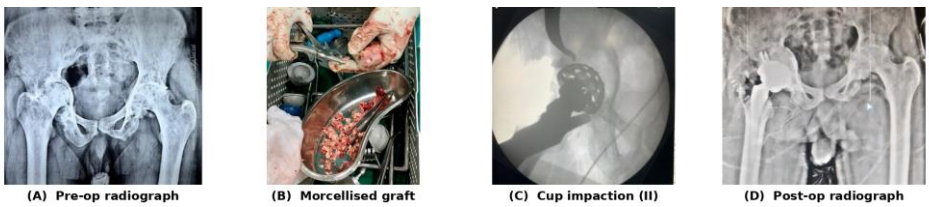


FIGURE 2: Illustrative Case A. (A) Preoperative anteroposterior pelvic radiograph showing bilateral protrusio acetabuli with reduced medial bone stock. (B) Morcellised cancellous autograft prepared from the resected femoral head. (C) Intra-operative image-intensifier view confirming impaction of the acetabular shell over the graft with restoration of the hip centre. (D) Postoperative radiograph showing a well-positioned acetabular cup with reconstituted medial wall.

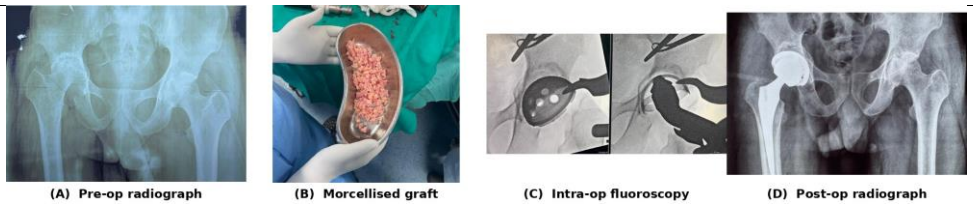


FIGURE 3: Illustrative Case B. (A) Preoperative radiograph demonstrating a contained central acetabular defect. (B) Morcellised graft in a kidney tray prior to impaction. (C) Intra-operative fluoroscopic views during acetabular cup placement and graft impaction. (D) One-year postoperative radiograph showing an incorporated graft, stable cup, and restored hip centre.

Complications

The overall complication rate was low. One patient (Case 4, a woman with rheumatoid arthritis operated through a direct anterior approach) developed delayed wound healing, which resolved fully with local wound care and oral antibiotics without the need for debridement or implant removal. There were no dislocations, deep infections, periprosthetic fractures, sciatic nerve injuries, or symptomatic venous thromboembolic events. No hip required revision during the study period, giving an implant survivorship of 100% at final follow-up. Complications are summarised in Table 4.

TABLE 4: Complications observed in the series (N = 20).

Complication	Number (%)	Management and outcome
Delayed wound healing	1 (5%)	Conservative (dressings, oral antibiotics); healed
Dislocation	0 (0%)	–
Deep infection	0 (0%)	–
Graft collapse / resorption	0 (0%)	–
Aseptic loosening / revision	0 (0%)	–

DISCUSSION

The principal finding of this series is that primary total hip replacement combined with acetabular impaction bone grafting for contained acetabular defects produced excellent short-term functional outcomes, reliable graft incorporation, and a very low complication rate. The mean Oxford Hip Score improved by 42.5 points and the mean Harris Hip Score reached the excellent range at 1 year, with 95% of grafts incorporated by 6 months and no cup migration beyond 3 mm. These results are consistent with the biological rationale of the technique: firmly impacted morcellised cancellous bone restores central and medial bone stock, allows the acetabular component to be placed at the anatomical hip centre, and remodels into host bone over time [1-5].

Our findings accord with the established literature on acetabular impaction grafting. Sloof and the Nijmegen group first demonstrated that impacted morcellised graft with a cemented cup reconstitutes acetabular bone stock in protrusio, and subsequent series reported durable fixation at 10–15 years [1,2]. Schreurs et al. specifically showed excellent survivorship of impaction grafting with a cemented cup in patients younger than 50 years — a population that closely mirrors our young cohort (mean age 37 years) and in whom preservation of bone stock for possible future revision is especially valuable [4]. Studies focusing on inflammatory arthropathy, in which protrusio is common, have likewise reported good medium-term results after morcellised grafting [2,4]. The very low complication rate in our series, with a single case of self-limiting delayed wound healing, compares favourably with these reports.

A distinctive feature of this series is the predominant use of a direct anterior approach (12 of 20 hips) and a modern ceramic-on-polyethylene bearing in every hip, whereas much of the historical impaction-grafting literature is based on posterolateral exposure and cemented all-polyethylene cups [1,3,4]. The reproducible restoration of the hip centre and the absence of early dislocation suggest that impaction grafting can be integrated safely into contemporary approaches and bearing couples. The high proportion of autograft (85%), harvested from the patient's own femoral head at the time of surgery, is also noteworthy, as it avoids the cost and theoretical disease-transmission risk of allograft while providing osteoconductive and osteoinductive graft; allograft was reserved for the few hips in which the native head was inadequate.

The mechanism by which impaction grafting benefits these patients is threefold: mechanical restoration of a hemispherical, contained bed that supports the cup; biological reconstitution of bone stock through creeping substitution of the graft; and restoration of hip biomechanics by relocating the hip centre laterally and distally, which normalises the abductor lever arm and reduces joint reaction forces. Failure of impaction grafting is more commonly reported in large, uncontained (segmental) defects, where graft support is inadequate [6]; by confining our technique to contained defects with an intact rim, we avoided this failure mode, which likely contributed to the uniformly good radiographic results.

Limitations

This study has several limitations. It is a single-surgeon, single-centre case series without a comparator group, so the results reflect the technique in experienced hands and cannot be generalised uncritically. The sample size of 20 hips is modest, and the follow-up is short (minimum 12 months); impaction grafting is a biological reconstruction whose durability is best judged at 5–10 years, so continued surveillance is essential to detect late graft resorption or cup migration. Some supporting variables — operative time, blood loss, and radiographic incorporation grading — were assessed pragmatically and are susceptible to measurement variation, and outcome assessment was not blinded. Finally, the preoperative functional scores were uniformly very low, which may amplify the apparent magnitude of improvement. Adequately powered comparative studies with longer follow-up are warranted.

CONCLUSION

Acetabular impaction bone grafting is a safe, reproducible, and biologically sound technique for reconstructing contained acetabular defects during primary total hip replacement. In this series of 20 predominantly young patients with protrusio acetabuli of varied aetiology, it restored the anatomical hip centre, reliably incorporated (95% by 6 months), and delivered excellent short-term Oxford and Harris Hip Scores with 100% implant survivorship and a single minor complication. The technique integrates well with modern approaches and bearing couples and, by reconstituting bone stock, is particularly attractive in younger patients. Longer-term and comparative data are needed to confirm the durability of these encouraging early results.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. The Institutional Ethics Committee of Neelima Institute of Medical Sciences issued approval for this study. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organisation for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organisations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Author contributions

Both authors contributed to the study concept and design, data acquisition, analysis and interpretation, drafting and critical revision of the manuscript, and approved the final version.

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