

# Singh's Sandwich Technique (SST): A Novel Method in Management of Neglected Acetabular Fractures

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**Abstract: Background:** Neglected acetabulum fractures are still encountered, especially in developing countries and the consequences have adverse impact on the quality of life of such patients. The present study is on management of Neglected Acetabular Fractures using Primary Complex THR with impaction grafting using Singh's Sandwich Technique (SST), which is a newer technique of acetabular reconstruction.

**Material and Methods:** This was a prospective study conducted in a tertiary care hospital for a period of four and half years in thirty patients presenting with acetabular fractures later than 3 weeks after injury or those inappropriately treated.

**Results:** There were 30 patients, with 26 (86.7%) males and 4 (13.3%) females. Right side was involved in 16 (53.3%) patients. Mean weight of the patients was  $69.03 \pm 9.32$  Kgs, Mean height  $166.33 \pm 5.82$  cms, and mean BMI  $23.64 \pm 3.14$  Kg/m<sup>2</sup>. Mean time to full weight bearing mobilization was 7.2 months. The median Harris Hip score rating was 1 pre-operatively, 74 at 6 weeks, 90 at three, 94.5 at 6 months, 96 at 9 months, 98 at 1 year and 2 years each post-operatively. Radiological examinations post-operatively showed no osteolysis, interface gap and demarcation gap in any of the patients at follow up.

**Conclusions:** This Singh's Sandwich Technique can be used for acetabular reconstruction in the management of neglected acetabular fractures with much confidence providing a unique advantage of more bone stock.

**Keywords:** Neglected Acetabular Fractures, Singh's Sandwich Technique.

## 1. Introduction

Acetabular fractures usually occur in vehicle collision accidents, often a result of high speed and high impact trauma. Patients usually present with multiple trauma and a complex clinical condition. This, in addition to limited access to the fracture site and limited availability of implants make them one of the difficult fractures in orthopedic practice, which is further compounded if the patients present late for treatment. For fractures presenting after six weeks of injury, surgery becomes inevitable and the outcome may also be compromised [1].

Neglected fractures of the acetabulum have been defined as those fractures that present after three weeks from the time of injury [2, 3]. Post-traumatic arthritis of the hip can develop in 12-57% of patients after an acetabular fracture [4]. Mal-union is one commonly encountered obstacle in the management of

neglected acetabular fractures. The fractured fragments, which are abnormally united, are difficult to reduce though not impossible. In addition, there could be formation of callus and increased vascularity leading to significantly increased intra-operative blood loss and organized non-unions too. In neglected fractures or following improper fixation, avascular necrosis, incarceration of sciatic nerve, innominate bone deformity [5], impaired musculature [6], secondary osteoarthritis and/or heterotrophic ossification can also occur. In such cases, Open Reduction and Internal Fixation (ORIF) might not be ideal and Total Hip Replacement (THR) is required. Moreover, THR often requires major acetabular reconstruction. This leaves the surgeon with only salvage procedures like THR or excision hip arthroplasty. Altered anatomy and hip centre, acetabular bone deficit, difficulty in achieving long-term fixation of the acetabular shell and risk of nerve injury are some of the challenging obstacles for THR [7].

Various studies reported different methods for operative treatment of neglected fracture-dislocations including the use of a sub-trochanteric osteotomy, the Girdle stone procedure, hip arthrodesis, hemi arthroplasty and THR [8]. All these procedures have their merits and give different outcomes. The results can further be altered by avascular necrosis of the femoral head which occurs in more than 50% of these cases [9]. Earlier studies emphasized that the most difficult but most important stage of operation is creating a sufficiently stable bone stock for the acetabular shell [7].

Neglected cases are still encountered, especially in developing countries [10] and the consequences have adverse impact on the quality of life of such patients [3], in terms of functional outcome, pain, activities of daily living etc. In displaced acetabular fractures, the occurrence of osteoarthritis is high (13%) even after achieving satisfactory reduction by ORIF, and the incidence increases further more markedly (44%) with unsatisfactory reduction [11]. With respect to THR, post-traumatic arthritis following acetabular fractures are more prone to go for revision compared to non-traumatic arthritis of the hip [12,13].

However, the ultimate aim of management in acute or neglected acetabular fractures is to achieve satisfactory reduction/reconstruction and as good functional outcome as

possible, with no or least possible complications. Hence, this study was done to evaluate a novel method of Acetabular Impaction Grafting (Singh's Sandwich Technique –SST) in Neglected Acetabular Fractures.

## 2. Material and methods

It was a prospective study conducted in a tertiary care hospital for a period of four and half years (April 2014 to Oct 2018). All the patients presenting with acetabular fractures later than 3 weeks after injury or those inappropriately treated were included in the study. The patients with pathological fractures, age below 18 years, polytrauma with involvement of other systems, patients who did not consent for the study and who were unfit for surgery were excluded from the study. Thirty-four patients presented with neglected acetabular fractures during the study period, of whom 30 patients satisfied the inclusion criteria and consented for participation in the study. A predesigned, pretested questionnaire was used to collect data. The questionnaire had questions about the socio – demographic, clinical and surgical details. Clinical history and examination was done. Body Mass Index (BMI) was classified using the WHO recommendations. The study was approved by the institutional ethics committee.

All subjects were subjected to preoperative pelvic x-rays (AP and Judet views) and non-contrast pelvic CT-scans with 3-dimensional reconstruction. Paprosky classification was used to classify acetabular bone loss as it helps in identifying the severity of bone loss and determines the necessary fixation<sup>14</sup>. All the study participants were assessed pre-operatively with a complete medical evaluation.

### A. Sandwich technique

This technique works on the principle of inserting a cancellous bone graft as a sandwich, which provides greater mechanical stability to joint and retains more bone stock. This technique relies on the ability to gain biological fixation of the underlying host bone. This is useful in situations where the highest osteogenic capacity is required, for example to fill cavitory and contained segmental defects such as those encountered in neglected acetabular defects.

#### *Steps followed in Sandwich Technique:*

**Surgical Procedure:** All cases were done with posterolateral approach. Sciatic nerve isolation was done. Dislocation of the hip was done and in difficult cases and a small overhanging portion of the posterior acetabular wall was removed to facilitate dislocation. In some cases, the head was incarcerated within the acetabulum that made dislocation impossible. In these cases, the neck was osteotomized in situ at the appropriate angle. Considerable soft tissue release of the proximal femur was necessary to deliver the end of the femur out of the depth of the wound. The head was removed from the acetabulum with a corkscrew or a threaded pin in a hand drill. If the head was more firmly fixed in the acetabulum, it was sectioned and then removed piecemeal. The thin medial wall of the acetabulum,

which may also be membranous, was not penetrated. Therefore, instead of medial reaming, the cartilage and soft tissues were removed with a curette. The smooth, sclerotic floor was then roughened with a curette or chisel and care was taken not to penetrate into the pelvis. Intraoperatively, Transverse Acetabular Ligament was identified and fibrosed material was removed. Intraoperative Fluoroscopic analysis was done to assess the defect, more importantly the posterior column. Reamer was carefully used.

### B. Graft Preparation

We used a mixture of bone milling and bone chips of various sizes (slurry to 1 cm bone chips). Femoral head was cut into two halves (approximately 5mm larger than the defect) and the cartilaginous part was removed (Figure 1). After the defect was fully visualized, 2-4 slices of cancellous bone were taken and the rest were used as morsellized graft (8-10 mm<sup>3</sup>) which were inserted and packed (Figure 2). Hence, the cancellous bone slices are incorporated like a sandwich in the defect in addition to underlying and over laying bone chips and/or reverse reamed. It was ensured that the bone chip sizes were not greater than this as the construct would not be stable to the torsional forces of the joint and prove detrimental. Later, impaction was done. This process was repeated until the defect had been additionally reconstructed. At the end of impaction process, a stable bed of bone was achieved which had an appearance similar to a cobble stone pathway<sup>5</sup>. Following impaction (Figure 3) and containment (Figure 4) was achieved.

Post – operatively, the patients were mobilized the next day following surgery using walker and crutches. Weight bearing was practiced slowly as a tolerated program. The patients were discharged when safe to go home. Weight bearing was not allowed immediately. Follow up was arranged at intervals of 6 weeks, 3 months, 6 months, 9 months, 1 year and 2 years. During each visit, patients were assessed for functional outcome using Harris Hip score and radiologically for osteolysis, interface gap, demarcation lines, calcar modeling, migration, subsidence and stem A, B and C.

The Statistical analysis was done using the of IBM SPSS Software Version 17. Categorical variables were expressed in percentages and proportions while mean and standard deviation were used to express continuous variables. Association between continuous variables are determined using Wilcoxon signed rank test. A 'p' value of < 0.05 was considered statistically significant.

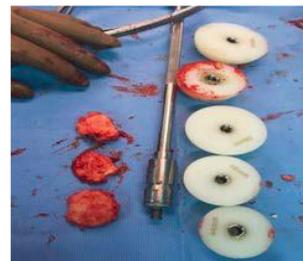


Fig. 1. Femoral Head Slices



6 months follow up. Mean time to graft incorporation was 5.4 months. There was no osteolysis, interface gap and demarcation gap in any of the patients at follow up radiological examinations post – operatively (Table 2). Calcar modeling, migration and subsidence were unable to be determined. There were no stem A and stem B while stem C was neutral in all patients. (Fig. 4 and Fig. 5).

#### 4. Discussion

Neglected acetabular fractures are those that remain untreated for more than 3 weeks after injury and present later. They may have poor clinical and radiological outcome<sup>23</sup>. The delay in management could be because of various reasons like lack of trained surgeons [17], insufficient intensive care unit beds [17], discrepancy in the referral system [7], economic incapacity, poor medical health, osteoporosis, poor soft tissue conditions, open injuries or comminuted fractures [18]. In the present study, 90% of the implants used were Uncemented and results have been favorable, which is consistent with the findings of Sporer SM et.al. [19], who reported favorable reports using Uncemented cups with a minimum 10 year follow up.

In the study conducted by Iotov et al. [20]. in 14 patients with neglected acetabular fractures (older than 3 months) treated with total hip arthroplasty, five had non–union, four had previous hip dislocation, three had protrusion and almost all patients had cavitory bone defect / local bone defect. Unlike the present study, Cemented cup was mostly used (12 patients) and Uncemented cup was used only in two patients. Cemented stem was used in ten cases and Uncemented in four cases. In order to provide adequate bone stock, they used techniques like approximate reduction and fixation, periacetabular osteotomy, structural or morcellized bone grafting. Surgery took a long duration of 3 – 7 hours and blood loss was about 850 – 2,200 ml. The mean Harris hip score showed significant improvement to 78 post – operatively compared to 54 pre – operatively, which is consistent with the present study showing mean Harris hip score of 4.93 pre – operatively and 97.88 post – operatively. The functional outcome was reasonably good with only 21.4% patients needing revision procedure within the follow – up period of 16 – 94 months. However, BellaBarba et. al. [21] reported that conventional hip replacement had comparatively better results than the late results of total hip replacement in neglected acetabular fractures.

Gavaskar A. S. et. al. used Uncemented components for the reconstruction of supportive columns and the posterior wall with bone grafts and reported better outcomes in their study. Several studies have shown that cancellous grafting and cementless THR in neglected acetabular fractures showed well integrated components and bone grafts radiologically with no evidence of aseptic loosening or osteolysis [21].

Sundaresh DC et. al. [16], concluded that neglected hip dislocation with acetabular fracture can be managed satisfactorily with Uncemented THR. Bone reconstruction using chunk grafts and use of cementless components prolongs

longevity and preserves adequate bone stock for revision, especially in young patients. Iotov et. al. concluded that the most difficult but most important stage of operation is creating a sufficiently stable bone stock for the acetabular shell. In non–union, bone healing is essential. While small gap may be filled with bone graft, large fracture gaps need to be approximated and stabilized. Stable osteosynthesis helps overcome the instability. Hence, they suggested cemented fixation with reinforcement ring as the most secure way to provide strong cup anchorage, while Uncemented press-fit cup may be used in cases with lesser initial displacement.

Using the Harris hip score, at the two-year follow up, clinically significant results were obtained in 100 % of the patients in the present study. Two other case reports showed that at the two-year follow-up, the patient had pain-free, stable hip and an unaided gait with a Harris hip score of 82 and the patient had one centimeter of shortening, for which a shoe rise was used. The same patient radiologically showed consolidated bone grafts and no radiolucent areas or osteolysis [22, 23].

Previous studies using cemented implants for THR in neglected acetabular fractures have showed satisfactory functional outcomes, though aseptic loosening rates were high. Newer Uncemented implants have also shown satisfactory functional and radiological outcomes with reduced loosening rates in neglected acetabular fractures that are comparable to THR for non-traumatic arthritis [4].

The controversy remains about the use of the type of implant, cemented or Uncemented. However, the surgeons emphasize preserving adequate bone stock to be available later in revision surgery if required.

The advantages of the Novel Singh's Sandwich Technique are:

Results are Encouraging.

- Average blood loss is minimal (650 ml or less).
- No iatrogenic injury.
- No usage of any Cages/ re-enforcement rings.
- A very stable construct with no radiological evidence of loosening/osteolysis (Figures 6 to 11).
- Statistically significant functional outcome.
- Unique advantage of this method is the more bone stock that will be available if a further surgery is required which is not available with other currently followed techniques.
- More stability could be obtained with a combination of chips and wafers of femoral head (Long term Results Awaited).



Fig. 6. Immediate Post-Operative X-Ray (AP View)



Fig. 7. Immediate Post-Operative X-Ray (Lateral View)

*X-Rays of an illustrative case:*



Fig. 8. Immediate post-operative



Fig. 9. Immediate post-operative



Fig. 10. At one-year follow-up



Fig. 11. At two year follow up

### 5. Conclusion

Various techniques have been tried to manage neglected acetabular fractures with Cemented and Uncemented implants. However, the prime concern of the surgeon has always been to achieve acetabular reconstruction with a stable osteosynthesis and preserving adequate bone stock. The ultimate expectation is a good radiological and functional outcome. Along with a good functional outcome, this Singh's Sandwich Technique has been proved to have a very stable construct with no radiological evidence of loosening/osteolysis and a unique advantage of more bone stock that will be available if a further surgery is required. In addition, it is emphasized that bony acetabular reconstruction by Singh's Sandwich Technique makes use of primary hip components, ensuring improved prosthesis longevity and preserving bone stock for a future revision. Thus, the Singh's Sandwich Technique can be used for acetabular reconstruction in the management of neglected acetabular fractures with much confidence.

The limitations of this study were that it was done with a small sample size and at a single center. There were no controls in the study. However, the results of this study were compared with results from previous studies. Multi-centric studies with larger samples are recommended to have more evidence regarding Singh's Sandwich Technique in the management of neglected acetabular fractures.

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