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Original article

Can salter osteotomy correct late diagnosed hip dysplasia: A retrospective evaluation of 49 hips after 6.7 years?

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ABSTRACT

Background: Surgical treatment of late diagnosed development dysplasia of the hip (DDH) remains challenging with several methods being described. We therefore retrospectively evaluated the outcome of salter innominate osteotomy (SIO) in patients with fully-grown bone, to evaluate whether this surgical procedure allows sufficient acetabular correction.
Material and methods: Between 2004–2012 SIO had been performed in 45 patients (49 hips) with late diagnosed DDH. The evaluation included pre- and postoperative radiographs ($n = 49$), the complication rate ($n = 49$) and the clinical outcome (WOMAC, HHS, UCLA) ($n = 34$).
Results: Mean age at surgery was 27.6 (16–51) with a follow-up of 6.7 ± 2.7 (0.9–11.0) years. Radiologically, a good acetabular correction with a significant improvement of the Center Edge angle (15.4° to 34.9°), sharps angle (45.7° to 32.0°) and migration percentage (33.2% to 14.4%) ($p < 0.001$) was found. Clinical results revealed a WOMAC of 13.9 ± 13.3, UCLA of 7.8 ± 2.1 and HHS of 85.0 ± 11.8. Complications were noted for 10 patients (20%) with 7 (14%) requiring revision.
Conclusion: The results demonstrated that SIO achieved a satisfying acetabular correction and good clinical results in late diagnosed DDH. It therefore might be an option in some cases, although periacetabular osteotomy techniques are currently preferable used as they allow a wider range of acetabular correction.
Level of evidence: IV, retrospective observational study.

1. Introduction

Development dysplasia of the hip (DDH) causes functional impairment and pain and is expected to result in early osteoarthritis of the hip [1,2]. Therefore correction is striven during childhood to achieve a better congruency with less stress on the joint to avoid early destruction of the labrum and cartilage [3,4]. For children the most common techniques used can be divided into reorientation osteotomies (e.g. Salter and Triple pelvic osteotomy) or acetabuloplasties (e.g. Pemberton and Dega) [4] and the Bernese periacetabular osteotomy which is predominantly used for young adults [5].

Salter innominate osteotomy (SIO) was introduced in 1961 for DDH with good results being reported [6–10]. The optimal age for SIO is usually considered about 2 to 10 years, as thereafter the flexibility of the symphysis and pelvic bone decreases and the bone has less capacity to remodel. [11,12]. Unfortunately, not all patients with DDH are detected at an early stage [13]. Although Salter extended his indication for SIO up to the fifth decade in patients without severe arthritic changes, rotational osteotomies like triple osteotomy (TO) or periacetabular osteotomy (PAO) are currently preferred as most surgeons assume that the degree of correction at this age is limited with SIO [3,14,15]. However, also rotational osteotomies have some drawbacks which include bone necrosis, loss of fixation, malreductions and pressure shift from the fossa to the boney rim of the acetabulum [14]. Furthermore, it is well known that treatment of DDH in fully-grown patients has less favorable outcome compared to a younger age [11,16–20].

Those factors make decision for a surgical correction in adults more difficult, but a non-operative treatment is likely to cause a rapid progression of osteoarthrosis resulting in a total hip arthroplasty (THA) at an early age. Although THA offers an excellent outcome, it is discussed controversially in those young and active patients [3,14,18]. Studies evaluating pelvic osteotomies reported about a good postoperative coverage of the femoral head and could

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demonstrate that a THA can be avoided for a long period [2,16–18]. Besides, it could be demonstrated that hip preserving surgery for DDH does not affect the function or survivorship of subsequent THA [21].

Until now, the superiority of one surgical procedures is not clearly defined and thus the optimal treatment and surgical strategy still remains controversial. [1–3,11,12,22]. Most surgeons currently favor rotational osteotomies in adults but some still prefer SIO as the easier procedure as they assume less complication [7].

As only few studies analyzed SIO in fully-grown DDH patients, we retrospectively evaluated our patient collective of adults treated with SIO. Three main questions were addressed:

- can the degree of boney correction be performed adequately;
- is the clinical outcome satisfactory and;
- how high is the complication rate.

Overall, we hypothesized that a modified Salter innominate osteotomy can achieve satisfying results in fully-grown adults.

2. Materials and methods

2.1. Study collective

The digital database of our orthopedic department was scanned for patients with SIO performed between 2004 and 2013. The surgical procedures were all performed by one surgeon or under his direct supervision (B.H.) who has a long experience in SIO.

Inclusion criteria for this study were fully-grown patients with DDH which were treated with SIO and already had completed ossification of the pelvis at the time of surgery. This was ensured by a minimum age of 18 years for male and 16 years for female patients and was confirmed on the preoperative radiograph. All patients had been symptomatic preoperatively and were treated conservatively, which however failed to improve the symptoms. Only patients with a sharp angle above 60 degree were, depending on age and degree of osteoarthritis, either counseled for THA or referred for TO or PAO.

A minimum follow-up of 6 months and an adequate pre- and postoperative pelvic overview were required. Exclusion criteria were a teratological dislocation or neurological disorders. Demographic data recorded were age, sex, operation side and date of surgery. The study was approved by the institutional review board at our institution (LMU No. 660-15) and patients had to give informed consent.

2.2. Modified salter innominate osteotomy

The surgical procedure was performed according to the original method as described by Salter in 1978 [23] with the surgical technique also described in detailed by others [24]. Furthermore, Salter et al. described the innominate osteotomy also for the management of residual congenital subluxation of the hip in young adults [25]. In comparison to the earlier description of the original method the following modifications were applied in our collective:

- supine position of the patient on a tiltable radiolucent operating table;
- removal of the wedge-shaped graft proximal to the anterior superior iliac spine;
- the Salter maneuver was performed on the tilted operating table;
- fixation of the fragments was performed with a guide wire;
- final correction of the acetabulum in supine position under control of an image intensifier;
- subsequent force fitting of a dovetail grooved, wedge-shaped bone graft;
- in parts of the procedures the fragments contact was stabilized with a medially inserted cannulated compression screw.

2.3. Radiographic evaluation

Radiographs were acquired digitally and were obtained from our institutional Picture Archiving and Communication Systems with the evaluation performed on a computer station using the Syngo medical imaging software (Siemens healthcare, Erlangen Germany). To compare the surgical correction, the latest adequate pre- and the most recent postoperative false profile and pelvic overview radiograph were used.

Pelvic overview radiographs were taken in the supine position with outstretched knees and an internal rotation of the feet of $15^\circ \pm 5^\circ$. False profile radiographs of the hip were obtained to evaluate the anterior acetabular coverage and taken as described by Lequesne and Laredo. The patient is standing with an angle of 65° between the pelvis and the film and the axis of the ipsilateral foot is parallel to the film to obtain a true lateral view of the proximal femur. All radiographs were analyzed by one person (JR) who was blinded and not involved in the surgeries. The following parameters were determined:

- sharps angle (Sharp);
- centre edge (CE) angle (Wiberg);
- Acetabular Index (AI) of weight bearing zone (Tönnis);
- migration percentage (MP) (Reimers);
- Acetabular Head Index (AHI) (Heyman and Herndon);
- acetabular roof (ACM) angle (Idelberger and Frank);
- vertical-center-anterior (VCA) angle (Lequesne and Laredo);
- Kellgren-Lawrence (K-L) grade for osteoarthritis (Kellgren and Lawrence);
- Tönnis Classification for Osteoarthritis (Tönnis).

2.4. Clinical evaluation

2.4.1. Hip scores

Patients where contacted and asked to complete a standardized evaluation measurement form. The form included the WOMAC, UCLA activity score and the HHS, with the range of motion used form the most recent assessment.

2.4.2. Complications

Complication and reoperation were evaluated according to the medical records for each patient. Complications were further graded according to the classification system introduced by Gosling and Gouma [26] with grade 1: is a temporary impairment without necessity for revision, grade 2 complete healing after revision/surgery, grade 3: permanent impairment, grade 4: death, grade 5: unknown due to early decease.

Finally, it was analyzed if a hip replacement arthroplasty had been performed in the postoperative course, which was also asked in the final evaluation.

2.4.3. Statistics and analysis

Results are given as means and standard deviations together with the range. Comparison between the pre- and postoperative radiological scores was performed with a two-tailed paired Student's *t*-test after assessing for normal distribution with a Kruskal-Wallis test. If normal distribution failed a Wilcoxon signed-rank test was applied. Statistics was performed and graphs were created using the GraphPad Prism software (Graph Pad Prism Version 5, La Jolla, USA). A p-value of < 0.05 determined significance.

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