



Evaluation of Test of Stability as an Aid for Osteotomy in Open Reduction for Developmental Dysplasia of Hip

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ABSTRACT

Background: Developmental dysplasia of hip (DDH) represents a spectrum of anatomic abnormalities that can result in permanent disability. The goals of treatment are to create normal anatomy of the proximal femur and acetabulum and then to maintain that anatomy to allow normal development of hip. Our aim was to identify significance of the test of stability in planning of appropriate osteotomy during open reduction in order to achieve stable concentric reduction in DDH in terms of Severin's clinical and radiological outcome.

Materials and Methods: In this study, 50 children with DDH, which required open reduction and osteotomy for stable concentric reduction, were admitted in Orthopaedic department of SIMS/Services Hospital from Mar 2004 - May 2008. Clinical assessment and radiograph of pelvis with both hips in anteroposterior view was done for all the patients to confirm the diagnosis. After the confirmation of diagnosis surgery was planned and during surgery test of stability applied. Test of stability are the maneuvers which included flexion, internal rotation and abduction performed by the operating surgeon to assess the need for a concomitant osteotomy. If hip found stable in internal rotation and abduction, varus derotational femoral osteotomy was done and fixed with 1/3rd tubular plate. If hip required flexion it was treated with innominate osteotomy and fixed with K-wires. Those hips which required flexion, abduction and internal rotation for concentric reduction were treated with both osteotomies and fixed with K-wire & plate. Postoperatively all the patients were applied hip spica. A descriptive and analytical statistical analysis was performed on SPSS, version 13.

Results: The mean age of patients was 4 years (Mean \pm SD: 4 \pm 1.31), youngest patient being 3 years of age and oldest 7 years. Sex distribution with female to male ratio was 1.8:1. On an average follow up of 3.2 years Severin's clinical outcome for 42 (84%) patients was excellent, 7 (14%) was good and 1 (2%) was poor. P-value was 0.001.

Severin's radiological outcome for 40 (80%) patients was excellent and for 10 (20%) patients was good. P value was 0.112.

Conclusion: The test of stability is simple and effective aid for osteotomy in open reduction for developmental dysplasia of hip with excellent clinical and radiological results measured according to severin's classification.

Keywords: Developmental dysplasia of hip; test of stability; Osteotomies around hip; clinical & radiological outcome; open reduction;

1. INTRODUCTION

Neglected cases of developmental dysplasia of hip (DDH) are generally difficult to treat satisfactorily. It represents a spectrum of anatomic abnormalities that can result in permanent disability (Shipman et al., 2006). The incidence of congenital dysplasia of the hip has been estimated to be approximately 1 in 1000 live births (Stephen et al., 2006).

Risk factors increasing the incidence of DDH have been identified; examiners should be alert to the following: Female sex (5:1 female to male ratio), Breech delivery, First-born child, Positive family history (Stephen et al., 2006), presence of other congenital abnormalities like C.T.E.V, congenital torticollis and metatarsus adductus.

Persistent acetabular dysplasia and hip subluxation in children lead to arthritis of hip as lifelong disability (Baloch et al., 2004). The goals are to achieve anatomical and stable reduction at earliest without pressure on the femoral head and vessels, to promote the development of hip joint due to growth stimulating effect of concentrically reduced femoral head (Umer et al., 2008). This stimulus of development of hip becomes less effective as age increases (Rayan et al., 1998).

Initial traction followed by closed or open relocation in children over the age of two years has been associated with high risk of complications such as redislocation, avascular necrosis of femoral head and premature fusion of the growth plate (Rayan et al., 1998). A pelvic or femoral osteotomy may be needed to maintain a stable concentric reduction after open reduction. It is believed in general that these osteotomies provide good conditions for proper development of hip joint in the children⁽⁶⁾ but there is still insufficient data to prove that how one should decide which osteotomy will be more beneficial. 86% of the patients have had a satisfactory outcome (Severin's classification) (Zadeh et al., 2000) by using test of stability. Test of Stability is the maneuvers performed by the surgeon peroperatively which include flexion, internal rotation and abduction to assess the need for a concomitant osteotomy while open reduction, to achieve the position of stable reduction.

We conducted this study to identify significance of the test of stability in planning of appropriate osteotomy during open reduction in order to achieve stable concentric reduction in DDH.

2. MATERIAL AND METHODS

During Mar 2004 – May 2008, 50 cases of DDH were selected from the outpatient clinics of Orthopaedic Surgery Department of Services Hospital Lahore.

The criteria for inclusion in the study were:

- 1) Complete dysplasia in the absence of a neuromuscular disorder.
- 2) Leg length inequality and limp due to DDH. For each patient detail history was taken including demographic information (age, sex, address).

Clinical assessment was done for leg length inequality and limp. Radiograph of pelvis with both hips anteroposterior (AP) view were taken for the confirmation of hip dislocation.

The informed consent was taken from their parents for assigning them for a particular procedure and using their data for our research. They were assured regarding confidentiality and expertise used for this particular procedure besides they were also educated about the use of test of stability for the procedure for an anticipated better outcome. Then patients were being operated. All the patients were operated by single surgical team including RM, MA and RDN. No image intensifier used during procedure.

2.1 PROCEDURE

After standard aseptic measures, all the patients were operated through ilio-inguinal approach. After incising skin and subcutaneous tissue iliac epiphysis approached and incised. Through a separate incision adductor tenotomy was performed. Ilio-psoas incised and capsule opened by making a 'T' shape incision. Position of the femoral head recognized, redundant ligamentum teres excised, pulvinar removed from the acetabular cavity and hip reduced. At this stage the test of stability was applied and stable position for hip reduction achieved to perform appropriate osteotomy (Pelvic/Femoral). If hip found stable in internal rotation and abduction varus derotational femoral osteotomy was done and fixed with 1/3rd tubular plate, if hip required flexion it was treated with innominate osteotomy and fixed with K-wires and those hips which required flexion, abduction and internal rotation for concentric reduction were treated with both osteotomies and fixed with K-wire & plate. Postoperatively all the patients were applied hip spica.

Radiographs of pelvis in AP view were taken at 12 weeks. Patients were evaluated clinically by modified severin's system (Table 1) and radiologically by the severin's radiological grading (Table 2) at 12 weeks to determine the utility of the test of stability in terms of clinical and radiological outcome, and 6 monthly thereafter till skeletal maturity.

Table 1. Modified Severin's Clinical Grading (Gibson and Benson, 1982)

| Grade | Criteria |
|--------------|---|
| 1. Excellent | No pain, No limp, Unlimited endurance |
| 2. Good | No pain, slight limp, Slight restriction of endurance |
| 3. Poor | Occasional pain, Noticeable limp, Endurance moderately restricted |
| 4. Failure | Regular pain, marked limp, severe restriction of endurance |

Table 2. Severin's Radiological Grading (Severin, 1941)

| Grade | Criteria |
|--------------|--|
| 1. Excellent | Congruent hip with no deformity |
| 2. Good | Concentric reduction but deformity at femoral neck, head or acetabulum |
| 3. Good | Dysplasia but no subluxation |
| 4. Poor | Subluxation |
| 5. Failure | Articulation with false acetabulum |
| 6. Failure | Redislocation |

2.2 FOLLOW UP

Patients were followed up at 2 weeks for the removal of stitches, 8 weeks for the removal of hip spica, 12 weeks postoperatively for the evaluation, clinically and radiologically using modified severin's grading and six monthly thereafter till skeletal maturity

2.3 DATA ANALYSIS

Data was analyzed by using SPSS version 13. The data which was analyzed included limp, leg length inequality and postoperative modified severin's grade and radiological grading of outcome. Quantitative variables such as age were presented as mean & standard deviation. Qualitative variables like mode of presentation i.e. (limp, leg length inequality and outcome in accordance with severin's radiological classification) were presented as frequencies and percentages.

Effect modifiers such as age, gender, mode of presentation (limp & leg length inequality) and test of stability (internal rotation & abduction, flexion and both) were controlled by stratification. Statistical significance was tested at 5% level of significance by using Chi square test of independence.

3. RESULTS AND DISCUSSION

3.1 RESULTS

The study sample was consisted of 50 patients. The mean age for the sample was 4 years with \pm SD 1.31, with the youngest patient being 3 years of age and oldest 7 years (Table 3). Out of fifty 48% patients were in the age group of 2-3 years, 36% patients were in age group of 4-5 years of age and 16% patients were in age group of 6-7 years. In sex distribution 64% patients were female and 36% patients were male, male to female ratio was 1.8:1.

Clinical outcome of 84% patients was excellent, 14% was good and 2% was in poor category (Table 3). Radiological outcome of 80% patients was excellent and good for 20%. Hips of 68% patients were stable in internal rotation & abduction so they were treated with varus derotational femoral osteotomy (VDRFO), hips of 26% patients were stable in flexion and underwent Salter innominate osteotomy (SIO) and hips of 6% patients were found stable in internal rotation, flexion & abduction and were treated with both types of osteotomies. Out of 18 (100%) male patients, 61.1% underwent VDRFO, 33.3% were treated with SIO and 5.6% were treated with both osteotomies. Out of 32 (100%) female

patients, 71.9% underwent VDRFO, 21.9% were treated with SIO and 6.3% were treated with both VDRFO & SIO.

On comparing Severin's clinical outcome with the test of stability leading to specific type of osteotomy, 84% patients was appeared with excellent outcome, 14% was in good category and 2% was in poor rating (Table 4). Chi-square value was 17.597 and P-value was 0.001. On comparing Severin's radiological outcome with the test of stability leading to specific type of osteotomy, it was found that there were 80% patients in excellent grade and 20% in good rating. Chi-square value was 4.374 and P value was 0.112.

Comparison of clinical outcome with age of presentation was made and showed that there were predominantly three age groups (Table 4). In group I there were patients of age 2-3, in group II there were patients of age 4-5 and in group III there were patients of age 6-7. Comparison revealed that there were 24 patients in group I and all were in excellent category. There were 18 patients in group II out of which 17 were in excellent and 1 was in good class. In group III there were 8 patients out of which 1 was in excellent, 6 were in good and 1 was in poor category. Value of chi square was 36.624 with degree of freedom (df) 4 and p value was 0.000. These age groups were compared with radiological outcome and noted that there were 24 patients in group I all were with excellent results. Out of 18 patients in group II, 14 were in excellent and 4 were in good category. Out of 8 patients in group III, 2 patients were in excellent and 6 were in good rating. Value of chi square was 21.181 with df 2 and p value was 0.000.

Table 3. Frequencies and perctages for different age groups, gender, clinical & radiological outcome and different procedures performed

| Variable | Details | Frequency | Percentage |
|----------------------|-----------|-----------|------------|
| Age groups | 1* | 24 | 48 |
| | 2* | 18 | 36 |
| | 3* | 8 | 16 |
| Gender | Male | 32 | 64 |
| | Female | 18 | 36 |
| Clinical outcome | Excellent | 42 | 84 |
| | Good | 7 | 14 |
| | Poor | 1 | 2 |
| Radiological outcome | Excellent | 40 | 80 |
| | Good | 10 | 20 |
| | Poor | 0 | 0 |
| Procedure Performed | VDRFO | 34 | 68 |
| | SI | 13 | 26 |
| | VDRFO+SI | 3 | 6 |

*1 (2-3 year), 2 (4-5 year), 3 (6-7 year) representing age groups
VDRFO: Varus Derotational Femoral Osteotomy; SI: Salter innominate

3.2 DISCUSSION

Developmental Dysplasia of hip has a vast variety of treatment options from simpler to complex procedure mostly related to the age at presentation and severity of dysplasia. It is always problematic to decide that which type of osteotomy should be done while performing

open reduction of DDH. In our study we used test of stability as an aid to decide whether osteotomies at femur or pelvic or both are required. Persistent acetabular dysplasia and hip subluxation in children lead to arthritis of hip as a lifelong disability. To avoid this complication dislocated hip must be reduced concentrically and this reduction needed to be maintained for proper development of hip. Haverkamp and Marti reported that the results of both types of surgery (pelvic osteotomy and Intertrochanteric osteotomy), have been described as tending to be better if the patients are younger and if the grade of OA is not too advanced (Haverkamp et al., 2007).

Table 4. Comparison of Clinical & Radiological outcomes with Different Osteotomies and Age Groups

| Variable | Category | Details | Freq. | %age | Chi-square value | P-value | df |
|----------------------------------|----------|-----------|-------|------|------------------|---------|-----|
| Clinical outcome + Osteotomy | VDRFO | Excellent | 30 | 88.2 | 17.597 | 0.001 | --- |
| | | Good | 4 | 11.8 | | | |
| | | Poor | 0 | 0 | | | |
| | SI | Excellent | 11 | 84.6 | | | |
| | | Good | 2 | 15.4 | | | |
| | | Poor | 0 | 0 | | | |
| | VDRFO+SI | Excellent | 1 | 33.3 | | | |
| | | Good | 1 | 33.3 | | | |
| | | Poor | 1 | 33.3 | | | |
| Radiological outcome + osteotomy | VDRFO | Excellent | 28 | 82.4 | 4.374 | 0.112 | --- |
| | | Good | 6 | 17.6 | | | |
| | SI | Excellent | 11 | 84.6 | | | |
| | | Good | 2 | 15.4 | | | |
| | VDRFO+SI | Excellent | 1 | 33.3 | | | |
| | | Good | 2 | 66.7 | | | |
| Age group + Clinical outcome | 1* | Excellent | 24 | 100 | 36.624 | 0.000 | 4 |
| | | Good | 0 | 0 | | | |
| | | Poor | 0 | 0 | | | |
| | 2* | Excellent | 17 | 94.5 | | | |
| | | Good | 1 | 5.5 | | | |
| | | Poor | 0 | 0 | | | |
| | 3* | Excellent | 1 | 12.5 | | | |
| | | Good | 6 | 75 | | | |
| | | Poor | 1 | 12.5 | | | |
| Age group + Radiological outcome | 1* | Excellent | 24 | 100 | 21.181 | 0.000 | 2 |
| | | Good | 0 | 0 | | | |
| | 2* | Excellent | 14 | 77.8 | | | |
| | | Good | 4 | 22.2 | | | |
| | 3* | Excellent | 2 | 25 | | | |
| | | Good | 6 | 75 | | | |

*1 (2-3 year), 2 (4-5 year), 3 (6-7 year) representing age groups
VDRFO: Varus Derotational Femoral Osteotomy; SI: Salter innominate

In our study patients of age ranging 1-8 years were in inclusion criteria but patients ranging from 3-7 only reported. This observation may be because that there is no screening available in our country. Khan et al. (2007) reported importance of the ultrasound screening of babies at risk and those with unstable hips on clinical examination optimizes conservative management and can reduce the rate of open surgical intervention in DDH. The use of early ultrasonography is also important to detect unstable hips which become normal in 6 weeks with conservative treatment (Waheed et al., 2008).

Difficulties posed in managing developmental dysplasia of hip diagnosed late include a high placed femoral head, contracted soft tissue and a dysplastic acetabulum. Vallamshetla et al. reported about the safety of one stage correction of DDH in older children and concluded that it is a safe and effective treatment with good results in short to medium term (Vallamshetla et al., 2006).

In this study 64% patients were female and 36% patients were male with male to female ratio 1.8:1. In a study from Turkey by Dogan et al. (2005) the sex distribution was 2:1. Some other authors reported higher female to male ratio. In a study from Japan Okano et al. reported sex distribution around 5:1 (Okano et al., 2008), which is higher than our study this difference may be due to local racial and geographical difference. Our study showed low female: male ratio because most of our population lives in villages and girls may be given less importance for their medical needs.

The mean age for the sample was 4 years $SD \pm 1.31$, with the youngest patient being 3 years of age and oldest 7 years. 48% patients were in the age group of 2-3 years, 36% patients were in age group of 4-5 years of age and 16% patients were in age group of 6-7 years. Gunal et al. (2007) reported in his study on DDH after walking age noted the mean age 3 years. In another study Karakurt et al. (2004) observed the mean age in his sample 2.5 years. In this study clinical outcome of 84% patients was excellent, 14% were good and 2% was poor.

Radiological outcome of 80% patients was excellent and 20 % were in good category. Our results are comparable to the study by Zadeh et al. (2000) from Royal National Orthopaedic Hospital trust, Stanmore, England. He reported 86% excellent radiological results in accordance to Severin's radiological classification in his sample (Zadeh et al., 2000). The mean age of his sample was 2 years and 4 months while the mean age of our sample was 4 years. He also stated that results were better under the age of two years. The age difference in our study sample is because we have no screening and most of our patients report in walking age when parents noticed limping gait and leg length discrepancy and this is the reason of some difference in our results. If a radiographically documented anatomic reduction is not obtained and maintained in DDH, the risk of complications such as residual hip dysplasia, redislocation, and severe types of proximal femoral growth disturbance may significantly increase (Omeroglu et al., 2007). Besides this, proximal femoral growth disturbance may have adverse effects on acetabular growth and development, even if the hip has initially been reduced anatomically (Shipman et al., 2006; Forlin et al., 2006, Zadeh et al., 2000). Omeroglu et al. (2007) stated that 95% of the anatomically reduced and uncomplicated hips would develop normally. In our series, all the hips were initially reduced anatomically, but we cannot comment over the late changes in hip as our follow up is short.

On comparing Severin's clinical outcome with the test of stability leading to specific type of osteotomy 42 (84%) patients appeared with excellent outcome, 7 (14%) were in good category and 1 (2%) were in poor rating. P-value was <0.005 . Severin's radiological

outcome with the test of stability leading to specific type of osteotomy. There were 40 (80%) patients in excellent grade and 10 (20%) in good rating. P value was > 0.005 . Umar et al. (2007) from Agha Khan University, Karachi reported that the triple procedure of open reduction, femoral shortening and Salter osteotomy gives best results in younger children. Early diagnosis and intervention is therefore imperative in the successful treatment of patients suffering from DDH.

In this study 68% hips were stable in internal rotation & abduction and were treated by VDRFO, 26% were stable in flexion only and SIO was performed. Only 6 % patients of the total sample were stable in flexion, internal rotation and abduction so underwent relatively extensive procedure of osteotomies at both pelvic and femoral level. Out of 34 patients which underwent osteotomy at femoral level 88.2% showed excellent clinical results and 11.8 % showed good results. No patient was in poor category. Similarly out of 13 patients which underwent osteotomy at pelvic level 84.6 % showed excellent result, 15.4 % were in good category and none was in poor group. Out of 3 patients who underwent osteotomy at both levels 1 was in excellent, 1 was in good and 1 was in poor category. These results were statistically significant with p-value < 0.005 . Our results are comparable to previous studies (Zadeh et al., 2000). Similar results were observed when comparison of specific type of osteotomy was made with radiological outcome. Out of 34 patients which underwent VDRFO 82.2 % achieved excellent and 17.6 % good results. Out of 13 which underwent SIO 84.6 % showed excellent result and 15.4 % were in good category. While out of 3 patients who underwent osteotomy at both levels 1 was in excellent class and 2 were in good grade. P-value was > 0.005 . In late presentations there are less chances of acetabular remodeling and development which lead to less favorable results (Staheli, 2006).

Comparison of clinical outcome with age of presentation revealed that 24 patients were in group 1 and all were in excellent category. There were 18 patients in group 2 out of which 17 were in excellent and 1 was in good class. In group 3 there were 8 patients out of which 1 was in excellent, 6 were in good and 1 was in poor category. P-value was < 0.005 and was statistically significant. These age groups were compared with radiological outcome and noted that there were 24 patients in group 1, all were with excellent results. Out of 18 patients in group 2, 14 were in excellent and 4 were in good category. Out of 8 patients in group 3, 2 patients were in excellent and 6 were in good rating. P-value was < 0.005 and was statistically significant.

Kinik et al. (2007) in his study reported that the age of the child is an important prognostic factor in the outcome (Kinik et al., 2007). A longer follow up at skeletal maturity months may add the information about final treatment outcome. However our experience with the test of stability has been very satisfactory that it helped in planning the osteotomy for the management of DDH in open reduction with excellent clinical and radiological results.

4. CONCLUSION

We find the test of stability as a very useful clinical mean of assessing the need for a pelvic or femoral osteotomy at the time of an open reduction for DDH. One of the main advantages of achieving a stable and concentric reduction at the time of open reduction to allow normal development of hip. Orthosis is not normally required and the child can be mobilized once the soft tissues and bony healing complete.

The test of stability is simple, effective and reliable method to evaluate the need of osteotomy and its level when used cautiously during open reduction of DDH. It provides excellent clinical and radiological early results.

Prevention is probably not possible, but early detection and treatment before complications occur is of paramount importance.

5. RECOMENDATIONS

- All newborns should be screened by physical examination. Ultrasonography of all newborns is not recommended.
- If the results of the newborn examination are negative, consideration may be given to risk factors for DDH. These risk factors include the following: female infants, a family history of DDH and breech presentation.
- There is a need for organizing a training program for lady health visitors and mid wives for screening of newborn babies by clinical examination and early referral in case of suspicion.

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