

Pelvic and Hip Osteotomies in Children

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1. Introduction

In this chapter four types of pelvic osteotomy in children will be addressed. We think that is very important to share our 25 years long experience in this field with other colleagues and help with variety of practical advices.

Congenital dysplasia of the hip involves the acetabular roof, which doesn't adequately cover the femoral head. Many pelvic operations are done to achieve better coverage of the femoral head. Among them are various types of pelvic osteotomies.

We have operated many children because of poor developed early ultrasound hip screening in past decades in our country or failure in diagnosis on early screening. In this chapter we would like to describe two types of pelvic osteotomies with case presentations for each.

We commonly use following two types of pelvic osteotomies:

1. Innominate Osteotomy of Salter
2. Chiari Medial Displacement Osteotomy of the Pelvis

2. Innominate osteotomy of salter

2.1 Definition

The Salter innominate osteotomy is sort of derotating osteotomy, usually performed in combination with an open reduction for dislocated hip in developmental dysplasia of the hip (DDH), and also in treatment of acetabular dysplasia in the child with a concentrically reduced hip.¹

2.2 Anatomy

The line of osteotomy extends from the sciatic notch to the anterior inferior iliac spine, perpendicular to the sides of the ilium.

The acetabulum is reorientated without changing its size or shape. It is rotated to improve anterior and lateral femoral head coverage.

Bone graft increases anterior and lateral femoral head coverage.⁶

2.3 Indications

1. Age of patient: patient 18 months of age and older till 8 year old
2. Complete and concentric reduction of the hip
3. Congruous hip joint
4. Absence of contracture

2.4 Pathogenesis

Acetabular dysplasia can have different causes:

- Lack of a reduced, spherical head within the growing acetabulum¹
- Abnormal interstitial or appositional growth within the acetabular and triradiate cartilage¹
- Abnormal development of the secondary centers of ossification of the ilium, pubis, and ischium¹

2.5 Patient history and physical findings

- patient with DDH are usually female and first - born children
- can be breech presentation at birth
- physical examination findings:
 - Hamstring tightness test - implies hip dislocation or flaccid paralysis of the hamstring muscles
 - Gluteus medius lurch - positive test - trunk lean over the stance phase leg
 - Galeazzi sign - positive test is when there are knees at different levels (nonspecific sign)
 - Limitation of hip abduction - asymmetric abduction signify unilateral hip dislocation, bilateral hip dislocation is shown by bilaterally decreased abduction
 - Trendelenburg sign- the test is positive if the pelvis dips away from the affected leg during single limb stance (nonspecific sign)
 - Inguinal skin fold - asymmetric skin fold (nonspecific sign)

2.6 Imaging and other diagnostic studies

- AP radiography, supine frog - leg lateral pelvis radiography
- to diagnose acetabular dysplasia it is necessary to measure acetabular index on the AP film, also Shenton's line is inspected for discontinuity, which implies hip subluxation
- subtle cases of acetabular dysplasia can be identify by false - profile view of the hip
- in older children for assessing acetabular morphology can be useful 3D CT scanning of the acetabulum, MRI of the hip

2.7 Differential diagnosis

- Congenital short femur
- Proximal femoral focal deficiency
- Legg - Calve - Perthes disease
- Developmental coxa vara

2.8 Nonoperative management

- Observation of acetabular index after successful closed reduction during the period of 12 - 18 month
- Salter innominate osteotomy can be performed if residual acetabular dysplasia exist⁹
- Open reduction of dislocated hip can be performed if a child less than 18 months old fails closed reduction
- If acetabular development is deficient after observation for improvement in the acetabular index Salter innominate osteotomy should be performed

2.9 Surgical management

2.9.1 Preoperative planing

- In cases of hip dysplasia before patient positioning confirmation of concentric reduction is done by hip arthrogram
- If concentric reduction is not achieve before performing a Salter innominate osteotomy than other procedures like open reduction, proximal femoral osteotomy sould be perfomed to achieve it
- Salter innominate osteotomy can be performed including intramuscular psoas lengthening without open hip reduction if patient is older than 18 monts and if a gentle concentric closed reduction is achieved
- To decide whether a concurrent femoral derotational osteotomy is necessary it is used fluoroscopy for estimation of femoral anteversion
- If femoral anteversion is greater than 45 degrees femoral derotational osteotomy is performed

2.10 Positioning

- We placed patient on the operating table with a gel roll under the thoracolumbar spine on the affected side.
- The area of sterile preparation is from the midline anterior and posterior, to the inferior rib cage proximally, and entire leg distally

2.11 Approach

- It is used an anterior Smith - Peterson approach to the hip

Surgical incision is placed over the anterior aspect of the hip, centered about 2 cm below the anterior superior iliac spine. Proximally it goes following the contour of the iliac crest but distal to it. Distally, incision curves between the sartorius and tensor fascia lata muscles.

2.12 Surgical techniques

- anterior surgical approach to the hip;
- release of adductor and iliopsoas muscles;
- Gigli saw is used for osteotomizing innominate bone from the sciatic notch to the anterior inferior iliac spine;
- acetabulum together with pubis and ischium is rotated anteriorly and laterally with symphysis acting as a hinge;

- the osteotomy is opened anteriorly by external rotation of the femur;
- osteotomy is held open anterolaterally by bone graft, and thus roof of acetabulum is shifted more anteriorly and laterally;
- bone graft is secured with Steinmann pins;
- it is necessary to take intraoperative radiograph with the pins in place to ensure they do not enter the triradiate cartilage

2.13 Pearls and pitfalls

- the osteotomy should be considered only for anterior and lateral acetabular deficiency in the concentrically reduced hip;
- the osteotomy should be avoided in conditions with known posterior hip dysplasia, such as myelomeningocele or cerebral palsy;
- it is essential strict subperiosteal exposure of the sciatic notch;
- Gigli saw passage is facilitated by twisting the retractors in opposite directions;
- to determine the proper osteotomy exit position the anterior inferior iliac spine needs to be fully exposed;
- pulling the distal fragment anterior and keeping the posterior cortex of the osteotomy opposed will hinge open osteotomy;
- estimation of proper pin length;
- obtain an intraoperative radiograph;
- extra-articular pin placement should be ruled out by direct palpation or by placing the hip through a full range of motion and feeling and listening for crepitus;
- proper medial pin placement is achieved by pins aimed deep to the medial cortex in the proximal and distal fragments and the graft;
- proper posterior pin placement is achieved by pins aimed in the posterior half of the graft

2.14 Postoperative care

- patient is immobilized in cast for about 6 weeks

2.15 Outcomes

- good to excellent functional outcomes scores at over 30 years are expected after Salter innominate osteotomy, in the absence of avascular necrosis

2.16 Complications

- during surgical exposure it can be injured: neurovascular structures in the sciatic notch, lateral femoral cutaneous nerve;
- consequence of inadequate patient selection preoperatively or inadequate acetabular rotation intraoperatively is inadequate correction of acetabular dysplasia;⁷
- injury of the femoral nerve can appear due to prolonged retraction of the psoas muscle or incorrect identification of the psoas tendon during intramuscular tenotomy;
- pin penetration into the hip joint or triradiate cartilage ;
- nonunion at the osteotomy site,
- migration of the graft,⁷

- avascular necrosis of the femoral epiphysis⁷
- growth arrest of the triradiate cartilage

2.17 Case presentation

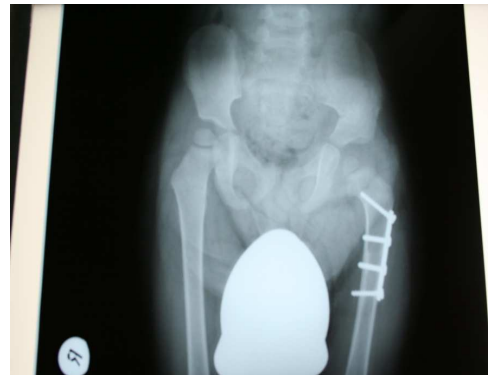
A boy born august 2008

x - ray took before surgery



x - ray took 30.12.2010.

x - ray took 17.05.2011.



3. Chiari medial displacement osteotomy of the pelvis

3.1 Definition

Chiari osteotomy is a acetabular osteotomy salvage procedure which is indicated in patients without concentrically reducible hip;

- goes through the iliac bone of the pelvis;¹
- medial displacement of acetabulum and hip joint;
- improving posterior and lateral coverage;
- shelf over the dysplastic, subluxated hip is formed by ilium;
- goal is create a stable, pain - free hip

3.2 Indications

1. Age of patient: patient over 8 year old, adolescents, young adult
2. An irreducible lateral subluxation of the hip with moderate incongruity of the joint

3.3 Contraindications

- severe arthrosis;
- age over 45;
- greater proximal migration of the femoral head

3.4 Anatomy

- **DDH** - deficiency of the anterior and anterolateral acetabulum;
- **Spastic hip dysplasia** - deficiency of lateral and posterolateral acetabulum;
- When planning the shape and orientation of the osteotomy and positioning of the iliac shelf over the hip joint it is necessary to consider location of acetabular deficiency;
- Femoral head deformity usually involves coxa breva, coxa magna, or coxa plana;
- Abductor mechanism may be improved by simultaneous advancement of the greater trochanter;
- In cases of high dislocation of the hip and in the pelvis in patients with advanced neurologic conditions Chiari osteotomy may not provide adequate coverage;
- Additional bone graft to supplement posterior, lateral and anterior coverage is usually necessary;
- Concentric reduction of the femoral head into the acetabulum is not required;
- Increasing the surface area of coverage provides decreasing the force across the hip joint;
- Obligatory shortening of the gluteal muscle length and abductor moment arm is caused by lateralizing the ilium to form a shelf that weakens the muscle and contributes to postoperative Trendelenburg limp;
- Resting length of the gluteus medius can be restored by advancing the greater trochanter

3.5 Pathogenesis

Advanced hip disease requiring salvage surgery may be caused by following:

- late diagnosis of developmental dysplasia of the hip;
- spastic or neuromuscular hip dysplasia;
- failed prior hip procedures;
- acetabular trauma

Incomplete or incongruous femoral head coverage can be caused by following femoral head conditions:

- primary malformation,
- secondary avascular necrosis,
- slipped capital femoral epiphysis,
- epiphyseal – metaphyseal dysplasia,
- secondary malformation from longstanding subluxation or impingement

3.6 Patient history and physical findings

3.6.1 Main parts include

- family or personal history of DDH,
- other hip disorder,
- trauma,
- skeletal dysplasias
- cerebral palsy
- birth order and weight

3.7 The physical examination

- limb length,
- gait,
- strength,
- assistive devices

3.8 Specific hip tests

- Trendelenburg test: weakness in abductors
- Anterior apprehension test: patient's subjective feeling of fear or instability
- Strength of gluteus medius and maximus
- Anterior impingement test
- Bicycle test
- Range of motion: testing internal and external rotation at multiple degrees of flexion because of variation of femoral head and acetabular deformities that can help in location of pathologic articulation
- Galeazzi sign: shows hip subluxation or dislocation
- Preoperative requirements: flexion to 90 degrees, full extension, at least 10 to 20 degrees of abduction
- Preoperative gait assesement: discern of limp antalgia what can be improve by Chiari osteotomy

3.9 Imaging and other diagnostic studies

- Radiography includes: weight – bearing AP views of bilateral hips, false profile of hips, AP of hips in maximal abduction and internal rotation what can provide assessment of lateral and anterior coverage of the femoral head as well as congruency of the hip joint.
- 3D CT can be used in preoperatively assessing the amount and direction of acetabular deficiency

- MRI can help in preoperative assessment of articular and labral cartilage

3.10 Differential diagnosis

- DDH
- Spastic hip dysplasia
- Legg - Calve - Perthes disease, avascular necrosis
- Posttraumatic hip or femoral dysplasia
- Multiple or spondyloepiphyseal dysplasia

3.11 Nonoperative management

- The patient who is candidate for Chiari osteotomy usually have pain and arthrosis;
- The onset of arthritic symptoms can be delayed by activity, job modification, weight loss
- Physical therapy can be useful in increasing of range of motion and strength but can not stop the onset of arthritis in the dysplastic hip

3.12 Surgical management

- Onset of spastic hip dysplasia can be delayed by hip adductor tenotomy, lengthening or Botox if performed before age 4 to 6 and if hip abduction is less than 45 degrees with hip flexed and extended;⁴
- Surgical correction is necessary in painful, unstable, moderate to severe dysplasia with incongruent articulation with or without femoral head deformity;
- Arthrodesis, shelf procedures and arthroplasty are additional options to Chiari

3.13 Preoperative planning

- A complete physical examination and radiographs
- If there is marked proximal migration, preoperative traction for 2 to 3 weeks can be used to improve the position of the femoral head relative to the acetabulum

3.14 Positioning

- The position of the patient is supine ;
- Antibiotic profilaxis and placement of catheter;
- General anesthesia is one that we prefer

3.15 Approach

There are two approaches:

- ilioinguinal approach – begins from the iliac crest and continues medially for about 10 cm
- iliofemoral approach provides better visualisation in larger patients and combined pelvic and femoral procedures to be done through one incision

3.16 Surgical technique

- iliac osteotomy is angled from the sciatic notch to the ASIS – anterolateral distally to posteromedial proximally;

- placing iliac buttress into horizontal position should be avoided since this will cause persistently unstable joint laterally;
- following osteotomy, a triangular osseous defect anteriorly which is stabilized with curved plate of bone graft from iliac wing;
- consequence of inadequate stabilization of anterior defect is anterior instability;
- acetabulum is displaced medially;
- acetabulum is abducted into a more vertical and medial position and replaces it with joint capsule supported by osseous buttress of the iliac wing;
- distal acetabular fragment is displaced medially and adducted;
- proximal iliac fragment should not be moved laterally;
- inferior surface of proximal fragment forms roof over femoral head;
- the osteotomy is fixed in place with cortical screws either along the iliac crest or along the outer table of the ilium

3.17 Pearls and pitfalls

- adequate patient selection;
- Chiari osteotomy may incompletely manage severe arthrosis or proximal migration;
- we pay special attention when considering Chiari osteotomy in young patients or in patients with neuromuscular disease as they may have insufficient thickness of ilium to provide adequate coverage;
- the contents of the sciatic notch must be carefully protected by subperiosteal placement of retractors;
- screws are placed at the iliac crest for fixation or along the outer table of the ilium in increased displacement;
- for augmenting deficient coverage we use a corticocancellous segment of the inner table of the ilium;
- after displacement our recommendation is palpation of the posterior edge of the osteotomy to confirm there is no soft tissue entrapment

3.18 Postoperative care

- Patients are placed in long - leg casts held in abduction by a connector bar

3.19 Outcomes

- Good to excellent outcomes for pain relief;^{2,3,5,7}
- We have better outcomes in younger patients with mobile hips and adequate corrected coverage

3.20 Complications

- Infection;
- Heterotopic ossification;
- Incomplete correction and resubluxation;
- Neuropraxia of sciatic and of the lateral femoral cutaneous nerve obtained by sciatic nerve entrapment or injury during osteotomy

3.21 Case presentation

A boy born in february 1998. Operatively treated out of our Institution, when he was one year old

x - ray took 19.10.2010.

x - ray took 01.11.2010.



x - ray took 14.12.2010.



4. References

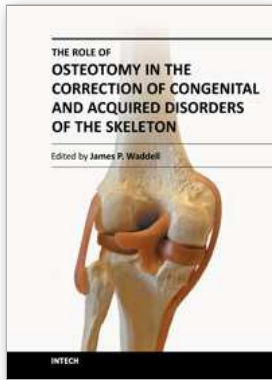
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The Role of Osteotomy in the Correction of Congenital and Acquired Disorders of the Skeleton

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This book demonstrates specific osteotomy techniques from the skull to the hallux. The role of osteotomy in the correction of deformity is under appreciated in part because of the ubiquitous nature of joint replacement surgery. It should be remembered, however, that osteotomy has a role to play in the correction of deformity in the growing child, the active young adult, and patients of any age with post-traumatic deformity limiting function and enjoyment of life. In this text we bring you a number of papers defining specific problems for which osteotomy is found to be an effective and lasting solution. I hope you find it useful.

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