

Invited lecture/Review

# Pelvic Osteotomies in Children and Adults - Experience of University Medical Centre Ljubljana

Kovačič B<sup>1</sup>, Zore L<sup>1</sup>, Stražar K<sup>1,2</sup>

<sup>1.</sup> Department of Orthopaedic Surgery, University Medical Centre Ljubljana, Slovenia

<sup>2.</sup> Medical school, University Ljubljana

\* Correspondence: Borut Kovačič; [borut.kovacic@kclj.si](mailto:borut.kovacic@kclj.si)

## Abstract:

Nowadays, hip dysplasia is recognized and treated mainly conservatively due to good screening program and early detection. There are still some cases found after first year of life, in later childhood and in adults. These cases are treated with pelvic osteotomies to improve femoral head coverage and joint stability and to decrease the hip stress with the final goal to preserve the joint in longer term.

There are three subtypes of pelvic osteotomies. The ones pertaining to first type are redirection osteotomies, which are incomplete osteotomies with the aim to reduce overall volume and redirect the acetabulum by a hinge located between triradiate cartilage and pubic symphysis. This type includes Salter, Pemberton, Dega and San Diego osteotomies. The osteotomies pertaining to the second type are reorientational osteotomies, which are complete osteotomies with the aim to reorient the whole acetabulum. This type includes periacetabular and triple osteotomies. The osteotomies pertaining to the third type are salvage osteotomies which enlarge the acetabulum and medialise the hip center in arthritic and/or incongruent joint and are performed in hips in which the reorientational osteotomy is contraindicated. This type includes shelf and Chiari osteotomies. In University Medical Centre Ljubljana, most of the above-mentioned osteotomies are being performed, however, yearly numbers are small. Redirectional osteotomies have been performed for many years in the Pediatric orthopaedic department and yearly number is under 10 cases. Reorientational osteotomies on young adults are made through minimally invasive approach for periacetabular osteotomy described by Soebale et al. (2015). In selected cases, electromagnetic surgical navigation system is used for more precise positioning of the acetabular fragment.

**Keywords:** Hip dysplasia, pelvic osteotomy, periacetabular osteotomy, hip preservation, hip pain

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## 1. Definition of Hip Dysplasia

Osteoarthritis is the most common idiopathic disease, with many factors identified which significantly increase the risk of its early onset. Osteoarthritis is defined by thinning and destruction of the articular cartilage and the deformation of anatomical structures around the joint (Harris, 1986). Poorly developed hip joint with deviation in size, shape, mutual proportions or orientation of the acetabulum and femoral head is described as dysplastic hip (Klaue et al., 1991). Hip dysplasia is most commonly found in a pediatric population, however development of the hip joint continues till the young adulthood and dysplastic hips can be found also at later age. It is important to know that untreated or unsuccessfully treated hip dysplasia can eventually lead to cartilage degeneration, presumably due to the pathologically increased stress on smaller articular surface area within the joint. The joint is overloaded on the chondrolabral junction which causes labral injury, chondral delamination and thinning, and rupture of the lig. capitis femoris (lig. teres) (Mavčič et al., 2002). Therefore, symptomatic hip dysplasia represents an important indication for surgical procedures to reduce hip joint stress, before irreversible joint changes may happen. This should at least slow down the pathological processes of the hip cartilage and thereby contribute to functional normalization of the joint biomechanics (Brand et al., 2002, Hadley et al., 1990, Vengust et al., 2001).

Hip dysplasia can be treated conservatively with splica cast in the first year of age. Later hip dysplasia treatment depends on the age of the patient and the level of secondary arthritic changes of the involved hip. In case of well preserved intraarticular cartilage, preservation procedure is indicated. Different pelvic osteotomies are considered from, depending on the type of hip deformation and the patient's age. On the other hand, if the osteoarthritic changes are already present together with intraarticular cartilage damage, pelvic osteotomies may lead to unsatisfactory results and in such cases preservation procedures are indicated. Hip arthroplasty is the procedure of choice and is one of the most common surgeries with excellent outcome. However, solution with artificial hip is still considered inferior to the one with native joint and is indicated in elderly but less optimal for younger active adults.

Pelvic osteotomies are most commonly indicated in children and in young adults with prearthritic hip changes. Dysplasia often results due to some underlying diseases such as developmental dysplasia of hip (DDH), neuromuscular disorders and Legg-Calve-Perthes disease. All mentioned disorders produce pathologic forces on the hip joint and pathological development of the hip joint. Depending of type of deformation and age the choice of the preferred pelvic osteotomy type is made.

## 2. Types of pelvic osteotomies

There are three subgroups of pelvic osteotomies described in the literature. In the first subgroup, there are redirection osteotomies with a goal to reduce overall volume and to redirect the acetabulum by a hinge located at the triradiate cartilage and/or pubic symphysis. In the second subgroup, there are reorientational osteotomies which tend to reorient the acetabulum. In the third subgroup, there are salvage osteotomies with the aim to enlarge the acetabulum, medialize the center of rotation and improve the femoral head coverage. The surgical approach for all osteotomies is similar, with the aim to avoid major vessels, nerves and muscles and to decrease soft tissue trauma to minimum. A standard anterior bikini incision is used to approach the pelvis and the hip joint. Proximally, the external oblique muscles are elevated from the iliac crest, and the iliac apophysis is split sharply to expose both the inner and outer tables of the iliac wing to a necessary extent. Distally, the direct head of the rectus femoris tendon is detached from the anterior inferior iliac spine, and tagged for later repair, to expose the hip capsule.

### 2.1. Salter (innominate) osteotomy

Salter innominate osteotomy was described in 1974 by Salter and Dubos who operated innominate osteotomy in congenital hip dislocations (Salter and Dubos, 1974). This type of surgery is indicated for children with congenital hip dislocation which are older than 18 months. Before that age the preferred treatment is conservative with closed reduction of hip dislocation and casting or bracing

to promote satisfactory remodeling (Gillingham et al., 1999). Also the bones are not mature enough for operation (Salter and Dubos, 1974). The upper age limit is estimated to 6 years since in older children, the joint

incongruity, poor remodeling potential of acetabulum and muscle contractures limit the reduction of the free fragment. However as long as the hip can be concentrically reduced and with good range of motion while reduced, children are the candidates. Salter osteotomy is a type of redirection osteotomy with the aim to reorientate the acetabulum without changing the joint surface or shape. After the surgery the patient is immobilized in a hip spica cast for 6 weeks.

The main goal of the Pemberton osteotomy (Pemberton, 1965) is to reorientate the acetabulum forward and lateral and therefore provide extra coverage of dysplastic anterolateral acetabulum (Pemberton, 1965; Pemberton, 1974) by pericapsular osteotomy around the acetabulum. The surgery is indicated for children 1 to 14 years old, with congenital subluxation of the hip. Before the age of one year, the bone is still too immature and the oldest age is defined by triradiate cartilage plasticity and remodeling potential needed for acetabular displacement (Baki et al., 2016). Postoperatively, hip spica cast is needed for 6 weeks.

### 2.2. Dega osteotomy

Dega osteotomy is another redirection incomplete osteotomy similar to Pemberton osteotomy. It is most often used in hip dysplasia due to developmental disorders such as spastic cerebral palsy (Mubarak et al., 1992). It was described by Dega et al to treat developmental dislocations of the hip with deficient anterolateral coverage. Dega osteotomy is indicated for children between 4 and 16 years of age. This procedure is not recommended for skeletally mature patients. Postoperatively, patients are maintained in a hip spica cast for 6 weeks.

### 2.3. San Diego osteotomy

San Diego osteotomy was developed by dr. McNeerney (McNeerney et al., 2000) for treatment of subluxated hips in children with an open triradiate cartilage in a similar way as Dega osteotomy. It was developed specifically for hip subluxations which resulted from neuromuscular abnormalities and is special in a way it combines osteotomy with muscle-tendon lengthening, open reduction of the hip with capsulorrhaphy and capsular acetabuloplasty. The aim of the osteotomy is to create greater posterior acetabular coverage (McNeerney et al., 2000). It is indicated in children between 4 and 15 years of age and can also be performed in cases with femoral head incongruity. It is used mainly for posterolateral acetabular deficiency (Kim et al, 2012). Standard postoperative casting is necessary.

### 2.4. Bernese periacetabular osteotomy

Bernese periacetabular **osteotomy** is indicated in skeletally mature adult patients with symptomatic acetabular dysplasia. The procedure is also known as periacetabular osteotomy (PAO)(Ganz et al., 1988). It is a reorientation type of osteotomy which combines ischial, pubic and iliac cuts and therefore releases the acetabular fragment free which permits considerable correction of version, lateral coverage and anterior coverage. The ischial osteotomy is incomplete and posterior column is spared which allows postoperative partial weight bearing and enables good healing potential. Free fragment is fixed with 2 or 3 cortical screws. Postoperatively, the patients don't need casting (Millis et al, 2009; Trousdale et al., 1995).

### 2.5. Triple (Tonis) osteotomy

Triple (Tonis) osteotomy is a complete reorientational osteotomy based on Salter innominate osteotomy to improve restricted movement of the fragment and limited lateralization of the acetabulum. It is a successful procedure for treatment of complex congenital, neuromuscular and teratologic hip conditions (Steel, 1973; Rebello et al., 2009). Unlike Salter and Pemberton osteotomies, three cuts in triple osteotomy allow complete freedom of the acetabular fragment and is used frequently.

### 2.6. Shelf osteotomy

Shelf osteotomy is a salvage procedure where bone graft is used to increase the femoral head coverage instead of cartilage. It is used in hips with acetabular abnormality or aspherical congruity. Shelf osteotomy was popular in treatment of acetabular dysplasia before reorientation osteotomies

became more popular and proved more effective (Wainwright D, 1976). After the surgery the spica cast is indicated. In contrast to reorientation osteotomies, the shelf osteotomy can be performed in a hip with osteoarthritis changes.

### 2.7. Chiari osteotomy

Chiari osteotomy is another type of salvage osteotomy described by Chiari (Chiari, 1974) who used medially displaced cancellus bone of the ilium to improve load distribution pattern in the hip joint. It is indicated in young adults when reorientation osteotomy is not possible (Morrissy, 2001). Both shelf and Chiari osteotomies are used in young adults to improve femoral head coverage in slightly osteoarthritis hips when reorientation osteotomies are contraindicated.

## 3. Experience of University Medical Centre Ljubljana

In Ljubljana Medical Centre at the Department of Orthopaedic Surgery the osteotomies are made for many years, however yearly numbers are small and are decreasing.

Redirectional osteotomies are performed at the Pediatric orthopedic department, yearly under 10 cases and mainly for treatment of hips in children with neuromuscular disorders.

Due to good ultrasound screening program of all newborn hips in the 6<sup>th</sup> week after birth, the need for later operative treatment of DDH has considerably decreased. Also the x-ray screening protocol for hip migration in children with neuromuscular diseases has decreased the number of hip reconstruction surgeries with pelvic osteotomies.

Some cases which are missed, refractory to conservative treatment or diagnosed to late, still need operative treatment. Since 2015, reorientational periacetabular osteotomies in young adults have been done through a minimally invasive transartorial approach described earlier by Soebale (Soebale, 2013). From 2018 on, electromagnetic surgical navigation system for precise positioning of the free acetabular fragment is applied which shows promising early results (Stražar, 2021).

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