U P T O D A T E

2006: the value of pelvic and femoral osteotomies in hip surgery

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Abstract. Hip problems are frequent and can represent a therapeutic challenge for the orthopaedic surgeon. In the wide spectrum of hip pathologies, coxarthrosis still remains the most common cause of hip disability. The treatment of hip disorders in adult patients has rapidly evolved during the past decades because of the enhanced understanding of osteoarthritis (OA) aetiology combined with improved imaging, better patient selection and refinements in surgical procedures. Despite great strides that have been made in the field of total hip arthroplasty (THA), femoral and pelvic osteotomy still play a successful role in the prevention and treatment of OA. Primary OA is rare, or may not exist at all, and the majority of cases that are considered as primary are secondary to a pre-existing anatomical deformity. If an identifiable anatomic and biomechanical hip abnormality is diagnosed, its surgical correction may prevent or lessen OA and postpone THA for many years or even indefinitely in certain cases. The success of such surgery depends on the correct indication, time of surgery, completeness with which osteotomies normalize the environment of the hip, and the grade of OA present when procedure is performed. (www.actabiomedica.it)

Key words: Osteotomy, hip, acetabulum, pelvis, femur, total hip arthroplasty

Introduction

Hip diseases are a common cause of disability, a fact made more problematic by the higher levels of physical activity in the mature population and by the increased life expectancy.

Their treatment in the mature population is challenging because these patients show a wide spectrum of disorders ranging from structural abnormalities of the joint to extra-articular problems. In this wide spectrum of pathologies, OA of the hip still remains the most common cause of disability in our society.

Despite continuing technical evolution and innovation, the increasing reliability and extension of the indication for THA, femoral and pelvic osteotomies maintain their essential role in the treatment and prevention of hip OA.

The widespread use and the advances in THA since the 1960's led many orthopaedic surgeons to abandon the use of osteotomies and the literature regarding hip diseases shows a heavy importance on arthroplasty (1, 2).

However, the still unsatisfied demand for artificial prosthetic surfaces with the mechanical properties and durability of articular cartilage (3) and the consciousness that each new generation of artificial weight-bearing surfaces and bone-implant interfaces, because of wear debris and osteolysis, result, in the long run, in functional limitations and high failure rate, increase the value and indications for femoral and pelvic osteotomies (2).

For these reasons THA has to be considered the treatment of choice for older patients who are not expected to outlive the implant and in end stage OA; in the younger and more active patient THA should therefore be considered with caution and becomes a less desirable solution in cases in whom the cause of OA is mechanically correctable (4-8).

By understanding the aetiology of OA one may be better able to direct its treatment (9). OA may be considered either a primary (idiopathic) or a secondary process.

Many studies suggest that primary OA is rare, or may not exist at all, and that a majority of cases of primary OA are secondary to a pre-existing anatomical deformity and hip joint degeneration due to primarily mechanical reasons such as hip dysplasia, slipped capital femoral epiphysis, Legg-Calvè-Perthes disease or other structural abnormalities (9-13). In these cases the anatomical deformity leads to excessive loads per unit area that exceed the tolerance levels of the intrinsically normal articular cartilage and subchondral bone (4); there is a mechanical overload of the joint, which would, if not corrected, lead to OA.

If an identifiable anatomic or biomechanical abnormality is diagnosed, the correction through osteotomies of the primary deformity, to a degree that brings joint contact pressure within tolerable limits and improves the hip mechanical environment, may prevent or lessen OA and postpone THA for many years or even indefinitely in some cases.

It has been demonstrated that the best results correlate inversely with the grade of OA and to the symptoms at the time of intervention (14, 15). Osteotomies of the hip can be discussed in relation to two different situations: prevention of OA and treatment of OA (4).

A technique that prevents OA may be considered as prophylactic and has to be performed on an established deformity before the development of this pathology. The goal is to prevent ("preventive" osteotomies) the deformity or mechanical condition that leads to secondary OA.

The majority of the patients undergoes surgery at a stage when symptoms are minimal and function is still excellent; for these reasons it is often difficult to convince the patient to undergo surgery. To justify the choice of such surgery, the orthopaedist must be able to identify those clinical situations in which the natural history would be that of ultimate OA and in which the predicted benefits of the osteotomy will exceed the predicted risks (16, 17).

A technique that "treats" OA may not be considered as prophylactic because the surgeon has missed the opportunity for true prevention of OA and is performed at a time when some degree of OA is present and before end-stage disease develops. The goal is to improve hip function and to postpone THA ("salvage" osteotomies); decades of improved function have been documented in hips already deformed by OA, sometimes obviating the need for THA entirely (18).

Hip osteotomies may be considered as surgical procedures that are too invasive or dangerous but, given the current technologic state of THA, in selected patients, the successful role of osteotomies still exists.

An important step of this surgery lies in understanding the pathomechanics of each particular deformity and in the refinement of patient selection criteria. A detailed history, physical examination and appropriate imaging of the hip are critical in understanding the specific origin and location of the disease, and in determining the most appropriate type of treatment.

Patient evaluation

Selection of patients and history

Every patient who has potential or established OA may be candidated for femoral and pelvic osteotomy. Their radiographs should demonstrate a mechanical pathogenesis of the disease with a correctable mechanical problem identified as the cause of hip dysfunction.

The patient's occupation, level of activity, preoperative articular range of motion (ROM), age, weight and smoking, preoperative grade of OA, alignment and lengths of the limbs and status of the ipsilateral knee and of the spine are all important factors in the decision to perform osteotomy.

Good preoperative ROM correlates with a better long-term outcome for hip osteotomies (19, 20). Obesity and smoking are factors that should be discussed and preoperatively treated (2).

Absolute contraindications to osteotomy include severe limitation of ROM (<60° of flexion), end-stage OA, neuropathic arthropathy, severe osteoporosis, inflammatory diseases and infection (2). Relative contraindications include mild to moderate stiffness, advanced age and mild to moderate OA (2).

Supposing that, the older the patient and the more arthritic the hip, the more clearly the relative advantages and disadvantages of joint replacement versus osteotomies should be discussed (5), we can assume that:

- the ideal candidate for a "preventive" osteotomy is someone with a mechanical hip problem younger than 25 years-old, without radiographic signs of OA and without joint stiffness
- the ideal candidate for a "salvage" osteotomy is someone with a mechanical hip problem younger than 50 years-old, with some radiographic signs of OA but before end-stage disease develops and without severe joint stiffness.

A complete interview including patient expectation, symptoms and previous trauma and surgical treatment is important.

The patient's symptoms may reveal the nature of the mechanical hip problem that is usually associated to pain, weakness of ipsilateral limb, limping, instability, locking and snapping.

Mechanical pain is initially mild, perithrocanteric, associated with fatigue of the abductor muscles and sometimes radiates to the knee. It relates to weight-bearing and relieves with rest.

In hip dysplasia the feeling of instability and giving way is also often present.

Femoro-acetabular impingement is characterized by pain depending on the position of the limb. It classically occurs at night and is relieved by repositioning of the limb in flexion, adduction and external rotation.

Acetabular rim syndrome is characterized by sharp groin pain, locking and catching symptoms (21).

Physical examination

The examiner should evaluate not only the ipsilateral hip but also the patient's back, knees and contralateral hip to exclude alternative sources of pain.

The clinical hip examination of a patient with potential mechanical related problems includes the examination of stance, ROM, gait, limb lengths, abductor strength and special tests.

Documentation of ROM in all planes and presence of contracture is essential.

Special tests are useful in patients with suspected hip related pain.

The "bicycle test" is useful in suspected hip dysplasia to elicit the pain of abductor fatigue. The patient should be examined in the lateral position with the affected hip up and a bicycle pedalling manoeuvre is performed while the lateral and posterior margins of the trochanter are palpated; the manoeuvre against resistance should exacerbate the pain.

The impingement test is used to delineate anterior acetabular rim disorders that are typical of impingement syndromes. It consists in a rapid internal rotation of the flexed (90°) and adducted (15°) hip.

The apprehension test is used to demonstrate anterior instability or labral lesions. It consists in a rapid external rotation of the extended hip and is positive if it elicits apprehension or anterior hip pain.

Imaging

The optimization of patient selection, preoperative planning and surgical technique requires an imaging in which hip anatomy is accurately detailed (22, 23). Plain radiographs remain the gold standard of imaging for most of mechanical hip problems. Initial radiographic assessment should include a standing antero-posterior (AP) pelvis, false profile (24), and frog lateral view of the hip. The identification of any structural abnormalities and of the presence and degree of cartilage space loss directs the treatment. Specific parameters that are assessed include the lateral center-edge angle of Wiberg (25) (normal greater than 25 degrees), the anterior centre-edge angle of Lequesne (24) (normal greater than 20 degrees), the acetabular index angle of Tönnis (normal 10°+/- 2°) (26), the sphericity of the femoral head, the femoral head-neck off-set, the height of the greater trochanter, the acetabular version through the cross-over sign, and the femoral cervico-diaphyseal angles (9). When considering an osteotomy, functional AP views of the hip with the femur in abduction and adduction should be performed to check congruency and to observe the articulation in a position simulating the osteotomy (23). Bi-dimensional or three-dimensional computed tomography (CT) scans can be useful to better understand the anatomy of the hip particularly in determining the version of the acetabulum and the femoral head deformity (13).

Gadolinium-enhanced magnetic resonance imaging (MRI) studies are utilized to demonstrate intra-articular pathology such as labrum abnormalities and acetabular cartilage damages (27, 28).

Preoperative planning and selection of the osteotomy site

Meticulous planning of the procedural details before surgery is important and related to the success of the osteotomy. Based on the clinical data and the imaging, the surgeon has to plan the site and level of osteotomy, the degree of correction, the need for wedge or block resection, the leg-length correction, the displacement, the mechanical axis alteration, the fixation devices, the need of bone grafting and the compatibility with future THA.

The site of osteotomy depends on the localization of the deformity. Usually femoral osteotomies are indicated for the treatment of primary femoral disorders (for example osteonecrosis, slipped epiphysis, Perthes disease, isolated coxa vara and valga) and pelvic osteotomies are indicated for the treatment of primary acetabular disorders (for example acetabular dysplasia) (4). In some particular cases both deformities are present and a combined femoral and pelvic osteotomy is necessary.

Osteotomies about the hip

Several hip diseases are characterized by structural abnormalities that predispose the joint to localized overload and premature secondary OA. The surgical treatment of these conditions is directed at addressing intra-articular diseases normalizing the osseous anatomy, improving hip biomechanics and relieving localized articular surface overload (4, 5).

The association of intra-articular disorders with a structural abnormality has to be preoperatively considered. Additionally hip arthrotomy or arthroscopy can be combined with osteotomy using the same anaesthetic to address and treat any intra-articular pathology.

Femoral osteotomies

Femoral osteotomies are usually classified referring to the final geometry of the proximal femur in the frontal plane (varus or valgus osteotomies). Corrections of rotation, length and coronal plane abnormalities can be added depending on the initial disease and deformity.

Isolated varus intertrochanteric (ITO) osteotomy (Figure 1) is indicated for isolated coxa valga or in the rare cases associated with mild dysplasia or ipsilateral leg-length discrepancy (ipsilateral leg longer) and in some cases of early OA or osteonecrosis; in general, the ideal candidate is a patient with a spherical femo-

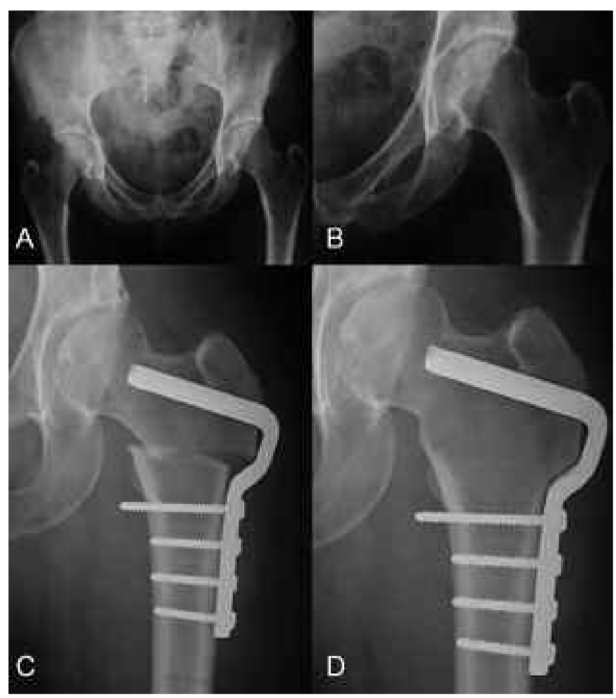

Figure 1. Bilateral coxa vara. A, B) preoperative X-ray of the pelvis and of the left hip. C) postoperative X-ray after varus femoral osteotomy of the left hip. D) consolidation of the osteotomy

ral head, little or no acetabular dysplasia with an eccentric sourcil, a neck-shaft angle of more than 135° of valgus and with preoperative dynamic radiographs that demonstrate improved congruency of the hip.

Isolated varus ITO for dysplasia is rarely performed and more frequently a combination of varus ITO and pelvic osteotomy is performed and since the problem is mainly localized to the acetabulum, the surgeon should not create excessive varus angulation of the femur in an attempt to compensate for a persistent oblique acetabulum.

In varus ITO, excellent fixation is achieved using a 90° osteotomy plate and a prerequisite of such surgery is a minimum of 15° of preoperatively passive abduction.

Excessive medial displacement of the femoral shaft may cause problems with healing and future femoral stem placement. Generally a medial displacement of ten to fifteen millimetres is desirable not only to decrease the adductor forces but also to keep the ipsilateral knee centred under the femoral head and to maintain the femoral axis (29).

Varus ITO may encounter some disadvantages including shortening of the leg, Trendelenburg gate and increasing of the prominence of the greater trochanter. The leg-shortening could be obviated by the execution of an opening wedge laterally rather than the removal of a medial wedge. A Trendelenburg gate is permanent in up to 30% of patients (20, 30); in these cases an osteotomy and distal transfer of the greater trochanter may obviate to abductor dysfunction and possible consequent chronic bursitis.

Valgus ITO is commonly indicated for the treatment of femoral neck nonunions and in these cases the goal is to convert shear forces into compressive stresses that increase the possibilities of union. Correction of proximal femur using the valgus ITO may also be useful in coxa vara (shaft angle of less than 120° of varus) associated with ipsilateral leg-length shortening and adult sequelae of Legg-Calvè-Perthes disease (31).

In certain cases of femoral head osteonecrosis (Ficat stage III of the antero-lateral segment of the femoral head with no more than 5 mm collapse on the AP radiographs) an additional flexion component to the valgus osteotomy is recommended to move healthier articular cartilage into the weight-bearing zone of the acetabulum.

In some young patients with initial supero-lateral OA a valgus-extension osteotomy may be indicated and the long-term results can be very good. The addition in the sagittal plane of an extension osteotomy increases the effectiveness of this procedure by improving anterior coverage of the femoral head and reducing any fixed flexion contracture (32).

In slipped capital femoral epiphysis no valgus correction is usually necessary. Most of these cases are associated with an extension deformity through the proximal portion of the femoral neck and the physis with an associated severe retroversion; varus deformity is only apparent (33). The best correction is obtainable with an osteotomy through the open physis but the risks of avascular necrosis of the femoral head and chondrolysis are high; an isolated flexion ITO is a less hazardous option with good results (34).

Pelvic osteotomies

Pelvic osteotomies are indicated for the treatment of primary acetabular disorders (for example acetabular dysplasia) and are divided into reconstructive and salvage procedures. The choice of the procedure depends on the disease, the deformity, and on the grade of OA.

Reconstructive osteotomies redirect the acetabulum into a more correct position relative to the femoral head. After these osteotomies the femur continues to articulate with hyaline cartilage. These surgical pelvic procedures are indicated in young adults (generally less than 25 years old) with minimal or no symptoms, with hip function and motion that are nearly normal and before the development of OA (4).

Salvage osteotomies provide additional support to the femoral head without redirection of the acetabular fragment. After these osteotomies the femur articulates with the hip capsule that, in the long run, changes into fibrocartilage rather than hyaline cartilage. These surgical pelvic procedures are indicated in adults (generally less than 50 years old) with moderate to severe symptoms, with limited hip motion but with > 60° of flexion and when some degree of OA is present but before end-stage disease develops (4).

Reconstructive osteotomies

The single innominate osteotomy was introduced by Salter (35) (Figure 2A) and reorients the acetabulum by wedging open bone that is cut just proximal to the infero-anterior iliac spine (filled by bone graft from ilium) and by rotating the pelvic fragment through the pubic symphisis. This osteotomy tends to lateralize the joint and to lengthen the limb. The degree of correction and the possibility of reorienting the fragment in multiple planes is limited because of the increasing age-related stiffness of the pubic symphysis and of the large soft tissue attachments.

The double innominate osteotomy was described by Sutherland and Greenfield (36) (Figure 2B). Proximally this procedure is similar to Salter osteotomy but distally a second osteotomy, just lateral to the symphysis, is performed to reorient the acetabular fragment. The degree of correction in this surgical procedure is limited.

Several triple innominate osteotomies have been described to avoid lateralization of the hip and to improve the amount of correction and femoral head coverage. The triple osteotomy introduced by Steel (37) (Figure 2C) combines an open wedge osteotomy, just proximal to the infero-anterior iliac spine (filled by bone graft from ilium), with that of the pubic ramus and of the ischial tuberosity. This osteotomy is quite far from the joint and the maintaining of sacro-pelvic ligaments limits the acetabular mobilization; sometimes the marked angular correction creates instability of the hemipelvis and this does not allow immediate weight-bearing and increases the potential risk of an ischial non-union (38). The modified triple osteotomy described by Tönnis (39) (Figure 2D) is juxta-articular and the bone cuts are made closer to the acetabulum, allowing for increased correction with less subsequent bone deformity. However it can potentially create a large bone defect between the ischium and the osteotomized acetabulum requiring extensive fixation as well as special methods of postoperative stabilization and multiple and extensive surgical approaches (13).

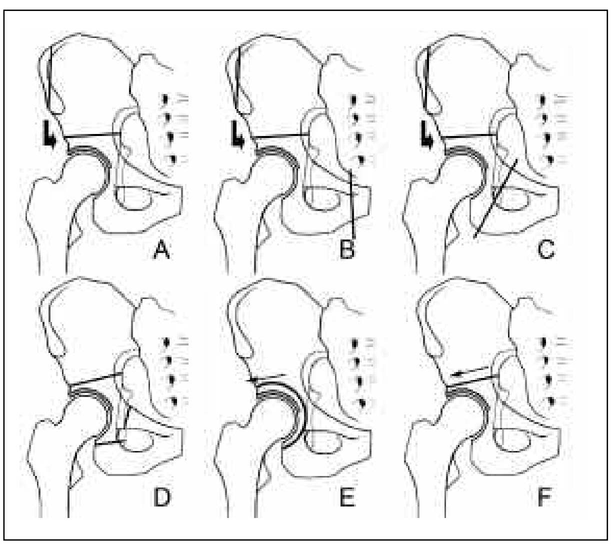

Figure 2. Pelvic osteotomies. A) Salter osteotomy. B) Sutherland and Greenfield osteotomy. C) Steel osteotomy. D) Tönnis osteotomy. E) Wagner spherical osteotomy. F) Chiari osteotomy

Spherical or rotational osteotomies described by Eppright (40), Wagner (41) and other authors (15, 42) tried to obviate the shortfalls of previous reconstructions. Eppright's osteotomy (40) is a barrel-shaped ostetomy along an antero-posterior axis which allows for excellent lateral coverage but a limited amount of anterior coverage. In Wagner's spherical acetabular osteotomy (41) (Figure 2E) special curved gouges allow the separation of the acetabulum from the pelvis approximately 15 millimetres above the articular surface. By making the bone cuts closer to the joint, larger corrections could be achieved without risks of hemipelvis instability and maintaining the posterior column intact. On the other hand in these spherical and rotational juxta-articular osteotomies the risk of unintended penetration of the joint and of acetabular avascular necrosis is increased. Acetabular fragment vascularity is warranted through the undamaged vessels of the hip capsule and, because of this, a simultaneous capsulotomy should not be performed but should be delayed until it has healed.

To address the difficulties and limitations of the previously described technique, the Bernese periacetabular osteotomy was developed in 1983 and first described by Ganz in 1988 (43). This is a polygonal shaped juxta-articular osteotomy (Figure 3) which may be performed through one single approach, where large corrections can be obtained in all directions without any external fixation since the posterior column of the ischium remains intact protecting the

Figure 3. Bernese periacetabular osteotomy in hip dysplasia. A, B) extent of osteotomy lines. C, D) preoperative X-ray of the pelvis and of the left hip. E) postoperative AP X-ray projection after periacetabular osteotomy of the left hip. F) consolidation of the osteotomy

sciatic nerve and permitting an early mobilization. The diameter of the true pelvis remains intact permitting unimpaired vaginal delivery. The blood supply to the acetabulum is preserved and this allows an anterior joint capsulotomy for the diagnosis and treatment of intra-articular diseases and to assess an intra-articular instrument penetration. Two different surgical approaches have been used: the Smith-Petersen modified approach (13, 44) and the ilio-inguinal approach (45). The majority of hip surgery centres use the modified S-P approach because of the higher rate of vascular complications with the I-I approach (46).

Five osteotomies have to be performed:

- "incomplete ischiatic osteotomy" which starts at the infracotyloid groove incompletely separating the ischiatic bone;
- complete osteotomy of the pubic ramus at its mid-point beginning medial to the pectineal eminence and angled medially;
- "supra-acetabular iliac osteotomy" extending through the ilium from a point between the anterior superior and anterior inferior iliac spines to a point 1 cm proximal to the pelvic brim and 3 cm anterior to the sacro-iliac joint;
- "retro-acetabular iliac osteotomy" extending, along the posterior column, from the end point of the supra-acetabular iliac osteotomy to a point distant 4 cm from the pelvic brim;
- "fracture controlled osteotomy" which connects the incomplete ischiatic osteotomy to the retro-acetabular osteotomy at a level 4 cm distal to and parallel to the pelvic brim.

The osteotomized acetabulum is then reoriented and definitively fixed with cortical screws. A periacetabular osteotomy combines the advantages of long-term pain relief, preserved range of motion and eventually the future possibility of total hip replacement. The operation is technically difficult, has a definitive learning curve, requires a complete understanding of the pelvic anatomy and should be performed on models and cadavers prior to patient intervention. The majority of complications occurs in the initial cases and include intra-articular penetration, avascular necrosis, nerve and vessel injuries, osteotomies nonunions, heterotopic ossification and fracture of the posterior column (14, 47-53). Postoperative under- or overcorrection of the acetabulum may lead to insufficient flexion, abduction or both, especially if a preoperative retroversion is not taken into account. In these infrequent but not rare cases (9) with posterior deficiency and with normal or excessive anterior coverage, a routine method of correction (lateralization and antiversion of the acetabular fragment) is not indicated and may result in a pathologic anterior femoro-acetabular impingement. In these particular situations a resection osteoplasty of the femoral neck after pelvic osteotomy should be indicated (54, 55).

Salvage osteotomies

Salvage procedures include the Chiari (56) and shelf osteotomies.

The Chiari osteotomy (56) (Figure 2F) is a medial displacement osteotomy of the ilium just proximal to joint capsule. After the bone cut is performed the hip is displaced medially, decreasing the hip joint reactive forces and reducing the stresses on the abductor muscles. However, it is difficult to obtain anterior coverage of the femoral head.

In the shelf-procedures corticocancellous bone is fixed to the antero-lateral aspect of the ilium. Local bone is used to augment the deficient lateral margin of the acetabulum increasing lateral head coverage.

Both procedures are limited by their dependence on fibrocartilage as a bearing surface, which is inferior in axial loading properties to articular hyaline cartilage.

Combination of pelvic and femoral osteotomy

In dysplastic hips there is an increasing body of evidence that the main problem is on the acetabular side (acetabular dysplasia) (44, 57); in the majority of patients there is a poor coverage of the superior and anterior part of the femoral head, a reduction of the femoral depth, excessive lateralization of the femoral head, an abnormal Wiberg angle, anterior centre edge angle and acetabular index. In these cases the most physiologic solution is an isolated reorientation of the acetabulum into a more normal position and restoration of normal biomechanics.

Less frequently the deformity is encountered on both sides of the hip joint; in these patients the ideal treatment should be directed to the femur and to the acetabulum and the selection of the appropriate surgical procedures should be preoperatively planned and based on clinical and radiographic findings.

In patients with coxa valga in combination with dysplasia a varus derotational femoral osteotomy (Figure 4) can be performed together with the pelvic osteotomy or at a later date. Many authors recommend doing a pelvic osteotomy first, followed by ITO (52, 58). This is indicated if the femoral head is still lateralised after the rotation of the acetabulum and congruent with the hip in abduction. On the contrary other surgeons perform first a planned ITO and later the pelvic osteotomy because the final position of the acetabular fragment is more easily reoriented (2).

Pelvic osteotomies and vaginal delivery

The majority of patients candidate for pelvic osteotomies are young fertile females. Concerns have been raised regarding the impact of the altered pelvic morphology after osteotomy on pregnancy and delivery. The Chiari, Salter, Steel and Sutherland osteotomies alter the pelvic diameters and in these cases a caesarean delivery should be considered (59, 60).

Figure 4. Combined Bernese periacetabular osteotomy and varus ITO in dysplasia of the right hip. A) preoperative AP projection X-ray. B) postoperative AP projection X-ray

The rotational and periacetabular osteotomies maintain the integrity of the posterior column and the true pelvis remains intact allowing unimpaired vaginal delivery (43, 61).

Discussion

Hip diseases in the young adult can cause considerable disability. The orthopaedic treatment of these patients requires a thorough understanding of the wide spectrum of disorders that may present in this population and consequently a meticulous selection and a clinical and radiographic assessment of the patients is necessary.

Coxarthrosis is the most common cause of hip related problems and, in the majority of the patients, it has a mechanical origin and is secondary to a developmental deformity. The correction through osteotomies of the primary deformity, to a degree that brings joint contact pressure within tolerable limits and improves hip mechanical environment, may prevent or lessen OA and postpone THA for many years or even indefinitely. New imaging techniques, including CT and gadolinium-enhanced MRI, have led to a much more precise characterization of anatomic abnormalities. MRI images are useful to demonstrate intra-articular pathology such as labrum abnormalities and acetabular cartilage damages that are often associated with bone deformity.

These factors and the consciousness that, despite continuing technological advances, no artificial joints have the durability or mechanical properties to allow their permanent implant in the young and active patient, have contributed to the expanding field of femoral and pelvic osteotomy surgery that still plays an important role in the surgical treatment of hip problems and should not be forgotten.

Meticulous preoperative planning of the procedural details is important. Based on the clinical data and the imaging the surgeon has to plan preoperatively the site and level of osteotomy, the degree of correction, the need for wedge or block resection, the leg-length correction, the displacement, the mechanical axis alteration, the fixation devices, the need of bone grafting and the compatibility with future THA.

The site of osteotomy depends on the localization of the deformity. In general femoral osteotomies are indicated for the treatment of primary femoral disorders and pelvic osteotomies are indicated for the treatment of primary acetabular disorders. Although the proximal region of the femur has been historically the usual site of realignment in hip's osteotomies, in the last decade pelvic osteotomies have been performed more frequently.

In some cases both deformities are present and a combined femoral and pelvic osteotomy is necessary.

Several osteotomies have been described in the orthopaedic literature; the results and the complication rate of this type of surgery have improved together with continuing advances in the surgical techniques.

Pelvic and femoral osteotomies are demanding technique and their success depends on correct indications, accurate imaging and preoperative planning, careful attention to technical details and surgical experience.

Contemporary muscle-preserving surgical approaches and combined intra-articular surgery (arthrotomy or arthroscopy) with osteotomy are contributing to these successes and to a more rapid and less painful rehabilitation.

Future directions in femoral and pelvic osteotomies include integration of preoperative planning with intraoperative computer assistance and navigation.

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