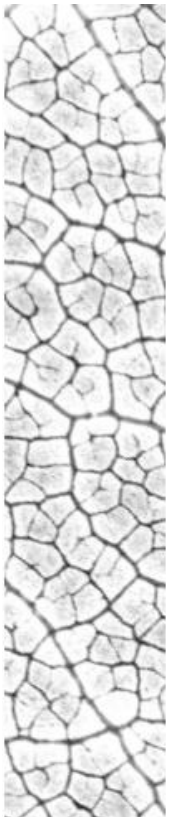

EurAsian Journal of BioSciences
Eurasia J Biosci 14, 4673-4676 (2020)

Pelvic support osteotomy using ilizarov external fixator

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Abstract
Injury and deformity remained part of human life and suffering for long. A deep injury requires a detailed diagnosis, strategic planning, and stepwise approach to recover the patient. The present review provides an updated view of the epidemiology, diagnosis, surgical technique, and complications, related to pelvic surgery or hip reconstruction. Hip surgery is an intricate and complicated process that requires keen attention to detail in many aspects of the process. Extensive care should be taken on the clinical, physiological, surgical aspects along with the patient's condition and specific surgical requirements.

Keywords: pelvic support osteotomy, ilizarov external fixator

Alsalihi AAM, Khalel Thalaj MI (2020) Pelvic support osteotomy using ilizarov external fixator. Eurasia J Biosci 14: 4673-4676.

INTRODUCTION

Injury and deformity remained part of human life and suffering for long. With complications and situations, we have always attempted to attain a feasible medical solution and render comfort to the victims of injury. Medical science poured tremendous effort in this direction to provide the best possible remedy to the patient having a serious injury in any body part. Bone injury and skeletal muscle injury require special attention due to long term suffering and treatment regime involved. Moreover, the deep injury requires a detailed diagnosis, strategic planning, and stepwise approach to recover the patient. Modern scientific advancements in imaging techniques, scales, surgical procedures and instruments, neuromuscular rehabilitation techniques, biomechanical support helped to enhance the patient outcome and the quality of life at the post-operative stage successfully. The present review provides an updated view of the epidemiology, diagnosis, surgical technique, and complications, related to pelvic surgery or hip reconstruction.

A hip injury is prevalent among the elderly population (Mattisson et al., 2018), women (Veronese and Maggi, 2018), and sports persons (Lundgårdh et al., 2019) due to various unavoidable reasons. Often, these types of debilitating hip injuries and fractures occur suddenly, sometimes such situations can be caused due to infection, and other reasons. Countering such a situation requires precision in treatment planning, proper short or long term rehabilitation and follow-ups, and depending on the necessity, multiple accurate surgeries.

Epidemiology

A prevalence of hip fracture is observed in women. The obtained epidemiological information regarding hip fracture suggests divergence among countries. However, the global estimates suggest that almost 18% of females and 6% of males are affected due to one or the other hip fracture associated complications (Veronese and Maggi, 2018). With the growing aging population globally, the number of patients with hip fracture and relevant issues is also increasing. The global data forecasting suggests that the number of patients in 2050 will be approximately 4.5 million (Veronese and Maggi, 2018). Such prevalence of hip fracture occurs mostly in the pelvis and hip joints due to age, weakness of the hip muscles and hip drop, participation in the contact sports, and working with field explosives (Larkin 2017). Several countries developed a precise database in this context and registered the patient information related to hip injuries. Trochanteric and subtrochanteric fracture data are available for the Swedish population that suggests that most of the patients are elderly and are above 80 years of age and the majority of the patients suffered such injuries due to sudden fall (Mattisson et al., 2018). Hip injuries are not always life-threatening but require long term care and support from the medical professionals and the family members of the patient. However, the association of higher mortality was noted for the patients having hip fractures and traumatic brain injury (TBI) by Albrecht and colleagues (Albrecht et al., 2019).

Received: June 2019
Accepted: April 2020
Printed: October 2020

Immediate measure

The apparent and immediate treatment regime followed for hip injury is the application of cold packs regularly throughout the day. Pain reliever medications including acetaminophen, ibuprofen, and similar compounds are often used in the form of a tablet or spray to reduce the pain temporarily. Resting with no movement is recommended depending on the condition of the patient.

DIAGNOSIS

Primary investigations

The primary clinical investigations include detection of the exact location of the origin of pain in the hip joint and the groin area. Assessment of the tenderness, muscle weakness, walking disability, and stair climbing are done to understand the nature of the injury and the intensity. Further, pains are assessed based on the leg movement through lifting towards chest and leg extension, pulling sensation, and associated pain. The existence of muscle spasm, swelling, and inflammations are also keenly evaluated.

Clinical and Radiological investigations

The availability of the examination algorithms pertaining to the diagnosis of the hip injury is limited. The evaluation of intra-articular and extra-articular symptoms is mandatory to understand the pain source. Advanced techniques such as Scour tests, Flexion-Abduction-External Rotation (FABER), and Internal Range of Motion with Over-Pressure (IROP) are commonly used for this purpose (Leunig et al., 1997; Sutlive et al., 2008). The movement of the hip joint is evaluated using a range of motion tests.

Assessment Scales

Normal hip functionality is estimated using the popular Harris Hip score that considers four important components such as pain, functionality, presence, and absence of deformity, and normal range of motion assessment (Nilsdotter et al., 2011). Depending on the requirement and specificity of the case, other scales are regularly used. In case of the presence of osteoarthritis and hip disability, Hip Disability and Osteoarthritis Outcome Score (HOOS) scaling system are used. In the case of total hip replacement, the Oxford Hip Score (OHS) is effectively used to evaluate the disability, psychological analysis of the patients (Wylde et al., 2005). Stages of osteoarthritis and relevant requirements assessment are scaled through the Lequesne Index of Severity for Osteoarthritis of the Hip (LISOH) by 11 items that allow understanding the subjective feedback of the patient's limb condition and osteoarthritis status (Dawson et al., 2005).

Impingement and instabilities detection

In addition to the mentioned measures, impingement and instabilities are examined with specific attention, especially the types of femoroacetabular impingement (FAI) such as Cam and pincer. The former type (Cam) occurs due to the atypical bumps, and abnormality of femoral head-neck attachment and localization that can result in cartilage damage in the acetabular region. Hip movement direction and deformity location are assessed to understand the location and intensity of the damage. The later type (pincer) caused majorly due to the acetabular shape, size, attachment, and movement damage. Both Cam and pincer type hip injury can be evaluated efficiently and accurately using Dynamic Internal Rotation Impingement test (DIRI), dynamic external rotation impingement test (DEXTRI). Apart from patients with the normal femur, evaluation of patients with abnormal femur due to congenital issues or other reasons are evaluated applying Craig's test. Diagnosis of instability requires additional evaluation of the hypermobility through Beighton Scale. Available other range of motion evaluation techniques can also be helpful in such a diagnosis of hypermobility and instability. Radiological investigations include anteroposterior radiographs through X-Ray and cross table presentation for detail axial views. Often, Ducroquet and Dunn radiographs opted for a similar diagnosis. The interpretation of the diagnosis includes information on the presence of osteoarthritis or similar bone and joint deformity related investigation outcomes for decision making and correlation. Management of the situation of hip injury often requires surgical interventions of various degrees.

Pelvic Support Osteotomy

Improvement of the gait mechanics through advanced biomechanic techniques remains the goal of osteotomy corrections. The process of pelvic support osteotomy depends on two major aspects, i.e., proper adduction of the pelvis and osteotomized femur and reducing limb length inequality by abductor lever arm and musculoskeletal length adjustment for limp free biomechanics. The PSO techniques used are of conventional and advanced types.

Conventional Pelvic Support Osteotomy

The conventional method of pelvic support osteotomy relied on fixing the hip directly along with minor adjustment of the femur and the tibia. Such techniques were efficient for fracture-related pain reduction and allowed the patient to walk after recovery. However, there were shortcomings during the fixation of limb, where certain issues such as inequality of the limb length, limping during walking, deformed stances while standing remained unaddressed. The requirement to address such issues inspired the advancement of the procedure towards almost complete recovery. Ilizarov revolutionized the hip reconstruction surgery, developing it as a multistep procedure through addressing the issues faced through a conventional protocol.

Advanced Ilizarov Hip Reconstruction (IHR)

The progress of hip reconstruction surgery is a long journey with multiple stages of advancements in diagnosis and surgical procedures. The most advanced surgical process for hip reconstruction is Ilizarov Hip Reconstruction (IHR). Ilizarov applied a modified technique of the conventional procedure successfully. The proximal femur is used to provide support to the pelvis in this advanced protocol. Instead of directly operating the hip joint, the distal femoral segment is positioned into the acetabulum through an oblique subtrochanteric valgus osteotomy.

Severe deformity or damage of the pelvic joints or associated skeletal structures requires surgical intervention including pelvic support osteotomy (PSO). PSO is regularly used to restore the movement of the patient with nominal limp. This hip bypass is done by bending the upper femur at a suitable angle to restore the normal connection with the pelvis. The surgical process is a multistep procedure and requires a minimum of two separate osteotomies. Preoperative preparations are mandatory before conducting PSO. During this preoperative stage, discrepancies of equal limb lengths are solved through serial lengthening applying some external fixation measures. Depending on the necessity, such external fixation is done for femur, tibia, or pelvis. Skeletal maturity is important, hence, PSO is only conducted just before or after the skeletal maturation. Further, at the preoperative stage, Trendelenburg gait is examined, and grading is done through the recording of positive, delayed, negative Trendelenburg test. The Trendelenburg gait allows understanding the patients' abduction strength and weakness. Gait analysis is also performed as part of the examination routine before the operation to ascertain the stance time asymmetry and level of ground reaction force.

The proximal osteotomy is done after the maximum adduction of the femur towards pelvis via rotation of 40°-50°. Adjustment of the femur and tibia joint is done in the successive step and an angle of 87° is set with reference to the knee joint. Besides, the adjustment is aligned for the right angle (90°) with the pelvis. The second or distal osteotomy is conducted after this phase where the femur length is adjusted using an external fixator. The proper alignment of the femur and the tibia is confirmed in this second osteotomy. After recovery, the patient is checked for reduced or no limp using a various range of motions and walking techniques. The extended procedure of Ilizarov applies external fixators for corrections.

Surgery age limitation

In most of the recommendations by the experts, growing age till 15 years is avoided for osteotomy. The secure age limit is considered between 18 and 40. However, there are varied opinions about the age limit among experts. The pubertal and growing age should be avoided for postoperative complications or loss of correction. Osteotomy correction in growing children can have a loss of correction between 3° and 13°.

Surgery technique

In this crucial surgical intervention, the patient is allowed to be in supine posture during the procedure. Fluoroscopy based analysis is done to detect and verify the exact site of the proximal osteotomy. Special attention is given to the junction of the femoral shaft and the ischium. The pelvic arch as proximal femur part holder, mid-segment related arch or rings (>5 in number), rings related to the distal segments are used as fixators. The hinges and the lateral regions are supported by motors between the mid-segment and the distal region. Schanz pins (6mm, 3 in number) are used from the horizontal plane in the proximal femur segment for better support and holding and are attached with an arch at the right angle. The arch lies perpendicularly to the ground level and the Schanz pins. Proper measures are taken to avoid skin tenting.

Postoperative care

Different post-operative precautions, care, rehabilitation, and patient management are essential for better and proper patient recovery. Postoperative care can include ambulation, frame care, lengthening, physiotherapy, and regular patient counseling.

The initial period of recovery requires the patient's effort to stand straight with the help of crutches. In a day, multiple times effort to stand should be exercised initially with the crutches, and later on with walking sticks. Slow passive and active hip movement should be attempted under the cautious care of the medical staff or physiotherapist. The reduction of pain should be evaluated repetitively through clinical observations. The restoration of the normal hip function should be monitored from time to time as well (Catagni et al., 1998). Any possible infection should be avoided through regular cleaning of the frame following the proper guidelines. A normal saline solution can be used for regular frame cleaning. Teleoroentgenogram should be used for the evaluation of the lengthening. Follow-ups should be done as recommended by the physician and the surgeon and it will vary for each case.

Probable complications

Varying degree of pin tract infections is observed during the post-surgical recovery. Dror Paley's suggested the classification of such infection which is of three different grades, namely, Grade I, Grade II, and Grade III. The first grade is associated with minor soft tissue redness, inflammation, and minor discharge. The Grade II infection is signified by seropurulent discharge along with the symptoms of Grade I. However, no infection of bone is accounted for Grade II infection. The serious infections are graded as Grade III that may

contain osteomyelitis, occasional purulent discharge, osteolysis, pin dislocation or loosening, etc.

Apart from pin tract associated issues, there are possibilities of development of secondary fracture after the removal of the frame that may require additional care through casting or internal fixations and long term care. Other complications such as knee stiffening, the problem with residual limb length, delayed consolidation may also arise as part of post-surgical complications.

Some specific issues may arise in relation to IHR that may include dislocation of Schanz screws, cosmetic issues, and psychological issues.

CONCLUSIONS

Hip surgery is an intricate and complicated process that requires keen attention to detail in many aspects of the process. Extensive care should be taken on the clinical, physiological, surgical aspects along with the patient's condition and specific surgical requirements. The IHR technique has improved the conventional surgery outcomes and provided better post-surgery quality of life to the patient. However, the surgical process requires further improvement considering the complications countered during the surgery, and at the postoperative recovery stage.

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