

HISTORICAL NOTES**THE HISTORY OF THE ANTERIOR APPROACH OF THE HIP AND REASSESSMENT OF CURRENT INDICATIONS****T.C. Munteanu³, Daniela-Elena Mutu³, B. Nistor², S. Ruianu¹, G. Dinu¹**¹The Orthopedics and Traumatology Clinic, The Emergency Clinical Hospital, Bucharest, Romania²Medicover Hospital³The University of Medicine and Pharmacy “Carol Davila”, Bucharest, Romania

Corresponding author: Tiberiu-Ciprian Munteanu

Phone no. 0040748207070

E-mail: tiberiumunteanu@yahoo.com

Abstract

Surgical approaches were noticed through direct and rapid access to the source of the medical problem on one hand, but on the other hand, through extensive damages of viable and healthy human tissue: blood loss, loss of natural barriers of defense against infections, collateral nervous and muscular lesions from which might result sensitive or motor denervating of an area, followed by immediate or late functional deficits. Noticing the unfavorable impact that surgery has on organism, efforts of the medical scientific world were directed toward development of minimally invasive approaches in order to minimize the post-surgical outcomes by saving as much healthy tissue as possible. Thus, this step is and has been conducted through the use of anatomical knowledge and landmarks in order to create surgical approach that would limit inevitable dissection, necessary to a procedure. A recent example is the more frequent use of direct anterior approach for surgical treatment of many orthopedic hip problems.

Keywords: *hip reassessment, anterior approach, current indications***Introduction**

Karl Christoph Hueter was the first to describe in a scientific paper the hip direct anterior approach (DAA). Published in 1881, “Der Grundris der Chirurgie” (“Surgery Compendium”), contains the first written reference to this new mean of treatment of hip pathology, although Sprengel, Bardenheuer or Depuy de Frenelle might be the first to have used this technique [1]. Hueter describes in his paper the steps to be followed in order to dissect and enter into the deep areas of the hip joint. He used the anterior superior iliac spine and the greater trochanter as landmarks for an incision of 10–15 cm which would then go down parallel and lateral to sartorius muscle, reaching the

interstitium formed between rectus femoris muscle and tensor fascia latae. The only muscular fibres affected were those of vastus lateralis muscle, which originates on the anterior side of the greater trochanter which had to be detached by knife [2]. Noticing the inadequate exposure of the acetabulum, the Norwegian surgeon, Marius N. Smith-Petersen, in 1917 at the Massachusetts General Hospital in the United States extended the approach of Huerter posteriorly, along the iliac crest, thus offering a better view of the acetabulum and superior capsule of coxofemoral joint [3]. From that moment on, direct anterior approach together with a large range of variants started to become famous in the surgical world for curing various hip pathologies such as hip congenital dysplasia,

pelvic fractures or coxarthrosis, with the common aim to reconstruct the hip articulation.

History

Congenital hip dysplasia (CHD) has been electively approached through DAA since Smith-Petersen. In 1925, Marcel Lance, using the same approach, imagined a new procedure which involved increasing the acetabular bearing surface with the aid of an autologous graft of cortico-spongy bone inserted at the level of the anterior upper articular capsule [4]. In the second half of the XXth century, the surgical therapy of CHD focused on osteotomies performed at different levels of the ileum, the Smith-Petersen approach being again useful. The pioneers of this method, Salter, Ganz and others benefited the advantage of this approach regarding an appropriate direct view of both the coxofemoral articulation and the inner or outer table of the pelvis for a correct realigning of the the acetabular cavity [5,6].

Femoral head and neck fractures are treated through a minimally invasive osteosynthesis using the Hueter interval. To improve access into the articulation area, Cubbins et al. suggested incision of tensor fascia latae beneath its insertion into the fascia lata band7 while Fahey proposed the inferior extension of the incision from the distal margin [8]. In 1943, Levine accounted success with a corrective intervention of an acetabulum fracture using modified Smith-Petersen approach [9]. The collaboration between Judet brothers and Emile Letournel after 1950 led to a new extended version of the iliofemoral approach: "To reach the anterior aspect of the acetabulum, we used an ileocrural approach. This approach extends along the anterior half of the crest of the ileum as far as the anterosuperior iliac spine and the runs obliquely anteriorly and medially along the lateral aspect of the sartorius muscle for about fifteen centimetres." [16]. The major risk of this intervention is lesion to superior gluteal artery, while heterotopic ossifications are minor but frequent complications [10].

Degenerative joint disease is nowadays one of the most common treated hip pathologies through DAA. This was observed by Smith-Petersen himself at the beginning of the XXth

century when he developed an acetabuloplasty procedure (Vitallium mould arthroplasty) for degenerative lesions of the coxofemoral joint: "A joint has two surfaces which must be so shaped as to be able to function without interference or impingement through the greatest possible arc. Consequently, in the case of the hip joint, it is necessary to expose the acetabulum and its adjacent structures, as well as the femoral head and neck" [11]. Since Smith-Petersen encountered in practice shortcomings such as deficitary exposure of the acetabulum and of the femoral head and neck through already existent approaches, he tried to adapt the Hueter approach for this new procedure. Success was soon to come, and his followers, among whom Judet confirmed exceptional potential offered by this approach for a reconstruction which involved the "excision of the pathologic femoral head and its replacement by an artificial head made of a synthetic plastic material, which is firmly fixed to the upper end of the femur. To obtain good movement later we believe that it is essential to avoid all damage to muscle and bone." [12]. Still, the anterior approach was not unanimously accepted, many surgeons criticizing the placement difficulty of the femoral component of the hip prosthesis [13].

In 1985, Judet successfully used an orthopedic table in order to enhance the femoral and acetabular exposure into the Hueter interval [14]. Light and Keggi have used a more traumatic approach, splitting the tensor fascia latae, thus gaining much easier access to the articular capsule. Furthermore, they added one or more incisions for easy passage of tools [15]. Berger, in 2003 applied effort for developing minimally invasive hip arthroplastic procedures through a technique which included anterior incision for handling of the acetabulum and another transgluteal one to fix the femoral component [16]. This was to be only the beginning of a trend which would combine efforts to preserve healthy tissues with an easy passage of tools for correct placement of prosthesis components or intervention in the area. One can note that minimally invasive surgery becomes more and more prominent in hip arthroplastic procedures as well.

The etiology of the degenerative hip disorders is in most cases the result of

biomechanical imbalance of forces acting at the level of hip joint. However, there are some other causes which lead to arthritic modifications such as osteonecrosis and vascular necrosis of the femoral head, each having different approaches. In order to prevent collapse of the femoral head, Hisashi et al. intervened through the Hueter interval to remove necrotic residues and graft the femoral head [17]. 1950s represented a standing point in the historical evolution of direct anterior approach since Kirkaldy-Willis managed to set a procedure of arthrodesis using easy access provided by this approach to the hip joint [18].

Technical notes

One can notice in the DAA history that it was adapted to different pathologies, facilitating a more direct and easy access in the hip area, while at the same time being minimally traumatic possible for the soft tissues: muscles, tendons, nerves, blood vessels. As a consequence, many alternatives of the approach arose. But if we take into consideration all the other paths to approach the hip, we can count numerous treatment options of the hip area, each having specific advantages and disadvantages.

However, anterior impingement was remarked through its capacity to protect the coxofemoral articulation surrounding the structures. This aim is accomplished through economical dissection of the tissues, mainly protecting vessels, nerves, muscles with their insertions, but also the skin adipose tissues, articular capsule and bone. Muscles must be protected because any lesion leads to loss of proprioceptive sensibility and consequent atrophy.

The aim of the minimally invasive hip surgery resides in limiting as much as possible the iatrogenic trauma of the periarticular soft tissues with obvious result of rapid, sustained and lasting functional postsurgical recovery. Direct anterior impingement through the Hueter interval seems to have these qualities, however late postsurgical monitoring has not yet been confirmed through the studies of statistical importance.

Patient is laid in supine position preferably either on table which may break in the middle in order to allow hyperextension of the leg and proper femoral exposure. The supine position allows easy intrasurgical assessment of the comparative leg lengths [19].

The landmarks which a surgeon must take into account when making incisions are anterior-superior iliac spine (ASIS) and the greater trochanter. Typically, incision may begin at the half distance between ASIS and the greater trochanter following the medial margin of the tensor fascia latae muscle, oriented more towards lateral than straight distally. Another possibility would be setting a point which can be found at 3 cm lateral and 3 cm distal away from ASIS from where the knife has to follow a distance of 8-10 cm in caudal direction, parallel to medial margin of the tensor. Incision has to be extended proximal or distal for a better exposure of the acetabulum, respectively of the femur.

Knife incision has to be continued until the encounter of the superficial fascia of tensor fascia latae. Using the cautery the surgeon must cut the fascia and detach it from the muscular body with great care to avoid the injury of the cutaneous femoral nerve found above the sartorius muscle. One finger can be used to identify the space between the tensor fascia latae muscle and the sartorius through which can be palpated the upper part of the hip joint capsule. The two muscular planes, represented by the tensor fascia latae and gluteus minimus on one hand and sartorius and rectus femoris on the other hand are split to have access to the articular capsule. At this step the use of retractors is utterly important to offer a better view of the deep structures. Thus, a curved retractor is positioned on the upper side of the incision, medial to the tensor, at the level of the upper articular capsule, another one just lateral to the sartorius and rectus femoris, and a third one lateral, at the greater trochanter. Next step is to cauterize the lateral circumflex vessels generally found towards the incision's distal end, in the interval between tensor and sartorius; neglecting this step will lead to abundant bleeding during operation and fearsome postsurgical complications (Figure 1). Further on, the fascia between rectus and tensor is dissected in order to expose the vastus lateralis.

Another retractor is positioned beneath the femoral neck in order to remove the sartorius and rectus femoris from work field.



Figure 1 - Identification and ligation of the Lateral Circumflex Artery

Capsule incision may be performed in 2 ways: conservatively, preserving it in case of the patients with a normal anatomy and sufficient range of motion or radically, in which a part of the capsule is extracted in order to release the tension around the joint. Another useful maneuver, which would give a proper mobility, would be the incision of the reflected head of the rectus femoris (Figure 2). Either way, the incision begins in the extreme upper part of the articular capsule, going the same direction with the femoral neck and then towards anterior, until meeting vastus lateralis that has to be spared. Introducing a retractor provided with a source of light in place of that sustaining the sartorius and rectus femoris enhances considerably the direct view into the articulation.



Figure 2 - Exposure of the Anterior Hip Capsule, following a partial incision of the reflected head of the rectus femoris

In order to make the femoral head osteotomy, particular care must be taken to protect the greater trochanter and the insertions of the external rotator muscles and hip adductors. Osteotomies can as well be made in 2 ways:

simple, when the neck is extracted together with the femoral head as one piece, or double, when there are 2 osteotomies, the femoral head and neck being extracted separately. The 2 osteotomies must be accomplished at a distance of approximately 1 cm one from another and parallel with each other. The proximal osteotomy must be accomplished as close as possible to the femoral head. To avoid lesions to the greater trochanter it is advisable to use a shorter saw blade. Impediments which may prevent the femoral head from going out from the acetabulum are the existence of osteophytes around the acetabular cavity which have to be removed before dislocation and the existence of a very strong femoral head ligament which has to be cut. A maneuver which can help both the disk and femoral head extraction is the axial pulling of the limb. Also, a considerable attention must be given to the resection of the sharp edges which may damage surrounding tissues upon extraction.

Preparing the acetabulum consists in removing the labrum and reaming the acetabular cavity for implantation of the prosthesis cup into a bleeding surface, which exposes little subchondral bone favoring the integration of the cup. This may have some wholes which may allow both bone development around prosthesis and an even better integration or screws may be implanted for a maximum stability; the last possibility may lead to a fracture of the coxal bone. Also, the cup has to be bigger than the reamer; it has to be integrated into the bone through drilling at maximum 1 mm. This drilling may be hardened sometimes by the limited access to the anterior rim of the acetabulum. It is very important that the reamer must not be leaned on the femur because this may pull the handler towards anterior causing dislocation of a piece of the anterior rim. In the rare case of acetabulum fracture occurrence, it is advisable to convert this minimally invasive approach to a posterior approach. Another advantage of the anterior approach or that is to say of the dorsal decubitus, is the possibility of comparative assessment with contralateral hip by direct visualization or fluoroscopic one. Fluoroscopic control is extremely useful in detecting the acetabulum cup position which has to be sufficiently covered and at the same time

must not compromise the articular motion by determining a bone impingement [19].

Femoral preparation through DAA, however raises the most problems. The inferior limb which underwent surgery should have no traction and be positioned in hyperextension, extreme rotation and adduction. A bone hook attached to a lifting mechanism is introduced through lateral, perpendicular on the long femoral axis; thus, the bone shall be supported and lifted for a better exposure in the wound. A femoral elevator is placed behind the greater trochanter, medial to the femur; here as well, another retractor supports the soft tissues. The resection of the supero-lateral and posterior aspects of the articular capsule is mandatory. In some cases, it is necessary to perform an extensive liberation of the femur which applies to the posterior periarticular structures, namely, the peritrochanteric insertions of the muscles: obturator internus, gemellus superior and gemellus inferior and piriformis. Among these, the piriformis is incised in approximately 10% of cases [20]. Resection of the posterior structures, muscles and capsule is mainly necessary in the case in which a sufficient hyperextension is not achieved, in order to expose the femur, to protect it from surrounding tissues (ASIS) and allow an easy and efficient drilling of the femoral canal.

With the aid of a bent curette, the surgeon begins the broaching of the femoral canal. This gives place and direction to the broaching canal. The broaches should have a double offset handler so that the femur may not lift too much or to ease access in case of the obese patients; it can be introduced when the femur is not completely exposed in the wound. After the least broach dimension is set, it is placed in line with the femoral axis and introduced slowly with hammer using back and forth moves, trying to set lateral the canal. For a perfect fit of the femoral component, it is important to assess the impaction and movement of broaches into the femoral canal through the tactile sense and not just through visualization of a radiological image. Great attention must be given to the impacting angle of the femoral component since fractures of femoral surfaces may result. This determines wrong orientation of the prosthesis components with biomechanical consequences on the joint: coxa vara, anterior deviation of the

prosthetic femoral head. In a study conducted by Matta et al., 4 fractures of the femoral proximal extremities and 3 fractures of the greater trochanter have been observed; the assumed complication rate through fracturing is around 2% [21]. Also, the femoral structure geometry should be adapted in such a way not to produce an exaggerated impaction over the greater trochanter as to avoid lesions at this level.

The closure of the wound uses a multi-layered technique, with particular attention given to the suture of the TFL fascia, which has to be made as lateral as possible in order to avoid sectioning of the lateral cutaneous nerve which seats on the medial side of the Hueter interval (Figure 3). Functional recovery allowed by the anterior approach is fast. Loading the leg may be done in several hours after the intervention, being mandatory during the first 24 hours.



Figure 3 - Image showing the suturing of the TFL's fascia.

Indications

Hip direct anterior approach may be used for total hip arthroplasty, for remodeling of areas damaged by arthrosis pathology, for open reduction and correction of hip congenital dysplasia, excision of hip tumoral pathology, collecting synovial and bone biopsies.

Coxarthrosis is the main indication for remodeling or replacement procedures of the hip joint. Causes are numerous: inflammatory arthritis, trauma, infections, untreated hip congenital dysplasia, Perthes disease etc. However physiopathological consequences are

the same and treatment is invariably similar. The total hip arthroplasty rate in United States is estimated to 250 000 per year, assuming a double increase for 2030. Prevalence among population for 2010 is estimated to 2,5 million of such interventions [26]. However, a serious protocol is necessary which, on one hand, may reduce the considerable morbidity associated to classical approaches (bleeding, pain) and fasten the postsurgical patient rehabilitation and social reintegration, on the other hand.

Direct Anterior Approach is indicated for patients identified with moderate degenerative lesions, limited to the surface of the acetabulum and of the femoral head, which have a body weight index below 30, poor represented muscular and adipose tissues in the area and an adequate femoral offset [19]. These characteristics are considered ideal. Still, by acquiring a sufficient experience, the anterior approach may be used for almost any patient and if necessary, extended and adapted to the intraoperative needs. If for primary hip arthroplasty, anterior approach may become standard, for prosthesis, revision is necessary, being an extensive and obviously, more traumatic one. However this extensive approach may spare the gluteal muscles, preventing occurrence of insufficiency or functional disorder after surgery [27,28].

Proximal femoral fractures represent relative indications of direct anterior approach and must be adapted to context. To obtain better access to the proximal femur, incision may be distally widened and furthermore, several muscular fibers pertaining to the tensor fascia latae may be detached from origin [7,8].

Femoral-acetabular impingement is a pathology which has an intense clinical expression and an unfavorable prognosis if not managed at the right moment. There are many methods to successfully accomplish this purpose, among which the femoral head dislocation with trochanteric osteotomy using a posterior approach, only arthroscopy, or combined procedures [29]. Direct anterior approach was suggested by Clohisy et al. [30] as a minimally invasive surgical treatment associated to arthroscopic evaluation. Hueter interval offers an excellent visualization and access to the antero-lateral portion of the femoral head-neck

junction and to antero-lateral margin of the acetabulum (Figure 4).



Figure 4 - Cervico-cephalic osteoplasty for abnormal anterior femoro- acetabular contact

Absolute contraindications of impingement are represented by the dermatological infections or pathologies around the incision. Lack of special tool kit adapted to the surgical conditions for proper exposure of the femur or acetabulum also represents an absolute contraindication. Several years ago, lack of an orthopedic table was an essential shortcoming, yet nowadays, with the aid of a table which may break in the middle and careful aseptic procedures, enough hyperextension and rotation of the inferior limb for an easy dislocation and a good femoral exposure in the wound may be achieved [19,31]. Body weight is an impediment in the way that patients with a rich adipose tissue present in the area of incision may have problems in the curing process, but also muscular patients may raise problems regarding exposure of the bone components through an exaggerate muscular tone [19].

Discussions

The direct anterior approach is a genuine intermuscular, internervous approach. It makes use of the interval between the tensor fascia latae and the gluteus medius on one hand and the sartorius and the rectus femoris on the other hand. The first muscular group is innervated by the femoral nerve while the second one by the superior gluteal nerve. Because of the technique of preserving the muscular insertions, it can be said that this approach fits into the minimally-invasive surgery standards. However, in practice, mainly for the osteotomized femur exposure, it is necessary more than posterior capsule

incision; common insertion of the outer rotator tendons or of the gluteus medius muscle or of the piriformis muscle alone must be sacrificed most of the time. Obviously, invasiveness of the direct anterior impingement is inferior to other approaches which, besides specified muscles may also sacrifice the gluteus maximus muscle or the quadratus femoris with obvious negative functional consequences [19]. These are confirmed by a study of Bergin et al. which demonstrates that in the case of DAA, the serum creatine kinase enzyme levels are much smaller than in the case of the classical posterior or lateral approaches [32]. Surgery through the Hueter interval offers the possibility of a rapid postsurgical functional recovery allowing weight bearing on the operated limb at just several hours after operation. Also, pain control is more effective, recommended analgesic doses being smaller than in the case of other approaches [19].

Another aspect to be taken into account regarding the direct anterior approach is the steep learning curve. Before being able to make such an intervention, a surgeon has to be used to the hip classical invasive techniques in order to extend the minimally invasive surgery if imposed by the circumstance. Under no condition, should he make the first surgery alone, but in the presence of an experienced doctor regarding the minimally-invasive hip surgery. Also, the surgeon has to be used to the special kits for the minimally-invasive hip surgery and has to have a clear reasoning and a preoperative plan regarding the acetabulum cup positioning and femoral component, if necessary with use of the navigation systems [19].

As specified before, critics have not stopped to appear in the case of the direct anterior approach and can only be considered justified, because patient benefit must prevail. Some studies in the mid 2000s have tried to show that the anterior impingement does not bring sufficient enhancements on short term in terms of using the postsurgical analgesics, postsurgical bleeding, time of hospitalization, appearance of the postsurgical scar and functional recovery in relation to difficulties of the technique [28,33,34]. However, direct anterior approach became more common with new experience communicated by many studies

which have highlighted excellent functional results. Technique and tool kit advancement are other reasons to increase acceptability of this intervention in several centres.

Conclusions

In conclusion, direct interior approach through the Hueter interval is considered minimally invasive, not because of the length of incision but through its capacity to enter into the deep spaces of the hip without damaging muscles and soft tissues. DAA of the hip joint can become a very reproducible and atraumatic procedure in selected cases.

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