Original article

Surgical hip dislocation through a direct lateral approach: A cadaveric study of vascular danger zones

Mohamad J. Halawi^{a,*}, David Brigati^b, Jennifer M. McBride^c, Richard L. Drake^d, Peter J. Brooks^e

^a Fellow, Department of Orthopaedic Surgery, Cleveland Clinic, Cleveland, OH, United States

^b Resident, Department of Orthopaedic Surgery, Cleveland Clinic, Cleveland, OH, United States

^c Associate Professor of Surgery, Cleveland Clinic Lerner College of Medicine, Cleveland, OH, United States

^d Professor of Surgery, Cleveland Clinic Lerner College of Medicine, Cleveland, OH, United States

^e Associate Professor of Surgery, Chief of Orthopaedic Surgery, Cleveland Clinic Euclid Hospital, Cleveland, OH, United States

ARTICLE INFO

Article history:

Received 23 March 2017

Received in revised form 27 May 2017

Accepted 3 June 2017

Available online 8 June 2017

Keywords:

Surgical hip dislocation

Hardinge approach

Vascular anatomy

Medial femoral circumflex artery

Hip preservation

ABSTRACT

Objective: There is limited information on the potential danger to the vascularity of the femoral head during surgical dislocation of the hip using the direct lateral approach. The objective of this study was to investigate the topographical anatomy of the medial femoral circumflex artery (MFCA), the primary source of blood supply to the femoral head, in relationship to the direct lateral approach.

Methods: Seven unembalmed cadaver hips had dye injection into either the profunda femoris artery or the MFCA. Surgical hip dislocation was then performed through a direct lateral approach, noting the danger zones to the MFCA branches during each step of the exposure.

Results: None of the MFCA branches were found to cross the anterior surgical field superficial to the capsule. The deep (main) branch of the MFCA pierced the inferior capsule at the level of the lesser trochanter after emerging posterior to iliopsoas tendon. Ascending branches up the medial femoral neck were identified at this level. The deep branch then coursed posteriorly terminating in a variable number of vessels ascending the posterior femoral neck. Dislocation of the femoral head did not stretch or alter the course of the deep branch of the MFCA.

Conclusion: Safe surgical hip dislocation preserving the MFCA can be performed through a direct lateral approach as long as the inferomedial portion of the anterior capsule is preserved (main branch of the MFCA pierces the capsule at this level). Extracapsular injury is possible from inadvertent dissection at the level of the lesser trochanter or aggressive retraction on the iliopsoas. The posterior capsule should be left intact and instrumentation around the posterior neck should be avoided.

© 2017

1. Introduction

Surgical hip dislocation provides wide exposure to the hip joint allowing 360° view of the femoral head and acetabulum. This advantage has made it the gold standard for management of femoroacetabular impingement, which commonly involves both sides of the hip joint.^{1,2} Other reported indications include femoral head fractures,³ acetabular fractures,^{4,5} benign hip tumors,⁶ cartilage/labral lesions not amenable to arthroscopy,⁷ and sequelae of childhood conditions.⁸ The ability to dislocate the hip without disrupting the femoral head blood supply is critical in adolescents and young adults to prevent osteonecrosis of the femoral head.

Safe surgical dislocation of the femoral head can be theoretically performed through any approach. However, the technique described by Ganz et al⁹ has been the most widely studied and used. This technique involves anterior dislocation of the femoral head following a trochanteric flip osteotomy through a posterior approach. The trochanteric osteotomy helps preserve the medial femoral circumflex artery (MFCA) by avoiding tenotomy of the external rotators, which is routinely performed during the standard posterior approach (Fig. 1). While several studies reported no cases of femoral head avascular necrosis using the Ganz technique,^{9,10} lateral hip pain from nonunion, malunion, or symptomatic hardware have occurred in varying rates, often requiring hardware removal or revision open reduction and internal fixation.⁹ Other limitations include the need for protected weight bearing while the osteotomy heals and the relatively long learning curve of the procedure.

* Corresponding author at: Department of Orthopaedic Surgery, Cleveland Clinic, 9500 Euclid Avenue, A40, Cleveland, OH 44195, United States.

E-mail address: halawim@ccf.org (M.J. Halawi).

Fig. 1. Posterior view of a left hip. The medial femoral circumflex artery, which lies on the posterior surface of the short external rotators, can be easily injured during the standard posterior approach to the hip.

Fig. 2. Exposure through the femoral triangle showing 1. femoral artery; 2. medial femoral circumflex artery; 3. lateral femoral circumflex artery; 4. profunda femoris artery.

While it is believed that anterior-based surgical approaches to the hip pose a relatively low risk of injury to the femoral head blood supply, there is limited literature evidence to support this practice. The purpose of this anatomic study was to investigate the topographical anatomy of the MFCA in relationship to a direct lateral (Hardinge) approach. First described in 1982¹¹, the Hardinge approach is relatively easy to learn, avoids the need for trochanteric osteotomy, and is commonly used for in hip reconstruction. Knowledge of the vascular danger zones during this approach may help avoid iatrogenic vascular injury leading to osteonecrosis of the femoral head during hip preservation surgery.

2. Materials and methods

IRB approval was not required. Anatomical dissection was performed in 4 unembalmed cadavers (7 hips): three males and one female (age range 72–87 years). None of the cadavers had evidence of prior hip surgery or vascular disease. In each hip, the profunda femoral artery, MFCA, lateral femoral circumflex artery (LFCA), and femoral artery were identified through the femoral triangle (Fig. 2). The correctness of the ligated vessels was verified by two senior anatomists (co-authors). In 4 hips, the MFCA and LFCA were injected with 0.75% methylene blue solution. In 3 hips, only the MFCA was injected. In each injection, the cannulated vessel was clamped proximal and distal to its branching site to reduce the volume of injection. 30 ml of the dye solution was injected each time. The patency of the distal vessels was confirmed by visualization of dye intake into the retinacular vessels. The results were documented with a digital camera.

2.1. Approach

The cadaver was placed in lateral decubitus position. A longitudinal incision centered on the greater trochanter was made

and the underlying fascia lata was split in line with the skin incision. The anterior third of gluteus medius and minimus were then divided in the direction of the muscle fibers just proximal to their insertion on the greater trochanter. Distal dissection was carried through the anterior third of the vastus lateralis. Exposure of the anterior capsule was aided by progressive external rotation of the leg and releasing the reflected head of rectus femoris. The capsule was then split along the midplane of the femoral neck starting from the acetabular rim and terminating at the superior head/neck junction. The capsulotomy was completed by excising a triangular piece on each side of the split. Care was taken to ensure the inferomedial capsular piece was kept proximal and lateral to the lesser trochanter (to avoid violating the deep branch of the MCFA as described below). The hip was then dislocated anteriorly by flexion, adduction, and external rotation.

3. Results

The MFCA branched off the profunda femoral artery in 4 hips and from the femoral artery in 3 hips. Stepwise dissection down to the capsule was safe with no branches of the MFCA crossing the operative field superficial to the capsule (Fig. 3). However, in the specimens that received LFCA injection, the ascending branch of the LFCA was found to pierce the anterior capsule at its inferior aspect, terminating in 1–2 vessels along the anterior femoral neck (Fig. 4). Stepwise excision of the anterior capsule showed the main branch of the MFCA pierced the anteroinferior capsule at the level of the lesser trochanter (Fig. 5). This branch became more visible with anterior dislocation emerging posterior to iliopsoas tendon. After piercing the capsule at the anteroinferior neck, ascending branches were given at this level. The deep branch then coursed posteriorly terminating into a variable number of terminal branches. These terminal vessels then ascended the femoral neck covered by a clear fibrous sheath (retinaculum); hence their

Fig. 3. Anterior view of a right hip after capsulotomy. Note the inferomedial portion of the capsule is preserved.

nomenclature as “retinacular arteries” although they have also been termed “nutrient arteries”, “epiphyseal arteries”, and “capsular arteries.”¹² The retinacular arteries were not found beyond the head/neck junction. Dislocation of the femoral head did not stretch or alter the course of the deep branch of the MFCA.

Fig. 4. Anterior view of a right hip after capsulotomy. The arrow points to the ascending branch of the lateral femoral circumflex artery.

Fig. 5. Anterior view of a right hip after dislocation. The arrows point to the deep branch of the medial femoral circumflex artery as it crosses the operative field at the level of the lesser trochanter before piercing the inferomedial femoral neck.

4. Discussion

The arterial supply to the femoral head has been extensively studied with the predominant contribution from the MFCA via its deep branch.^{13,14} This finding was confirmed in our study. Anastomosis between the MFCA and the inferior gluteal artery has also been described.^{14,15} Gautier et al.¹⁴ even suggested that this anastomosis “may be capable of compensating after injury to the deep branch of the MFCA”. Recently Steffen et al.¹⁶ described a modified posterior approach that preserved the femoral head oxygenation after dividing the deep branch of the MFCA. Without providing specific description, the authors noted that the premise of this approach was preserving the “anastomoses around the greater trochanter and the retinacular vessels around the femoral neck”. Based on previous anatomic studies,^{14,15} we believe the authors were referring to the anastomosis between the MFCA and the inferior gluteal artery.^{14,15}

Variations in the origin of the MFCA have also been reported with the most common pattern being from the profunda femoral artery (59%–81%).^{13,17,18} Our findings were consistent with those reports. Specifically, we found the MFCA mostly originated from the profunda femoral artery (4 of the 7 hips) followed by the femoral artery (3 of the 7 hips).

The study has a few limitations. First, we dissected a relatively small number of specimens. However, the findings were consistent among the specimens used and published literature. Another

Fig. 6. Anterior view of a right hip after capsulotomy. The asterisk marks the anteroinferior capsule that should be preserved.

potential limitation is the use of methylene blue to visualize the vascular structures. Unlike liquid latex injection, methylene blue does not enhance the texture of the vessels, making dissection more difficult. However, methylene blue achieved excellent penetration into the terminal branches of the MFCA. Most importantly, injection with methylene blue did not alter the structural integrity of the vessels, which was more appropriate to examine the integrity of the vascular supply during dislocation of the hip.

This study provides evidence that, with proper knowledge of the MFCA danger zones, anterior-based surgical approaches to the hip, such as a direct lateral approach, can be used for safe surgical hip dislocation. This approach could be used as an alternative to the widely popular trochanteric flip osteotomy technique described by Ganz et al.⁹ thereby avoiding the potential morbidity associated with the osteotomy. The direct lateral approach is also relatively easy to learn and is commonly used in hip reconstruction. Its major disadvantage, however, is the potential for development of postoperative limp and heterotopic ossification (HO) when aggressive dissection is performed. Still, it should be noted that in a recent systematic review of 8 studies involving 2455 primary total hip arthroplasties, Masonis and Bourne¹⁹ found the incidence of postoperative limp to be similar between the direct lateral and posterior approaches. In another review of 1420 consecutive primary total hip arthroplasties performed using direct lateral approach, Harwin²⁰ reported that while the incidence of HO was 26%, only two patients (0.001%) required surgical incision. Just like any surgical procedure, the risks and benefits of the direct lateral approach should be carefully weighted based on patient's body habitus, risk factors for HO, activity level, extent of required exposure.

In summary, surgical hip dislocation without disrupting the anatomic integrity of the MCFA branches can be performed with

the Hardinge approach. How this would translate into actual preservation of the femoral head vascularity during hip preservation surgery with this approach still needs to be studied further. Our study found that extracapsular injury to the MFCA could result from inadvertent dissection at the level of the lesser trochanter or aggressive retraction on the iliopsoas tendon. The inferomedial portion of the anterior capsule should be preserved as the main branch of the MFCA pierce the capsule at this level (Fig. 6). While the terminal branches ascending the femoral neck are protected by a thick sheath of connective tissue, instrumentation around the femoral neck (e.g., insertion of a bone hook to facilitate dislocation) should be used with caution. The posterior capsule should be left intact. Knowledge of the anatomy of the MFCA during this approach is important for potential considerations of preserving the vascularity of the femoral head as this approach is studied further.

Conflict of interest

The authors have none to declare.

References

- Ross JR, Schoeneker PL, Clohisy JC. Surgical dislocation of the hip: evolving indications. *HSS J.* 2013;9(1):60–69.
- Sierra RJ, Trousdale RT, Ganz R, et al. Hip disease in the young, active patient: evaluation and nonarthroplasty surgical options. *J Am Acad Orthop Surg.* 2008;16(12):689–703.
- Massé A, Aprato A, Alluto C, et al. Surgical hip dislocation is a reliable approach for treatment of femoral head fractures. *Clin Orthop Relat Res.* 2015;473(12):3744–3751.
- Massé A, Aprato A, Rollero L, et al. Surgical dislocation technique for the treatment of acetabular fractures. *Clin Orthop Relat Res.* 2013;471(12):4056–4064.
- Siebenrock KA, Gautier E, Woo AK, et al. Surgical dislocation of the femoral head for joint debridement and accurate reduction of fractures of the acetabulum. *J Orthop Trauma.* 2002;16(8):543–552.
- Nisar A, Gulhane S, Mahendra A, et al. Surgical dislocation of the hip for excision of benign tumours. *J Orthop.* 2014;11(1):28–36.
- Leunig M, Tibor LM, Naal FD, et al. Surgical technique: second-generation bone marrow stimulation via surgical dislocation to treat hip cartilage lesions. *Clin Orthop Relat Res.* 2012;470(12):3421–3431.
- Leunig M, Ganz R. The evolution and concepts of joint-preserving surgery of the hip. *Bone Joint J.* 2014;96-B(1):5–18.
- Ganz R, Gill TJ, Gautier E, et al. Surgical dislocation of the adult hip a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg Br.* 2001;83(8):1119–1124.
- Sink EL, Beaulé PE, Sucato D, et al. Multicenter study of complications following surgical dislocation of the hip. *J Bone Joint Surg Am.* 2011;93(12):1132–1136.
- Hardinge K. The direct lateral approach to the hip. *J Bone Joint Surg Br.* 1982;64(1):17–19.
- Lazaro LE, Klinger CE, Sculco PK, et al. The terminal branches of the medial femoral circumflex artery: the arterial supply of the femoral head. *Bone Joint J.* 2015;97-B(9):1204–1213.
- Zlotorowicz M, Szczodry M, Czubak J, et al. Anatomy of the medial femoral circumflex artery with respect to the vascularity of the femoral head. *J Bone Joint Surg Br.* 2011;93(11):1471–1474.
- Gautier E, Ganz K, Krugel N, et al. Anatomy of the medial femoral circumflex artery and its surgical implications. *J Bone Joint Surg Br.* 2000;82(5):679–683.
- Grose AW, Gardner MJ, Sussmann PS, et al. The surgical anatomy of the blood supply to the femoral head: description of the anastomosis between the medial femoral circumflex and inferior gluteal arteries at the hip. *J Bone Joint Surg Br.* 2008;90(10):1298–1303.
- Steffen RT, De Smet KA, Murray DW, et al. A modified posterior approach preserves femoral head oxygenation during hip resurfacing. *J Arthroplasty.* 2011;26(3):404–408.
- Vazquez MT, Murillo J, Marañillo E, et al. Patterns of the circumflex femoral arteries revisited. *Clin Anat.* 2007;20(2):180–185.
- Lalovic N, Malis M, Korica M, et al. Origin of the medial circumflex femoral artery—a cadaver study. *Med Glas (Zenica).* 2013;10(2):198–202.
- Masonis JL, Bourne RB. Surgical approach, abductor function, and total hip arthroplasty dislocation. *Clin Orthop Relat Res.* 2002;405:46–53.
- Harwin SF. Trochanteric heterotopic ossification after total hip arthroplasty performed using a direct lateral approach. *J Arthroplasty.* 2005;20(4):467–472.