GAVIN PUBLISHERS

Journal of Orthopedic Research and Therapy

Ebraheim N, et al. J Orthop Ther: JORT-139.

Review Article

DOI: 10.29011/JORT-139.000039

Femoral Triangle Anatomy: Review, Surgical Application, and Novel Mnemonic

Nabil Ebraheim*, James Whaley, Jacob Stirton, Ryan Hamilton, Kyle Andrews

Department of Orthopedic Surgery, University of Toledo Medical Center, Toledo Orthopedic Research Institute, USA

***Corresponding author:** Nabil Ebraheim, Department of Orthopedic Surgery, University of Toledo Medical Center, Orthopaedic Residency Program Director, USA. Tel: 866.593.5049; E-Mail: nabil.ebraheim@utoledo.edu

Citation: Ebraheim N, Whaley J, Stirton J, Hamilton R, Andrews K(2017) Femoral Triangle Anatomy: Review, Surgical Application, and Novel Mnemonic. J Orthop Ther: JORT-139. DOI: 10.29011/JORT-139.000039

Received Date: 3 June, 2017; **Accepted Date:** 8 June, 2017; **Published Date:** 15 June, 2017

Abstract

We provide an anatomical review of the femoral triangle, its application to the anterior surgical approach to the hip, and a useful mnemonic for remembering the contents and relationship of the femoral triangle. The femoral triangle is located on the anterior aspect of the thigh, inferior to the inguinal ligament and knowledge of its contents has become increasingly more important with the rise in use of the Smith-Petersen Direct Anterior Approach (DAA) to the hip as well as ultrasound and fluoroscopic guided hip injections.

A detailed knowledge of the anatomical landmarks can guide surgeons in their anterior approach to the hip, avoiding iatrogenic injuries during various procedures. The novel mnemonic "NAVIgate" the femoral triangle from lateral to medial will aid in remembering the borders and contents of the triangle when performing surgical procedures, specifically the DAA.

Keywords: Anatomy; Anterior Approach; Femoral Nerve; Femoral Triangle; Smith-Petersen

Introduction

The femoral triangle of Scarpa derives its name after the Italian anatomist Antonio Scarpa's work on hernias in the 1800's. The consistency of the femoral triangle's anatomy has been utilized by the medical community for generations. Here we provide an anatomical review of the femoral triangle and its application to the anterior surgical approach to the hip.

Anatomy

The femoral triangle is a superficial space located on the anterior aspect of the thigh. The boundaries of the femoral triangle are the inguinal ligament superiorly, the medial border of the Sartorius muscle laterally, and the medial border of the Adductor Longus muscle medially. Two of the three points of the triangle are bony landmarks, the Anterior Superior Iliac Spine (ASIS) and the pubic tubercle. The floor of the triangle, from lateral to medial, is made up by the Iliacus, Psoas Major, Pectineus, and Adductor Longus muscles. The roof is composed of skin, superficial fascia, and deep fascia. The important contents, from lateral to medial, are the femoral nerve, femoral artery, femoral vein, and the deep inguinal lymph nodes. The femoral artery gives off the superficial epigastric artery, superficial and deep pudendal arteries, and the deep artery of the thigh.

The femoral sheath is a sleeve of fascia enclosing the upper four centimeters of the femoral artery, vein, and canal in the femoral triangle. The femoral sheath is created anteriorly by downward extension of the transversalis fascia and posteriorly by the iliac fascia. The femoral sheath is broken down into the lateral, intermediate, and medial, or femoral canal, compartments and contains the femoral artery, vein, and lymphatic tissue respectively. The femoral nerve lies within the groove between the Iliacus and Psoas Major muscles. Two other important nerves located in the femoral triangle are the lateral cutaneous nerve of the thigh and the femoral branch of the genitofemoral nerve. The lateral cutaneous nerve crosses the lateral corner of the triangle and supplies the skin on the lateral aspect of the thigh although cadaver studies have shown its course to be variable [1,2]. The femoral branch of the genitofemoral nerve is located in the lateral compartment of the femoral sheath and supplies the skin of the upper anterior thigh including the femoral triangle. Certain anatomical variations, although relatively limited, have been reported. The deep artery of

the thigh has been reported to course lateral, instead of deep, to the femoral artery [3,4]. Another anatomical variation reported is the lateral and medial circumflex femoral arteries originating from the femoral artery and not the deep artery of the thigh [4,5]. Femoral vein duplication has also been reported in the literature [6].

Surgical Significance/Application

Knowledge of femoral triangle anatomy is of great importance and utility to many physicians. The femoral artery is frequently used by vascular surgeons, general surgeons, and interventionists to gain access to the arterial system. There has also been an increase in the popularity of the direct anterior approach to the hip as well as the use of ultrasound guidance and fluoroscopy for intrarticular hip injections. Of note is the increasing frequency of the anterior approach to the hip (DAA) for total hip arthroplasty.

This increasing frequency is due to the belief that the approach leads to less pain, less muscle damage, shorter hospital stays, and better gate mechanics [7]. An 87-patient randomized trial by Barret, et al. [8] showed that patients had less pain at six weeks post-op with the DAA as compared to the PA. However, the difference was negligible at six months. Potential bias could obscure the results due to the fact that more men were treated with the DAA [9]. Other studies have used postoperative MRI, biochemical markers, and visual inspection to show decreased muscle damage using DAA vs THA [10-12]. However, no clinical significance can be extrapolated from these findings [7]. There also seems to be better gait mechanics postoperatively with DAA compared to other approaches [9,13]. Regardless, the literature is limited and more studies are needed to support the claims made by proponents of the DAA [7].

This technique is not without its difficulties. The most important danger is injuring the neurovascular bundle by traveling too medial. To overcome this obstacle, it is important to position the incision over the TFL fascia lateral to the ASIS [7]. In order to effectively ream the acetabulum, place and remove the head of the reamer independent of the handle with a Kocher clamp [7]. A guidewire placed on a handle can also be used to help prevent perforation of the femoral canal during broaching [7]. Major complications are dislocations after surgery, damage to Lateral Femoral Cutaneous Nerve (LFCN), perforation of the femoral canal, and iatrogenic fractures [7].

The Smith-Petersen approach is described below [14]. The patient is placed supine. An incision is made from the anterior half of the iliac crest to the ASIS. The incision then proceeds inferiorly for 8-10 centimeters in the direction of the lateral patella. The dissection then begins by identifying the gap between the Tensor Fascia Lata (TFL) and the Sartorius muscle. As the dissection proceeds through the subcutaneous fat, care is taken not to injure the lateral femoral cutaneous nerve. Next, incise the fascia on the medial side of the TFL and detach its origin from the iliac to create the internervous plane. Ligate the ascending branch of the lateral femoral circumflex artery. As the dissection moves deep, identify the plane between the rectus femoris and gluteus medius. From there, detach the rectus femoris from its origins and retract the rectus femoris and the iliopsoas medially. The gluteus medius is retracted laterally to expose the hip joint capsule. The thigh is then adducted and externally rotated to put the capsule under tension. The capsule is then incised with a longitudinal or T-shaped capsular incision. After the capsulotomy is complete, the hip can be dislocated with external rotation. The femoral head is now exposed for total hip arthroplasty.

The femoral triangle is located on the anterior aspect of the thigh, inferior to the inguinal ligament. The lateral border is formed by the medial border of the Sartorius muscle. The medial border is formed by the medial border of the Adductor Longus muscle and the base of the triangle is the inguinal ligament. The muscular floor is created by the Iliacus, Psoas, Pectineus, and Adductor Longus from lateral to medial respectively. The skin, superficial and deep fascia form the roof of the triangle. An intimate knowledge of this anatomy will allow us to successfully NAVIgate the femoral triangle from lateral to medial (Figure 1).

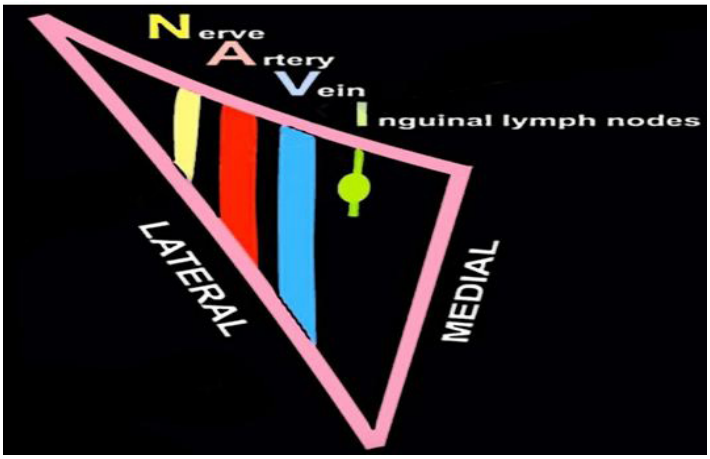

Figure 1: Novel mnemonic for femoral triangle. "NAVIgate" the femoral triangle from lateral to medial.

This helpful mnemonic was created to easily remember the relevant anatomy and relationships [15]. NAVI gate the femoral triangle from lateral to medial is used to remember the contents; femoral Nerve, femoral Artery, femoral Vein, deep Inguinal lymphatics. The femoral sheath covers the proximal four centimeters of the femoral vessels. The sheath is formed from downward extension of the transversalis fascia anteriorly and by the iliac fascia posteriorly. The sheath is broken down into the lateral, intermediate, and medial (femoral canal) compartments; which house the artery, vein, and lymphatics respectively. The base of the femoral canal is formed by the femoral ring, which is the location of femo-

ral hernias. In the groove of the Iliacus and Psoas major muscles lies the femoral nerve. Two other nerves in the femoral triangle are the LFCN and Femoral Branch of the Genitofemoral Nerve (Figure 2).

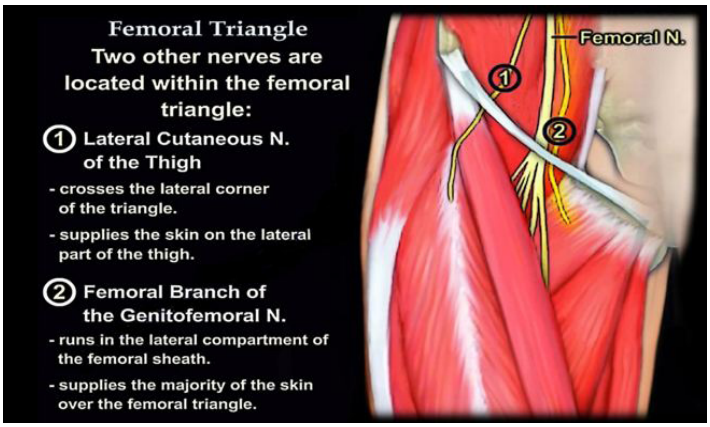

Figure 2: Two nerves located in the femoral triangle, one of which (the LFCN) can be damaged in the Smith-Peterson anterior approach to the hip.

The LFCN cross the lateral corner of the triangle, providing cutaneous innervation to the lateral thigh [16-18]. The Femoral Branch runs in the lateral compartment of the femoral sheath and supplies the majority of the skin overlying the femoral triangle. An important landmark in the DAA is the lateral border of the Sartorius muscle, which also forms the lateral border of the femoral triangle on its medial side. Medial to the Sartorius muscle is the neurovascular bundle, which can be injured in the DAA. Therefore, when performing DAA it is imperative to stay lateral to the sartorius muscle (Figure 3).

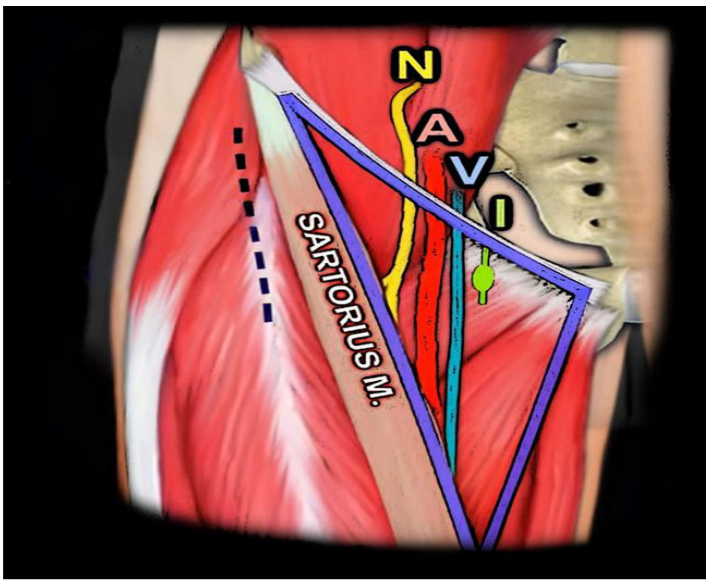

Figure 3: Importance of staying lateral to the sartorius muscle in the Smith-Peterson anterior approach to the hip.

Conclusion

A detailed knowledge of the anatomical landmarks can guide surgeons in their anterior approach to the hip, avoiding iatrogenic injuries during various procedures. The novel mnemonic "NAVI gate the femoral triangle from lateral to medial" (Figure 1) will aid in remembering the borders and contents of the triangle when performing surgical procedures, specifically the DAA. Most importantly, identifying the Sartorius muscle and staying lateral to it can help avoid iatrogenic injury to the neurovascular bundle of the femoral triangle.

References

1. Aszmann OC, Dellon ES, Dellon AL (1997) Anatomical course of the lateral femoral cutaneous nerve and its susceptibility to compression and injury. Plast Reconstr Surg 100:600-604.
2. Grothaus MC, Holt M, Mekhail AO, Ebraheim NA, Yeasting RA (2005) Lateral femoral cutaneous nerve: an anatomic study. Clin Orthop Relat Res 437:164-168.
3. Muhly W, Orebaugh S (2011) Ultrasound evaluation of the anatomy of the vessels in relation to the femoral nerve at the femoral crease. Surgical and Radiologic Anatomy 33:491-494.
4. Nasr A, Badawoud M, Al-Hayani A, Hussein A(2014) Origin of profund a femoris artery and its circumflex femoral branches: anatomical variations and clinical significance. Folia Morphologica 73:58-67.
5. Sol M, Galdames I, Vásquez B (2011) Las Arterias Circunflejas Femoralesen el Triángulo Femoral. International Journal of Morphology 29:644-649.
6. Paraskevas P (2011) Femoral vein duplication: incidence and potential significance. Phlebology 26:52-55.
7. Post Z, Orozco F, Diaz-Ledezma C, Hozack W, Ong A (2014) Direct Anterior Approach for Total Hip Arthroplasty: Indications Technique and Results. The Journal of The American Academy of Orthopedic22:595-603.
8. Barrett WP, Turner SE, Leopold JP (2013) Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. J Arthroplasty 28:1634-1638.
9. Mayr E, Nogler M, Benedetti MG, Kessler O, Reinthaler A, et al. (2009) A prospective randomized assessment of earlier functional recovery in THA patients treated by minimally invasive direct anterior approach a gait analysis study. Clin Biomech Bristol Avon 24:812-818.
10. Bergin PF, Doppelt JD, Kephart CJ, Benke MT, Graeter JH, et al. (2011) Comparison of minimally invasive direct anterior versus posterior total hip arthroplasty based on inflammation and muscle damage markers. J Bone Joint Surg Am 93:1392-1398.
11. Bremer AK, Kalberer F, Pfirrmann CW, Dora C(2011) Soft-tissue changes in hip abductor muscles and tendons after total hip replacement: Comparison between the direct anterior and the transgluteal approaches. J Bone Joint Surg Br 93:886-889.
12. Meneghini RM, Pagnano MW, Trousdale RT, Hozack WJ (2006) Muscle damage during MIS total hip arthroplasty Smith-Petersen versus posterior approach. ClinOrthopRelat Res 453:293-298.
13. Varin D, Lamontagne M, Beaulé PE (2013) Does the anterior approach for THA provide closer-to-normal lower-limb motion? J Arthroplasty 28:1401-1407.

14. Hoppenfeld S, De Boer P, Buckley R (2009) Chapter Eight: The Hip. Surgical Exposures in Orthopedicsthe Anatomic Approach. In: 4. Lippencott Williams & Wilkins, Philadelphia 2009: 405-420.

15. Ebraheim Nabil. "Femoral Triangle - Everything You Need to Know" Online video clip. YouTube. YouTube, 27 Feb. 2015. Web. 2 Feb. 2015.

16. Rodriguez JA, Deshmukh AJ, Rathod PA, Greiz ML, Deshmane PP, et al. (2014) Does the Direct Anterior Approach in THA Offer Faster Rehabilitation and Comparable Safety to the Posterior Approach? Clinical Orthopedics and Related Research 472:455-463.

17. Standring S (2008) Pelvic Girdle, Gluteal Region and Thigh. Gray's Anatomy: The Anatomical Basis of Clinical Practice. In:40. Elsevier Churchill Livingstone, Edinburgh 2008: 1349-1385.

18. Üzel M, Akkin SM, Tanyeli E, Koebke J (2011) Relationships of the Lateral Femoral Cutaneous Nerve to Bony Landmarks. Clinical Orthopaedics and Related Research 469:2605-2611