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*Lean in Medical Education: Reaching for Quality Management Tools to Teach Human Anatomy Effectively in a Multicultural and Multilingual Learning Space* – ERASMUS+ Project LEANBODY - 2021-1-HU01-KA220-HED-000027542

# *Role of anatomy in developing professionalism:*

## Lessons learnt from a dissection-based anatomy course

Human Anatomy Centre, Department of Physiology, Development & Neuroscience  
University of Cambridge

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## *Some recent headlines*

Is dissection dying out in UK medical schools?

**Sheffield University no longer wants your body**

Cadaveric Dissection a Thing of the Past?

**Is Cadaver Dissection Still Necessary in Surgical Education?**

# *Why are they abandoning cadaveric dissection?*



**University of Bristol**

**University of Birmingham**





**University of Edinburgh**

**University of Oxford**



***“A lot of students themselves want cadaveric dissection, but there are a lot of reasons why it is not being offered.***

***One of the big factors is costs and resources. The cost of having the licence, of the facilities, maintaining the labs, and the cadavers themselves, is an expensive option for medical schools.”***

Ed Fitzgerald, general surgical trainee in London and past president of the Association of Surgeons in Training

*We are still  
doing  
cadaveric  
dissection  
because it is*



## ***3 Key Outcomes: General Medical Council***

*“Medical students must apply their knowledge and skills in a competent and ethical manner. They must use their ability to provide leadership and to analyse complex and uncertain situations.”*

**Outcomes 1: Professional values and behaviours**

**Outcomes 2: Professional skills**

**Outcomes 3: Professional knowledge**

# *Anatomy in the medical course*

## **PRECLINICAL YEARS: THE MEDICAL SCIENCES TRIPOS**

**Year 1 (Part IA)**      **FAB (Functional Architecture of the Body)**

*cadaveric dissection*

**Year 2 (Part IB)**      **HNA (Head and Neck Anatomy)**

*prosected specimens*

**Year 3 (Part II)**      **Experimental Project**

**SaRA (Surgical and Radiological Anatomy)**

## **CLINICAL YEARS: SCHOOL OF CLINICAL MEDICINE AND REGIONAL HOSPITALS**

**Years 4-6**      **Anatomy Revision**

**Student Selected Components**

**Medical Electives**



## ***GMC Outcomes 1: Professional values and behaviours***

- Professional responsibilities
- Ethical responsibilities
- Team working
- Respect and gratitude



## *Professional responsibilities*

**A**

Guiding Principles and the  
Fundamental Principle of Consent



Code of Practice

Introductory lecture on body donation

Signed code of conduct in the Dissection Room

Non-compliance: “Fitness to Practise” referral

# *Ethical responsibilities*

## **Body of work: the silent teacher helping students learn anatomy**

For over 450 years, students have been studying anatomy at Cambridge through whole body dissection. But students find that they learn far more than just the architecture of the human body during their classes.



## Team working



- Task allocation
- Managing conflict
- Active discussion

- Donor Tribute as a Table Group

*“To our donor – we have held your heart in our hands without knowing for whom it was beating and for whom you felt love. We looked into your eyes without knowing what they had seen before. We hope to make you proud, as clinicians, applying all you have taught us – the knowledge, skills and values – in practice, as doctors and fellow human beings, every day for the rest of our lives.”*

# *Respect and gratitude*

## **Committal Service**

- held in Dissection Room
- end of academic year
- students and staff only

## **Memorial Service**

- held at university church
- students and staff
- relatives and friends of donors



## ***GMC Outcomes 2: Professional skills***

- Diagnosis and medical management
- Communication skills
- Manual dexterity
- Technical competence



## *Diagnosis & Medical Management*

- Reported cause of death withheld
- Only age and occupation provided

During the year, students discover medical history (pathology and procedures) and postulate cause of death through dissection.

Zoom session after completion of dissection, with:

- Presentation by Consultant in Palliative Care to discuss **end of life trajectory** and **completion of Medical Certificate of Cause of Death**
- Discussion facilitated by **Year 5 clinical students** who have just completed their **Palliative Care placement**

# Communication Skills

- Applied Anatomy seminars with cases
- Complements dissection task

Facilitated by 2 clinicians

Students prepare in advance and present their answers in front of the whole class.

Example of *flipped learning*

## CASE 1 – GP phone consultation

AGE and SEX  
77-year-old female.

PRE  
Coli  
  
HIST  
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wor  
  
Her

### EXAMINATION in A&E



<https://www.medicinenet.com/>



- 1) What do you see?
- 2) What question(s) could be asked during the phone consultation that may be helpful?
- 3) What are the differential diagnoses?
- 4) The examining clinician concludes that there is an *irreducible* hernia. What does that mean?



# Manual Dexterity

- Haptic skills
- Tissue handling
- Cultivating focus



*“Prosecting gives you the time to tease out finer structures and finer anatomical details. Opening your toolbox on day one is enough to make any aspiring surgeon giddy. You will develop a feel for which instrument is best suited to each task – the satisfaction this gives is hard to put into words.”*

*from second year medical student, currently on an MRC Fellowship doing clinical orthopaedic research*

# Technical Competence

- Hands-on ultrasound scanning
- Complements dissection task

Demonstrators include:

- Consultant radiologists
- Trainee radiologists
- Junior demonstrators
- Years 4-6 clinical students who have undergone tutor training in use of ultrasound

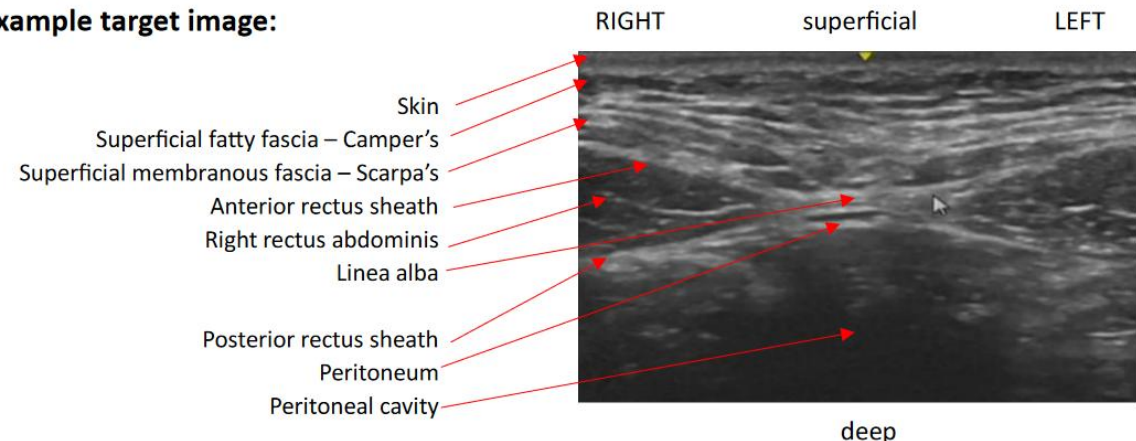
## TASK 1



### Anterior Abdominal Wall Musculature

1. Ensure your subject is lying flat, supine, and comfortable with their abdominal wall relaxed.
2. Select the correct transducer and/or pre-set (superficial structures), apply ultrasound gel, and ensure you have the correct transducer orientation.
3. Place the transducer on the anterior abdominal wall in a transverse orientation in the midline in the epigastrium or just above the umbilicus.
4. Adjust the depth settings to observe the linea alba and the two bellies of **rectus abdominis**.
5. Observe the underlying peritoneum.

Example target image:



## ***GMC Outcomes 3: Professional knowledge***


- Data collection
- Anatomical variations
- Interventional procedures
- Clinically relevant research


# Data Collection: Anatomical Variations

## STUDY EXAMPLE 1: Lung Fissures

Table No. \_\_\_\_\_ Morphology of the lobes and fissures of the lungs

	Right Lung				Left Lung			
Lobes	1	2	3	4				
Oblique fissure	<i>Is it present?</i>	Yes	No					
	<i>Is it complete?</i>	Yes	No					
	If incomplete, Length if complete							
Horizontal fissure	<i>Is it present?</i>	Yes	No					
	<i>Is it complete?</i>	Yes	No					
	If incomplete, Length if complete							
Accessory fissures								
Hilum	Arteries	1	2	3	4			
	Veins	1	2	3	4			
	Bronchi	1	2	3	4			
Additional notes								




Original Communication | [Open Access](#) | 



Are textbook lungs really normal? A cadaveric study on the anatomical and clinical importance of variations in the major lung fissures, and the incomplete right horizontal fissure

Charles T. West , Naim Slim, Duncan Steele, Alexander Chowdhury, Cecilia Brassett

First published: 26 July 2020 | <https://doi.org/10.1002/ca.23661>

[ejournals@cambridge](mailto:ejournals@cambridge) - find full text'

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### Abstract

#### Introduction

The lungs have three main fissures: the right oblique fissure (ROF), right horizontal fissure (RHF), and left oblique fissure (LOF). These can be complete, incomplete or absent; quantifying the degree of completeness of these fissures is novel. Standard textbooks often refer to the fissures as complete, but awareness of variation is essential in thoracic surgery.

# STUDY EXAMPLE 2: Colonic Configurations

Determine the configuration of the following colonic segments.

**Sigmoid colon**

- "Low mobility"
- "Intermediate mobility"
- "High mobility"

**Presence of a peritoneal sac**

**Transverse colon**

- "Low mobility"
- "Intermediate mobility"
- "High mobility"

If in doubt regard as intermediate mobility  
above and take note of any other features  
Please add any other notes

### Mobility Classification

	Low Mobility	Intermediate Mobility
Sigmoid Colon		
Transverse Colon		

CLINICAL ANATOMY

Original Communication

## Exploration of colonic looping patterns in undisturbed cadaveric specimens

Jacob Lam [✉](#), James Wilkinson, Jonathan Brown, Michelle Spear, Cecilia Brassett

First published: 15 November 2020 | <https://doi.org/10.1002/ca.23702>

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### Abstract

### Introduction

This study examines sex differences in the disposition of the sigmoid and transverse segments of the colon in undisturbed cadaveric abdomens and relates these findings to the anecdotal observation that colonoscopy is more challenging in females through the formation of tortuous bowel loops.

## *Interventional Procedures*



Coronary artery bypass grafting  
vs. Coronary angioplasty



Oesophageal stenting:  
Indications, risks & benefits



Umbrella filter in the inferior vena cava:  
Prophylaxis against pulmonary embolism

# Interventional Procedures

**TREATMENT OPTIONS**

### EVAR

ENDOVASCULAR ANEURYSM REPAIR

A minimally invasive procedure in which a stent graft is placed in the artery to prevent blood flow to an aneurysm

**ADVANTAGES**

- 98%-99% FULLY RECOVER
- LESS PAIN**
- FASTER RECOVERY  
SHORTER HOSPITAL STAY
- FEWER MAJOR COMPLICATIONS

**DISADVANTAGES**

- NEED REGULAR FOLLOW UP SCANS AFTER OPERATION
- SLIGHT RISK OF STENT **GRAFT MIGRATION**

### OPEN REPAIR

A large cut is made to the abdomen, after which the abnormally dilated part of the aorta is removed and replaced with a graft

**ADVANTAGES**

- 93%-97% FULLY RECOVER
- ARTIFICIAL VESSEL **CAN FUNCTION** WELL FOR YEARS
- AVOIDS THE EXPANSION** OR RUPTURE

**DISADVANTAGES**

- NOT RECOMMENDED FOR PEOPLE IN POOR HEALTH
- HIGH SURGICAL COMPLICATION RISK
- MORE PAIN FROM THE WOUND
- SLOWER RECOVERY  
LONGER HOSPITAL STAY

EVAR =

aneurysm repair

## *Clinically Relevant Research*

- Co-supervised with clinicians
- May involve:
  - cadaveric dissection
  - ultrasound scanning
  - interpretation of MRIs
  - 3D reconstruction of microCTs
- Presentations at national or international conferences
- Publications

Many students continue to pursue a career in clinical academia.

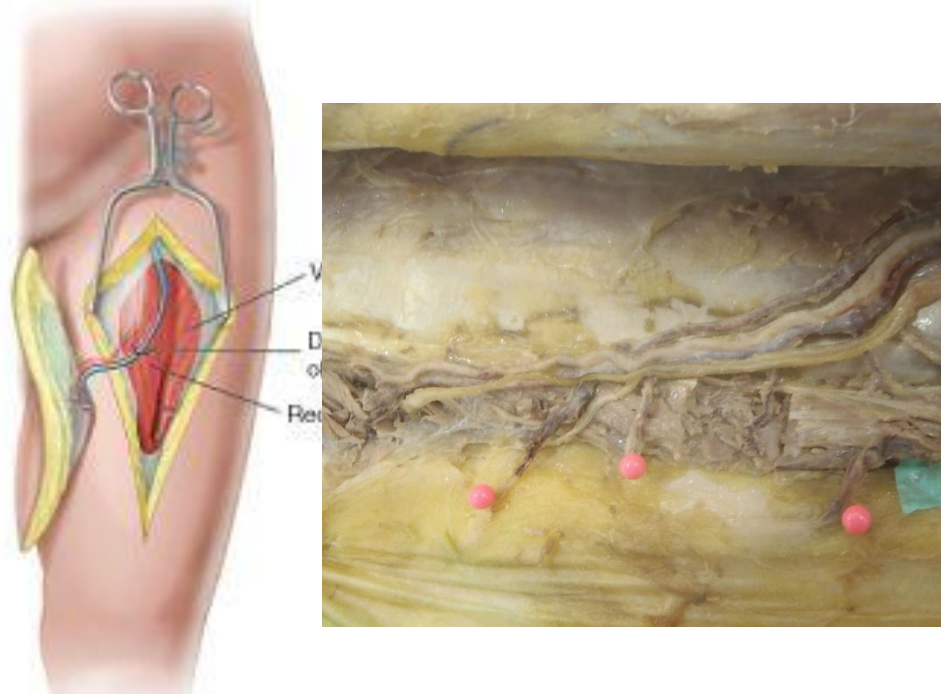
*“My third year was the year where I learnt most about life. It was a very challenging year, both in terms of personal development and academic progress. It changed the way I looked at the world.*

*The project was incredible. It changed my perspective on science, and opened my eyes to how we think about things. It increased my confidence in sharing my ideas with other people. Now I treat everything as a project, even something as simple as cooking a meal.”*



# Clinically Relevant Research

## PROJECT EXAMPLE 1: Harvesting the Anterolateral Thigh Flap



> *J Reconstr Microsurg.* 2019 May;35(4):254-262. doi: 10.1055/s-0038-1670649. Epub 2018 Sep 15.

### Neurovascular Anatomy at the "Box Junction": Considerations in the Anterolateral Thigh Flap

Max Stewart <sup>1</sup>, Cecilia Brassett <sup>2</sup>, Ahid Abood <sup>3</sup>

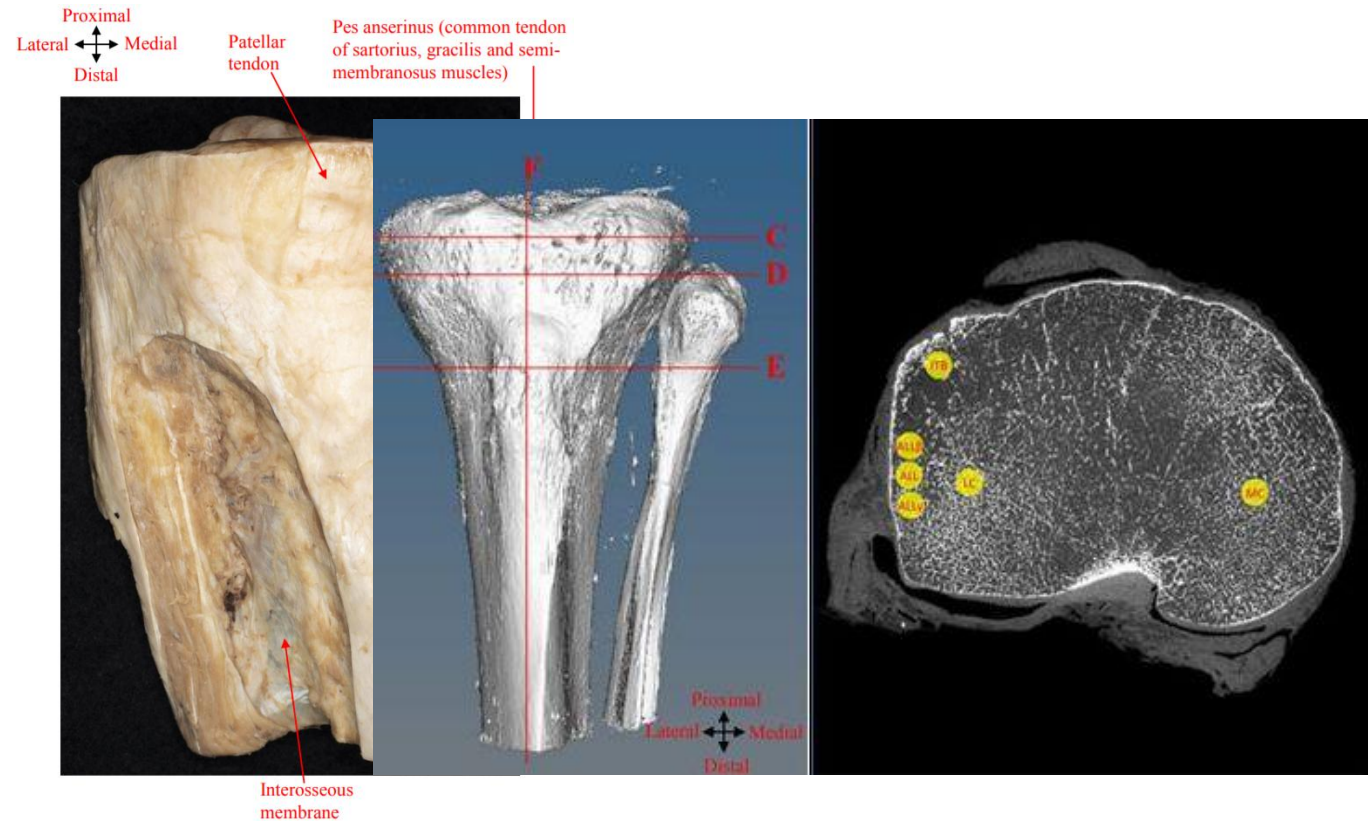
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PMID: 30218993 DOI: 10.1055/s-0038-1670649

#### Abstract

**Background:** The anterolateral thigh (ALT) perforator flap is one of the most widely used flaps in reconstructive microsurgery. This study investigated a previously unexplored and clinically relevant aspect of perforator anatomy: the "box junction" (BxJn), the point at which the perforator arises from its source vessel. Negotiating the BxJn can be a challenging and time-consuming step in flap harvest, due to the neurovascular structures in the area which must be protected from injury. However, as the presence and location of these structures have yet to be clearly defined, painstaking exploration is necessary on each occasion. Knowledge of BxJn anatomy could allow surgeons to harvest the ALT flap more rapidly and safely.

# PROJECT EXAMPLE 2: Pathogenesis of the Segond Fracture



## Journal of Anatomy

ORIGINAL PAPER

### The Segond fracture occurs at the site of lowest sub-enthesal trabecular bone volume fraction on the tibial plateau

William Mullins , Gavin E. Jarvis, Daniel Oluboyede, Linda Skingle, Ken Poole, Tom Turmezei, Cecilia Brassett

First published: 08 August 2020 | <https://doi.org/10.1111/joa.13282>

SECTIONS

#### Abstract

In a series of human cadaveric experiments, Dr. Paul Segond first described the avulsion injury occurring at the anterolateral tibial plateau that later took his name. The fracture is thought to arise as a consequence of excessive tibia internal rotation which often also elicits damage to other connective tissue of the knee. The exact mechanism behind the avulsion is, however, unclear. A number of ligamentous structures have been proposed in separate studies to insert into the Segond fragment. Suggestions include the iliotibial band (ITB), biceps femoris and the controversial 'anterolateral ligament' (ALL). Despite increasing knowledge of tibial plateau bony microarchitecture in both healthy and disease states, no studies have yet, to our knowledge, considered the role of tibial sub-enthesal bone structure in pathogenesis of the Segond fracture. The goal of this study was thus to elucidate the differences in trabecular properties at regions across the tibial plateau in order to provide an explanation for the susceptibility of the anterolateral region to avulsion injury. Twenty human tibial plateaus from cadaveric donors were dissected and imaged using a Nikon-XTH225- $\mu$ CT scanner with  $<80 \mu\text{m}$  isotropic voxel size. Scans were reconstructed using MicroView 3D Image Viewer and Analysis Tool. Subsequent virtual biopsy at ten anatomically defined regions of interest (ROI) generated estimates of bone volume fraction ('bone volume divided by total volume' (BV/TV)). The overall mean BV/TV value across all 20 tibiae and all 10 ROIs was 0.271. Univariate repeated-measurements ANOVA demonstrated that BV/TV values differed between ROIs. BV/TV values at the Segond site ( $S\alpha$ ,  $S\beta$  or  $S\gamma$ ) were lower than all other ROIs at 0.195, 0.192 and 0.193, respectively. This suggests that, notwithstanding inter- and intra-specimen variation, the Segond site tends to have a lower trabecular bone volume fraction than enthesal sites elsewhere on the tibia. Since BV/TV correlates with tensile

## *What do our students say?*

*“My experience in the dissection room set the tone for the rest of my medical studies. We were taught to respect our donors and to make the most of their generous gift. At the memorial service, I had a long conversation with the family of our donor, which left a lasting impression on me. We learnt a lot more than just anatomical knowledge.”*

*“I wanted to extend my thanks to you for this: without your recruitment of such high-quality demonstrators and drive to run a clinically relevant course, I would never have had the chance to meet people who proved to be such an inspiration. My eventual goal is to use the scientific grounding that Cambridge and its staff have given me to make a genuine contribution to the field.”*



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*Lean in Medical Education: Reaching for Quality Management  
Tools to Teach Human Anatomy Effectively in a Multicultural  
and Multilingual Learning Space*

**Hvala puno!**

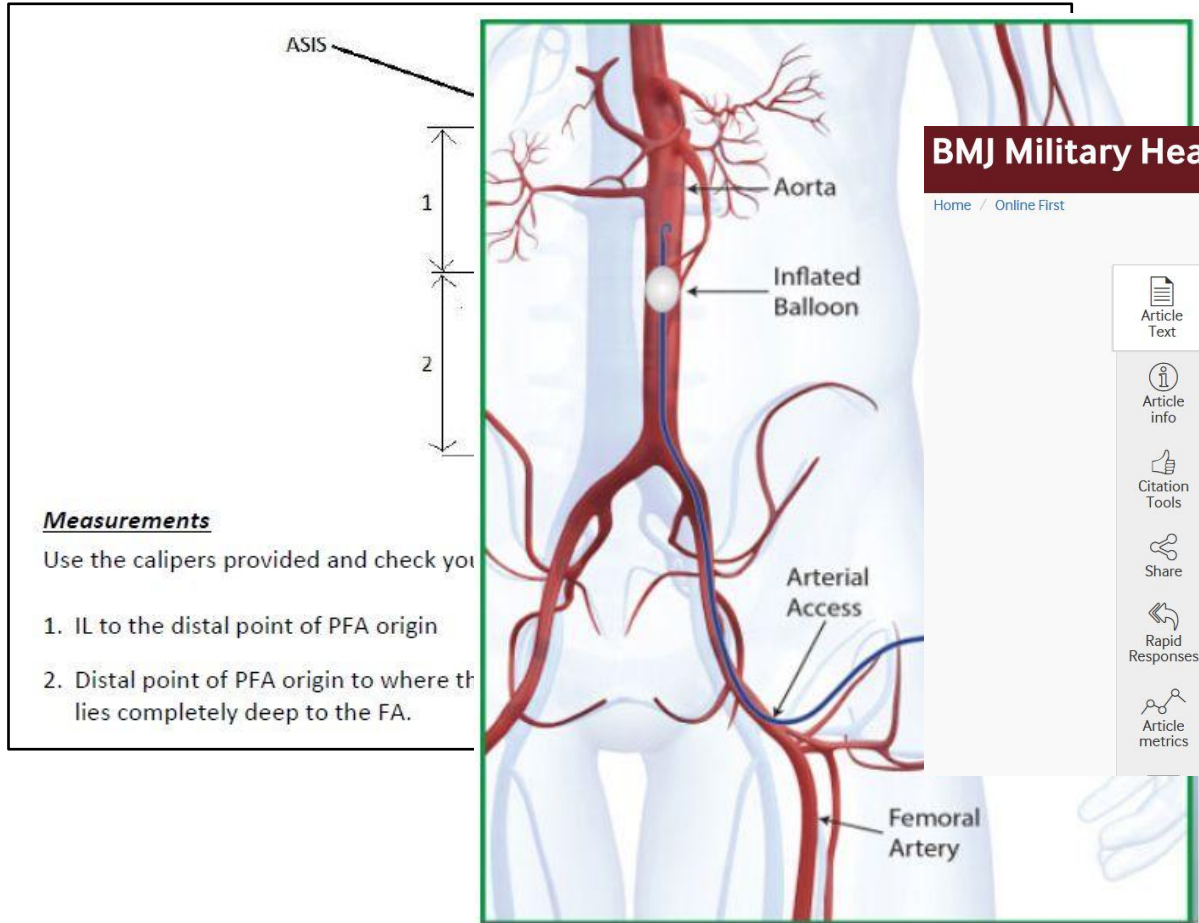


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# STUDY EXAMPLE 3: Femoral Vessels



**Measurements**

Use the calipers provided and check you

1. IL to the distal point of PFA origin
2. Distal point of PFA origin to where the vein lies completely deep to the FA.

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Original research

### The REBOA window: a cadaveric study delineating the optimum site for austere cannulation of the femoral artery for resuscitative endovascular balloon occlusion of the aorta

Naim Slim<sup>1</sup>, C T West<sup>1, 2</sup>, P Rees<sup>3, 4</sup>, C Brassett<sup>1</sup> and M Gaunt<sup>1</sup>

Correspondence to Major C T West, Colorectal Surgery, University Hospital Southampton NHS Foundation Trust, Southampton SO16 6YD, UK; ctimothyw@gmail.com

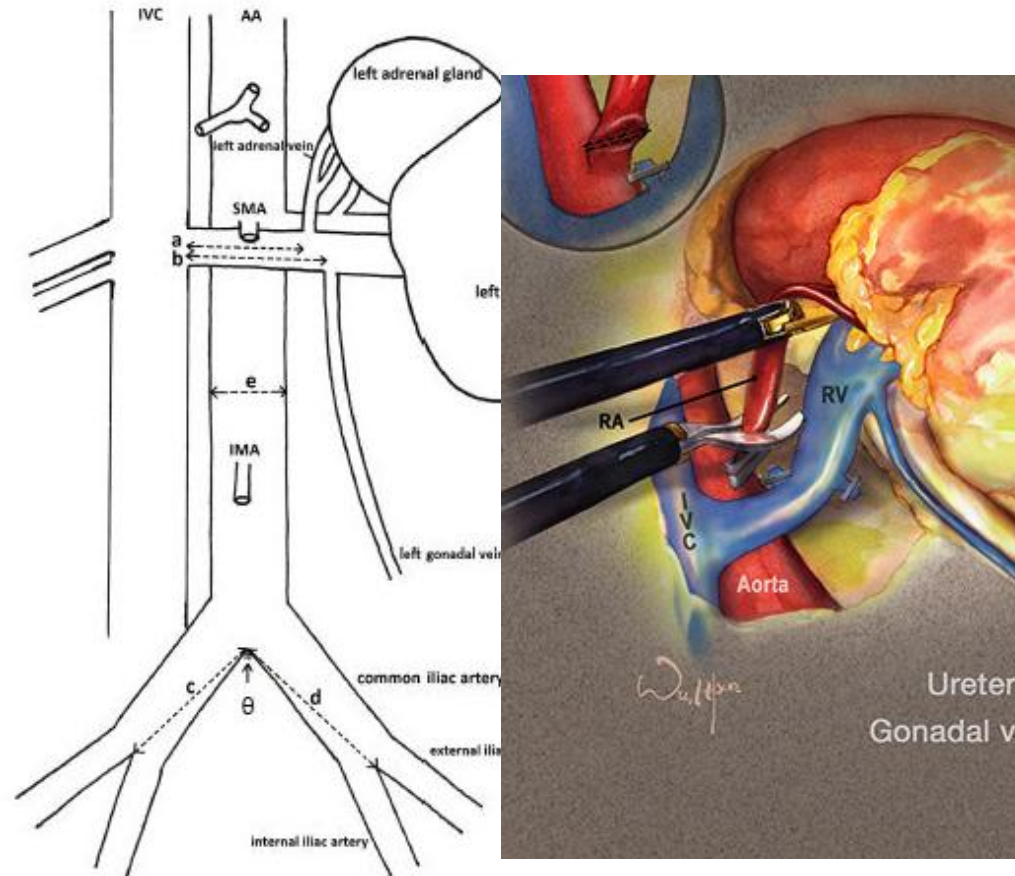
**Abstract**

**Introduction** Haemorrhage is the major cause of early mortality following traumatic injury. Patients suffering from non-compressible torso haemorrhage are more likely to suffer early death. Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) can be effective in initial resuscitation; however, establishing swift arterial access is challenging, particularly in a severe shock. This is made more difficult by anatomical variability of the femoral vessels.

**Methods** The femoral vessels were characterised in 81 cadaveric lower limbs, measuring specifically the distance from the inferior border of the inguinal ligament to the distal part of the origin of the profunda femoris artery (PFA), and from the distal part of the origin of the PFA to where the femoral vein lies posterior to and is completely overlapped by the femoral artery.

# STUDY EXAMPLE 4: Tributaries of the Left Renal Vein

## Clinical Significance of Variations in Renal Vascular Anatomy



> Surgeon. 2020 Dec;18(6):349-353. doi: 10.1016/j.surge.2020.01.001. Epub 2020 Feb 20.

## Configuration of the extra-renal venous system in relation to the left renal vein: A cadaveric study and new proposed classification

Alexander Walker<sup>1</sup>, Naim Slim<sup>2</sup>, Michael Nicholson<sup>3</sup>, Cecilia Brassett<sup>2</sup>

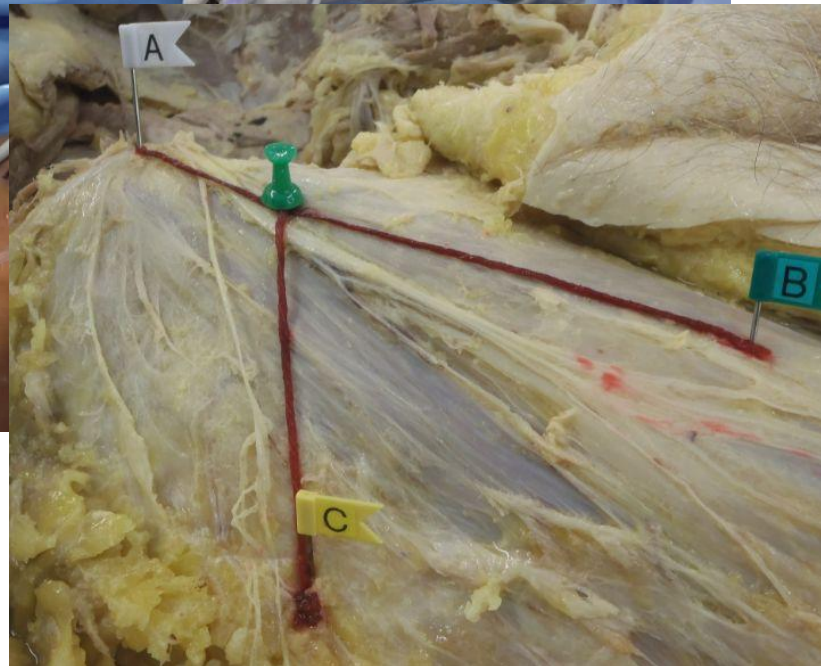
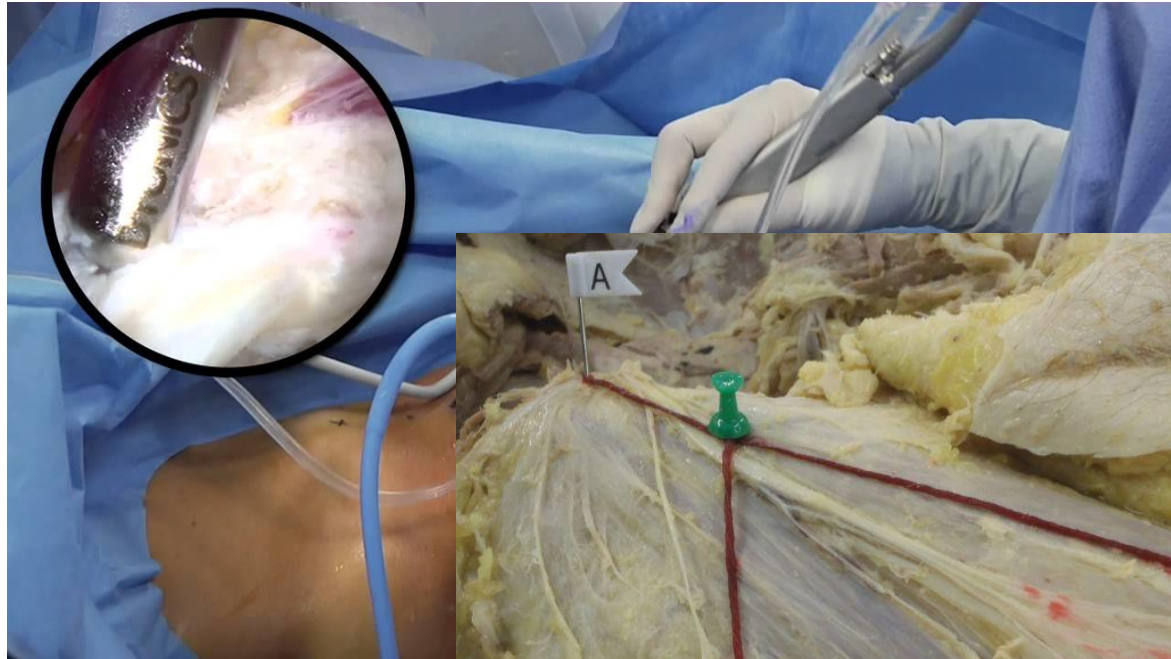
Affiliations + expand

PMID: 32089372 DOI: 10.1016/j.surge.2020.01.001

### Abstract

The advent of laparoscopic live-donor nephrectomy for renal transplantation has prompted the need to define the precise anatomical relations of the left renal vein (LRV) and its tributaries. The left kidney is preferred as the greater length of the LRV facilitates implantation in the recipient. While previous studies have described variations in the LRV system, the connections between the left ascending lumbar vein (LALV) and LRV tributaries have been less well-defined. This study aims to further characterise the LALV and proposes a novel classification for its relation to other veins. Dissection of the LRV system, including the left suprarenal vein (LSV), left gonadal vein (LGV) and LALV, was performed in 38 cadavers. Their drainage points into the LRV were recorded, and measurements taken of the distances from these points to the junction of the LRV and inferior vena cava (IVC). The position of the LRV in relation to the aorta was anterior in 35 cases (92%), entirely posterior in 1 case (3%), and circumaortic in 2 cases (5%).

# PROJECT EXAMPLE 3: Lateral Femoral Cutaneous Nerve



> [Arthroscopy](#). 2018 Jun;34(6):1833-1840. doi: 10.1016/j.arthro.2018.01.012. Epub 2018 Feb 23.

## What Is the Risk Posed to the Lateral Femoral Cutaneous Nerve During the Use of the Anterior Portal of Supine Hip Arthroscopy and the Minimally Invasive Anterior Approach for Total Hip Arthroplasty?

Jonathan D Bartlett <sup>1</sup>, John E Lawrence <sup>1</sup>, Vikas Khanduja <sup>2</sup>

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PMID: 29482861 DOI: 10.1016/j.arthro.2018.01.012

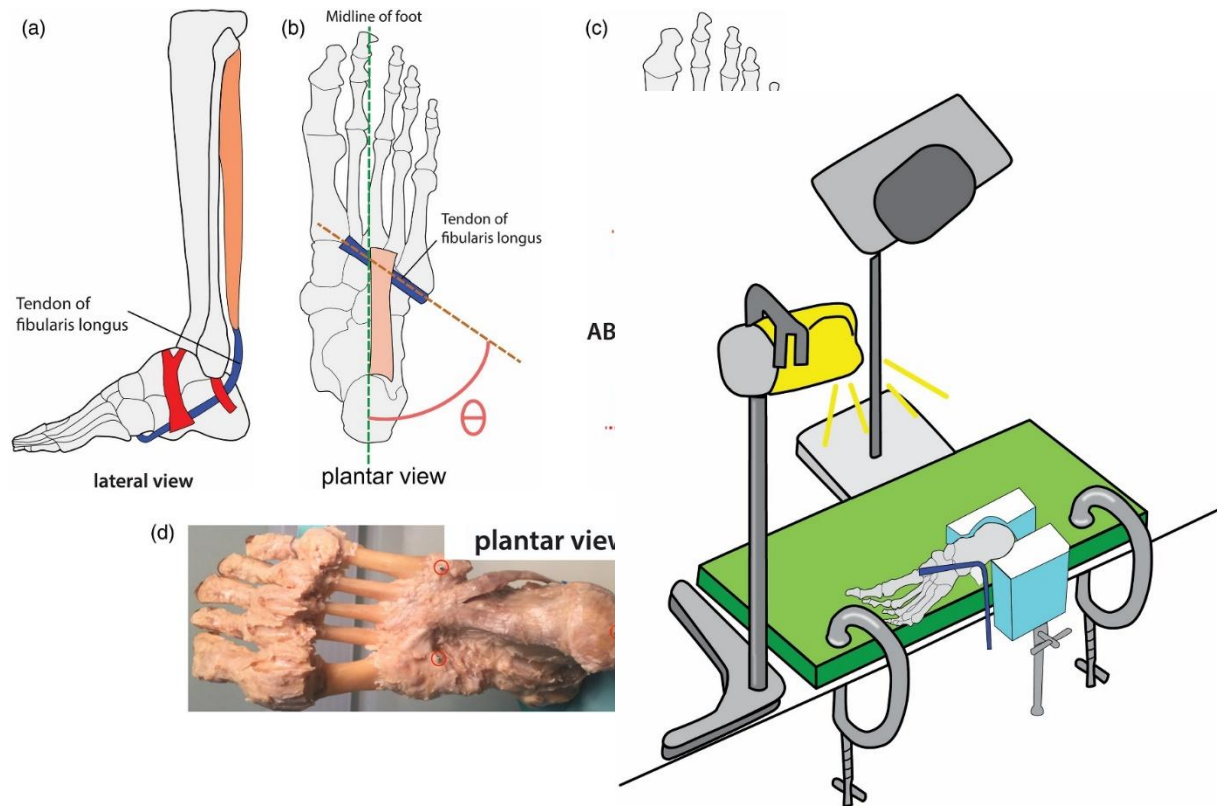
### Abstract

**Purpose:** To determine: (1) What is the proximity of the lateral femoral cutaneous nerve (LFCN) to the anterior portal (AP) used in supine hip arthroscopy? (2) What is the proximity of the LFCN to the incision in the minimally invasive anterior approach (MIAA) for total hip arthroplasty? (3) What effect does lateralizing the AP have on the likelihood of nerve injury? (4) What branching patterns are observable in the LFCN?

**Methods:** Forty-five hemipelves were dissected. The LFCN was identified and its path dissected. The positions of the nerve in relation to the AP and the MIAA incision were measured.

**Results:** The AP intersected with 38% of nerves. In the remainder, the LFCN was located  $5.7 \pm 4.5$  mm from the portal's edge. In addition, 44% of nerves crossed the incision of the MIAA. Of those that did not, the average minimum distance from the incision was  $14.4 \pm 7.0$  mm. We found a significant reduction in risk if the AP is moved medially by 5 mm or laterally by 15 mm ( $P = .0054$  and  $P = .0002$ ). The LFCN showed considerable variation with 4 branching variants.

# PROJECT EXAMPLE 4: Role of Fibularis Longus



## The role of the angle of the fibularis longus tendon in foot arch support

Anoop S. Sumal  Gavin E. Jarvis, Alan R. Norrish, Cecilia Brassett, Robert H. Whitaker

First published: 28 September 2020 | <https://doi.org/10.1002/ca.23686>

Research was presented at the British Association of Clinical Anatomy (BACA) Winter Meeting on 17th December 2019 at Newcastle Medical School, Newcastle University, NE2 4HH, UK.

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### Abstract

#### Introduction

Understanding the contribution of the fibularis longus tendon to the support of the midfoot arches has potential therapeutic applications. This cadaveric study sought to quantify this support across both the transverse arch and medial longitudinal arch and to establish whether a correlation exists between this support and the angle at which the tendon enters the sole.

#### Materials and methods

Markers placed in 11 dissected cadaveric foot specimens defined the arch boundaries. Incremental weights up to 150 N were applied to the fibularis longus tendon to simulate progressive muscle contraction, and associated changes in the transverse and medial longitudinal arch boundaries were recorded.