

Technical Note

Vascular Coloration for Anatomical Study of the Pelvis and Hip: Implications in Hip Preservation Surgery

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Abstract: Hip preservation surgical techniques have steadily increased in the recent past. Therefore, precise knowledge of the vascular system of the hip and pelvis is critical for avoidance of possibly devastating complications during surgery. A colored latex injection in the common iliac artery of cadavers allows for a complete staining of the hip and pelvis vascular system. This technique creates more resilient vessels, whereas coloration with dye causes the vessels to be highly visible in comparison with the surrounding tissue. The proposed colored latex-dye solution injection allows for complete identification of the circulatory system of the lower extremity with specific focus on the hip and pelvis. This technique is simple, reproducible, and easily usable by orthopaedic surgeons in the laboratory to better understand the vascularization of the lower limb. The purpose of this technical note is to describe our technique for the injection of latex-dye solution in the common iliac artery, followed by dissection to key vascular structures of the hip and pelvis.

Hip joint preservation surgery is exponentially growing, because of the better understanding of hip pathologies, improved surgical techniques, and technology advancement. Knowledge of the vascular anatomy of the hip and pelvis is critical when performing hip preservation surgical procedures such as hip arthroscopy, osteotomies, surgical dislocations, and periacetabular osteotomy. An in-depth understanding of the anatomy is the cornerstone of any physician's general knowledge and of surgical procedures. The vascular anatomy of the hip and pelvis is exceptionally intricate and delicate.^{1,2}

In cadaveric dissections, the intra-arterial injection of different fluid materials allows for better visualization of the vasculature during dissection, improving the understanding of the vascular anatomy.³ Silicone,

gelatin-lead oxide, and latex have all been described.⁴ Gelatin-lead oxide is superior in marking small vessels, but not as easily accessible as silicone or latex. Gelatin also has poor flexibility. Silicone yields similar results to latex, but the silicone has unpredictable hardening times and penetration depth, and also requires more steps in preparation.⁴ Ultimately, given the similar results, we believe that latex decreases the number of steps and lowers the complexity of the procedure.

The purpose of this technical note is to describe the technique for injecting latex-dye solution in the common iliac artery and the subsequent dissection to identify the hip and pelvis vascularization and its implications in hip preservation surgical techniques.

Surgical Technique

Limb Preparation and Latex-Dye Injection

A full limb is used for this purpose so that the injected latex could flow from the arterial system into the venous system. The cadaveric specimen is oriented in a supine position. The common iliac artery is exposed by resecting the surrounding muscle tissue using sharp dissection. Once approximately 4 cm of the common iliac artery is exposed, a K30 Foley catheter (BARDEX, I.C. 2 way, 22FR, Covington, GA) is inserted and then secured with surgical thread (Fig 1). A prewarmed 0.9% saline solution is slowly injected into the catheter using a syringe to ensure proper and complete circulation throughout the lower extremity and to clear

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Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Meticulous dissection of the external iliac artery before injection, exposing approximately 5 cm of the artery to insert and secure the catheter	Not dissecting enough stump of the artery to be secured to the catheter
The catheter should be secured to the artery with a suture	Loose sutures securing the catheter to the artery
Rinse the vasculature with warm 0.9% saline to remove blood clots and debris in the vessels before injecting the dye to ensure free passage. Rinsing the vessels also allows for better filling with the latex dye and thus better visualization	Injecting the latex dye before rinsing or injecting normal saline solution to remove blood clots and debris
Inject the dye slowly with gentle constant pressure until the dye can be seen coming from the vein. This signals free passage and that the dye fills the vascular system	Injecting the dye too fast with a lot of pressure resulting in loosening of the catheter and/or spillage of the dye
Put a clamp on the artery to avoid back flow of the dye and to ensure that the dye remains in the vessels	Removing the arterial clamp too soon
Freeze the extremity for at least 48 h for the dye to set. This improves visualization and makes dissection easier	Not allowing adequate time from injection to dissection
Make a deep incision on the plantar side of the big toe to confirm that the dye is present	

debris (Figs 2 and 3). A mixture of liquid latex (FX Latex, Beverly, MA) and red paint (iLoveToCreate, Fresno, CA) is then injected through the catheter using a syringe to dye the circulatory system and create noncompliance. This facilitates tracking the branching arteries more accurately because only those derived from the common iliac artery receive the latex dye. While performing the injection, it is vital to keep constant low pressure to ensure that the small vessels are being filled by the dye. A small incision is made in the hallux to assure that the latex dye has properly

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Easy-to-use technique	Waiting time from injection to dissection
Low cost	Time consuming to prepare the cadaver before injection
Small vessels can be identified	It can be messy if the dye spills
Blood vessels filled with latex dye are less compliant, thus easier to identify and dissect	
Can be used for most body parts	

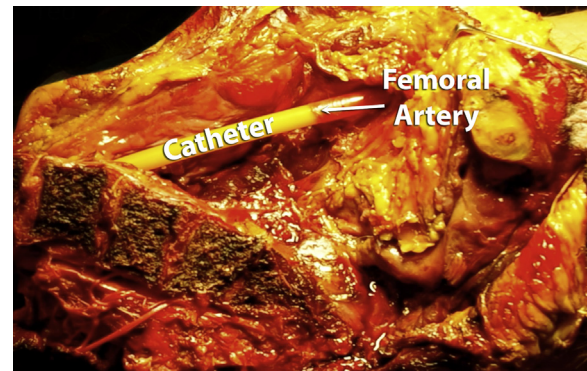


Fig 1. A catheter is inserted into the femoral artery of the left hip before injection of latex-dye solution. Care must be taken to avoid potential damage to the femoral artery.

circulated in the capillary vasculature. In the incision, bright pink vessels should be visible, guaranteeing that the circulation has been successful (refer to Video 1). Pearls and pitfalls and advantages and disadvantages of this procedure are detailed in Tables 1 and 2, respectively.

Dissection

The dissection proceeds 48 hours after the latex injection. Skin and fat is resected to improve the examination of the muscle structure and the branches of the common iliac artery throughout the leg. The muscles are slowly dissected away so as to trace the origin of various arteries. The cadaver leg is continually rotated throughout the dissection to get the best angle. The hip joint and vessels are exposed with the leg in Figures 4 to 6.

Discussion

The proposed technique confirms the ability of coloring the main vascular system in the hip and pelvis through inoculation of colored latex in the common iliac artery. This technique allows coloration and visualization of the medial femoral circumflex artery, the

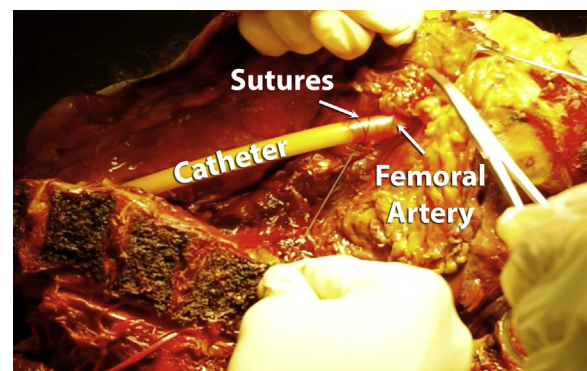


Fig 2. Once the catheter is inserted carefully into the femoral artery of the left hip, sutures must be used to properly secure the catheter. Here we show (white arrows) the use of sutures for proper securement.

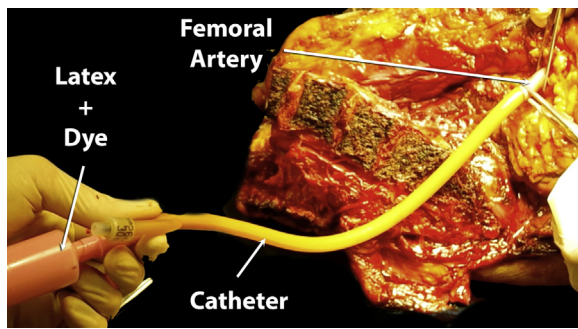


Fig 3. The latex-dye solution is injected via the catheter into the femoral artery of the left hip. The solution will disperse throughout the vascular system of the hip for future study.

superior and inferior gluteal arteries, the obturator vessels, and the periacetabular vascular ring. All these vessels are critical when performing different hip preservation procedures, such as hip arthroscopy.

Comparing different dye materials, we believe that latex has advantages over others. First, it has low cost, is easily available, and has the ability to flow through small vessels.⁴ The literature pertaining to latex injection is limited, but has been commonly reported for small vessels, including the intricate structuring of the head,⁴ and in fetuses.⁵ In addition, less preparation is required for liquid latex, leading to similar vascular distention as for other dye materials.⁴ The speed of injecting the latex-dye solution is also crucial. Injecting at a slow, steady rate allows the latex to flow through the vessels, whereas quick injection of the latex-dye solution could result in dislocation of the catheter or bursting of a vessel in the cadaver. Because latex hardens at a predictable rate and consistency, it is ideal for vascular injection. The properties of latex create

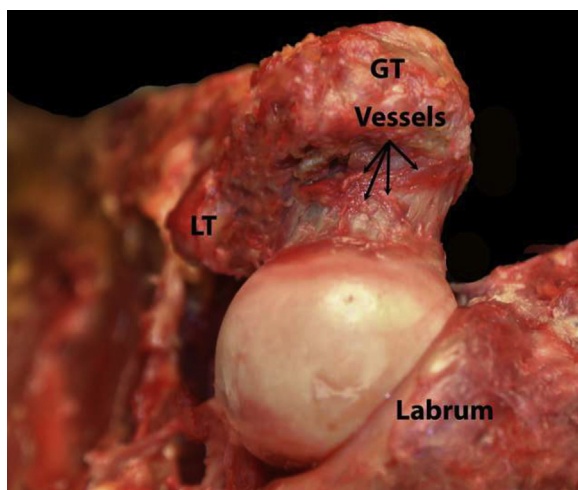


Fig 4. Cadaveric dissection of the femoral artery in a left thigh showing the branching of the vessel and its relation with the most important soft tissues. (GT, greater trochanter; LT, lesser trochanter.)

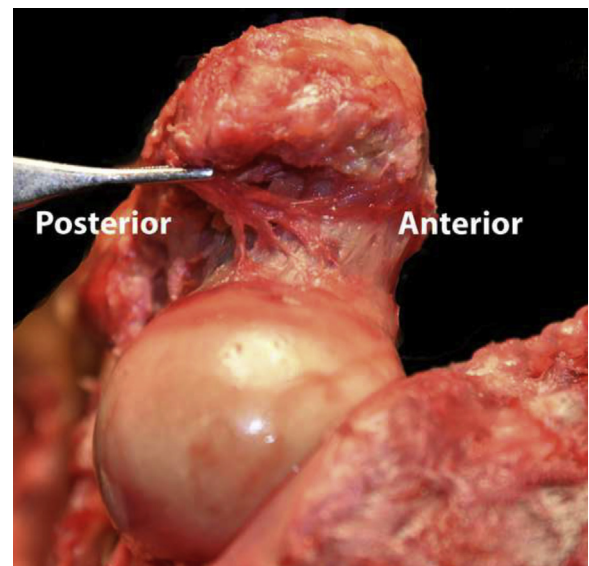


Fig 5. Cephalic view of a subluxated left hip showing the subsynovial branches of the deep branch of the medial femoral circumflex artery located in the posterosuperior aspect of the femoral neck. The lesser trochanter and labrum are shown for reference. The image shows the vessels that supply blood source for the femoral head. The muscles surrounding the femoral head have been dissected and removed for better viewing of the joint itself. The vessels are protruding from the structure itself due to the latex-dye solution.

congruency across the vessels and the solution spreads to the distal regions of the limb.

In conclusion, the latex-dye solution provides adequate vascular staining of important anatomic structures of the hip and pelvis. This technique is simple, reproducible, and allows students, surgeons, and other health care providers to perform anatomic dissections that will provide an in-depth understanding of anatomic vascular hip and pelvis structures.

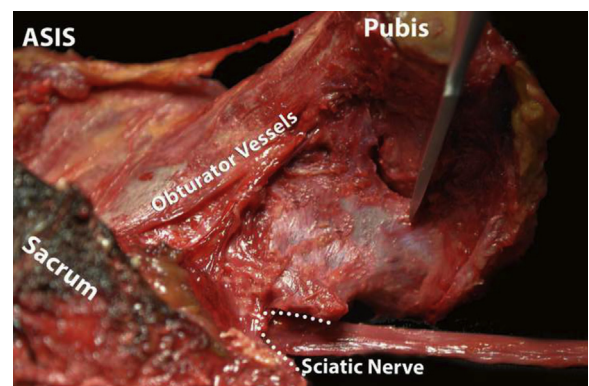


Fig 6. Posterior view of a left hip showing the branching of the inferior gluteal artery in the acetabular side and the medial circumflex artery on the posterosuperior aspect of the femoral neck. (ASIS, anterior superior iliac spine.)

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