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Abstract: INTRODUCTION: Vascular injury may be encountered during an anterior approach to the pelvis or acetabulum-be it due to hematoma decompression, clot dislodgement during fracture manipulation, or iatrogenic. This can be associated with significant bleeding, hemodynamic instability, and subsequent morbidity. If the exact source of bleeding cannot be easily identified, compression of the internal iliac artery may be a lifesaving procedure. MATERIALS AND METHODS: We describe an extension of the lateral window of the ilioinguinal (or Olerud) approach elaborated on cadavers. RESULTS: The approach allows emergent access the internal iliac artery and intraoperative cross-clamping of the internal iliac vessels to control bleeding. CONCLUSION: The approach allows rapid access to the internal iliac artery. The surgeon should be familiar, however, with the surgical anatomy of this region to avoid potential injury to the ureter, peritoneum, lymphatics, and sympathetic nerves overlying the vessels when using the approach described.

DOI: <https://doi.org/10.1007/s00402-010-1143-y>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-43639>

Journal Article

Published Version

Originally published at:

Karkare, N; Yeasting, R A; Ebraheim, N A; Espinosa, N; Scheyerer, M J; Werner, C M L (2011). Anatomical considerations of the internal iliac artery in association with the ilioinguinal approach for anterior acetabular fracture fixation. *Archives of Orthopaedic and Trauma Surgery*, 131(2):235-239.

DOI: <https://doi.org/10.1007/s00402-010-1143-y>

Anatomical considerations of the internal iliac artery in association with the ilioinguinal approach for anterior acetabular fracture fixation

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Received: 12 March 2008 / Published online: 29 June 2010
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Abstract

Introduction Vascular injury may be encountered during an anterior approach to the pelvis or acetabulum—be it due to hematoma decompression, clot dislodgement during fracture manipulation, or iatrogenic. This can be associated with significant bleeding, hemodynamic instability, and subsequent morbidity. If the exact source of bleeding cannot be easily identified, compression of the internal iliac artery may be a lifesaving procedure.

Materials and methods We describe an extension of the lateral window of the ilioinguinal (or Olerud) approach elaborated on cadavers.

Results The approach allows emergent access the internal iliac artery and intraoperative cross-clamping of the internal iliac vessels to control bleeding.

Conclusion The approach allows rapid access to the internal iliac artery. The surgeon should be familiar, however, with the surgical anatomy of this region to avoid potential injury to the ureter, peritoneum, lymphatics, and sympathetic nerves overlying the vessels when using the approach described.

Keywords Ilioinguinal approach · Acetabulum · Pelvic ring · Bleeding · Complication

Introduction

Pelvic hemorrhage might be encountered during either an anterior approach to the ilium or SI-joint (Olerud), or during an ilioinguinal [13, 15] approach to the acetabulum. This might be due to injuries to the internal iliac artery associated with pelvic fractures, clot dislodgement during fracture manipulation, or iatrogenic (e.g. injury to the corona mortis) [1, 6–10, 12, 13, 17, 18, 22, 24–28, 30, 31, 33, 34]. These major sources of bleeding are addressed by open exploration and repair, ligation, intraoperative embolization, packing, or percutaneous selective arteriographic embolization [2, 3, 14, 16, 18, 32]. If the exact source of bleeding cannot be immediately identified intraoperatively, approach the proximal vasculature to control bleeding might be warranted. For such a scenario, operative strategy remains controversial in literature [33]. A method of access to the internal iliac artery using the lateral window of the ilioinguinal approach—to the best our knowledge—has yet not been described. An extension of the given ilioinguinal approach allowing rapid access to the internal iliac artery has been carried out on cadavers and is described.

Technique

The approach described is an extension of the lateral window of the ilioinguinal approach [13] (similar to Olerud [23] approach to the SI-joint, Fig. 1). It gives rapid access to the bifurcation of the iliac vessels. The psoas muscle is identified and serves as a major landmark for further surgical dissection. Staying extraperitoneal, the plane of dissection is between the medially retracted pelvic content/peritoneum, and the psoas muscle (Fig. 2).

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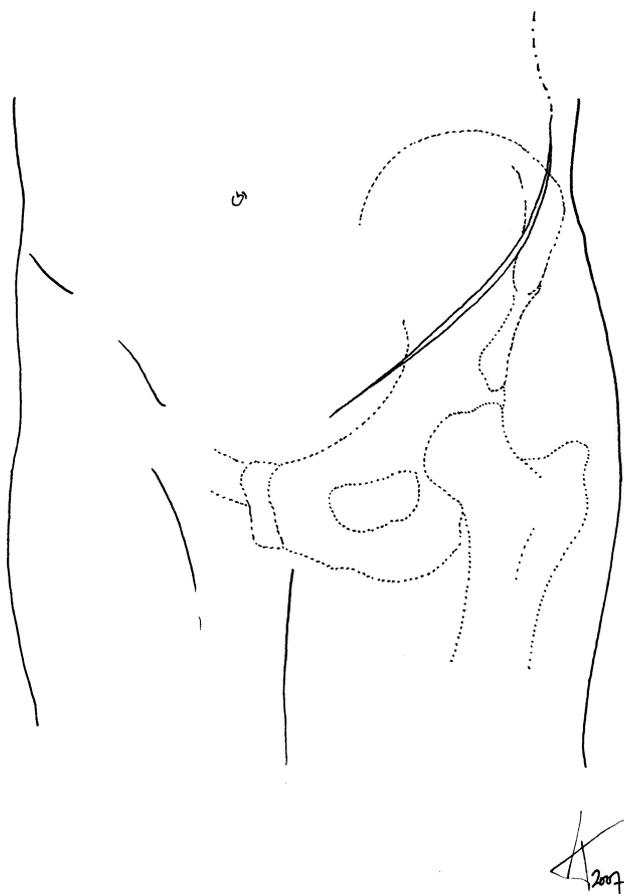


Fig. 1 Proximal extension of the incision parallel to the operating table (*dotted line*)

The common iliac and the external iliac arteries are parallel and in close vicinity of the medial border of the psoas (Fig. 3). The external iliac artery can be palpated in the operative field infero-laterally and is a pointer to the bifurcation of the iliac vessels. If necessary (obese patients), the skin incision can be extended parallel to the operating table along the course of the psoas muscle to get a better access to the deep retroperitoneal structures (Fig. 1 dotted line). The dissection is carried out bluntly along this vessel leaving the space between its surrounding connective tissue and the antero-medial aspect of the psoas muscle undisturbed. This is important, since the sympathetic nerves and the lymphatics overlying the external iliac artery—as well as the common iliac vessels and the internal iliac artery—are to be protected. As the dissection is carried medially beyond the external iliac artery, the ureter and the internal iliac artery can be identified (Fig. 4). If in doubt, light touching of the ureter leads to peristaltic movements *in vivo*. The internal iliac artery is the vessel that runs off the common iliac and the medial border of the psoas to disappear in the inner pelvis (Fig. 1). It can be distinguished from the middle sacral artery by its closer

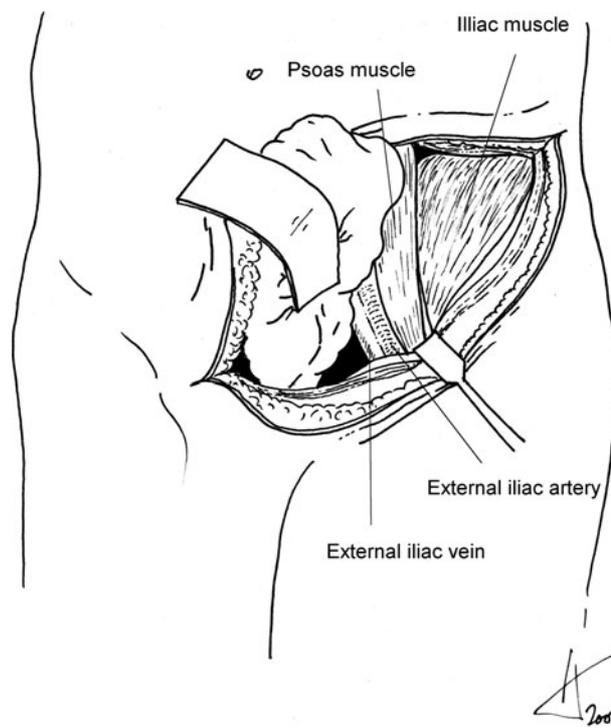


Fig. 2 The psoas muscle serves as a landmark for further surgical dissection. Staying extraperitoneal, the plane of dissection is between the medially retracted pelvic content/peritoneum, and the psoas muscle

relationship with the psoas muscle and its more lateral position. Both, the ureter and the internal iliac artery remain unseparated from the posterolateral structures they lie on. The bifurcation of the common iliac vessels (into internal and external iliac) can be expected at the level of the anterior superior iliac spine. Once it is reached, no further dissection is necessary.

In the midline of the body, the lumbosacral prominence is an important landmark which can easily be palpated. At its lateral aspect, the internal iliac artery is in close vicinity and can be compressed against the bone to control bleeding. Also, the artery can be cross-clamped from antero-medially, should ligation be required. Compared to simple compression to the bone for temporary control of bleeding, cross-clamping and ligation needs a more extensive dissection of the vessel.

Another possible way of compressing the internal iliac artery is to apply pressure laterally and compressing it between the psoas and the pelvic brim. Attempts to expose the internal iliac from the lateral aspect (underneath the psoas major) is likely to be more time consuming and may also damage the sympathetic fibers lying over the common iliac and the external iliac vessels. After compression or clamping of the internal iliac artery, pulses should be checked in the lower limb to ensure that the external iliac artery is intact.

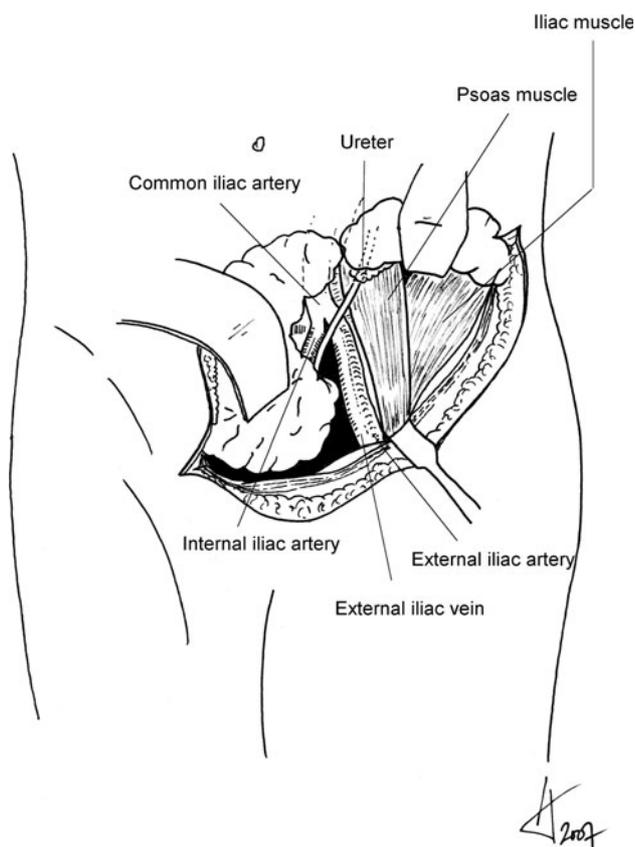


Fig. 3 The common iliac and the external iliac arteries are parallel and in close vicinity of the medial border of the psoas. The external iliac artery can be palpated in the operative field infero-laterally and is a pointer to the bifurcation of the iliac vessels

Cadaver series

Five embalmed cadavers (two males and three females) were used in this study. The age of cadavers ranged from 40 to 85 years. They were placed in a supine position and bilateral ilioinguinal approaches [13] were performed. In all cases, we were able to approach the bifurcation of the iliac vessels on both sides using this approach. The bifurcation of the common iliac artery was consistently found to be at the level of the anterior superior iliac spine. Three specimens had calcification at the level of the common iliac bifurcation. Compression of the internal iliac artery against bone was possible in all cases. It was felt to be more difficult, however, in subjects with calcified vessels.

One specimen had a partial sigmoid resection that made medial retraction more difficult. Numerous nerves (sympathetic) and lymph nodes overlying the iliac vessels were encountered in all the dissections. If the dissection was carried out too close to the external iliac vessels, these were likely to be damaged. The ureter was in close relationship with the iliac bifurcation and had to be identified and protected.

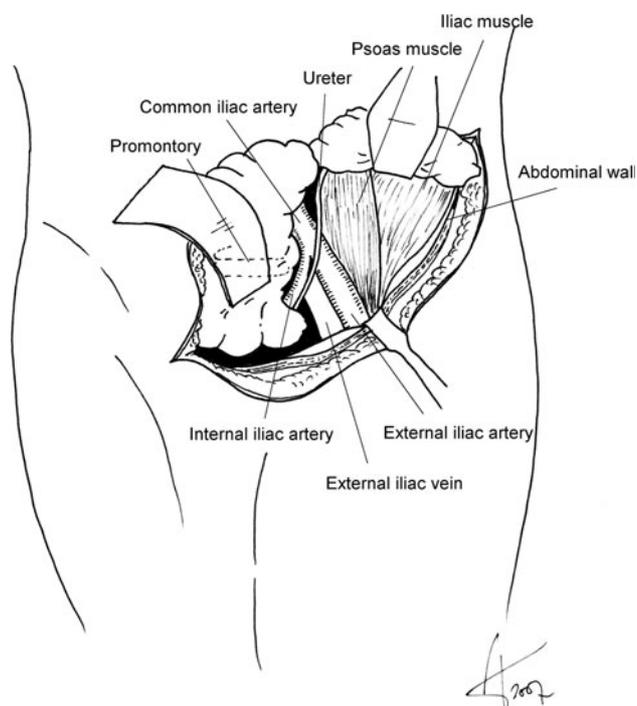


Fig. 4 Sympathetic nerves and the lymphatics overlying the external iliac artery are to be protected. As the dissection is carried medially beyond the external iliac artery, the ureter and the internal iliac artery can be identified. The promontory, against which the artery can be pressed, is marked with *dotted lines*

We also attempted to approach the internal iliac artery (1) by dissecting posterior to the iliacus muscle in the retro-peritoneal space, and (2) dissecting between the iliacus and the psoas muscles. Both of these alternate approaches, however, were not only found to be more difficult due to limited visualization, but also to be associated with possible damage to the soft tissue/sympathetic fibers surrounding the vessels.

Discussion

Fractures of both the pelvis and acetabulum may be associated with injury to the major pelvic vessels. This can be associated with the primary injury in more severe fracture patterns [9, 10, 12, 17, 18, 24, 27, 34], or later due to clot dislodgement or iatrogenic trauma during fracture manipulation [1, 6–10, 12, 13, 17, 18, 22, 24–28, 30, 31, 33, 34].

The sources of bleeding have been reported to be more posterior (internal iliac vessels or their posterior branches) in patients with unstable posterior pelvic fractures, while in patients with lateral compression injuries they are located more anteriorly (pubental or obturator vessels) [7, 19]. Treatment of these vascular injuries can be open exploration

and repair, exploration and ligation, intraoperative embolization, or percutaneous selective arteriographic embolization [2, 3, 7, 14, 16, 32].

The common iliac divides into the internal and external iliac arteries at the level of the anterior superior iliac spine. The internal iliac artery divides into anterior and posterior trunks. The anterior trunk gives rise to the vesical branches, the middle rectal, the obturator, internal pudendal, inferior gluteal, and the uterine arteries. The iliolumbar, lateral sacral, and superior gluteal vessels arise from the posterior trunk.

Waiting for a vascular surgeon to arrive and access the artery can be time consuming even at a level 1 trauma center. Compression of the internal iliac artery by the orthopedic surgeon maybe a lifesaving procedure allowing to minimize the pooling of blood and to identify the source of bleeding even when the exact source of bleeding is not immediately apparent.

The approach used by vascular surgeons to get access to the pelvic vessel usually is a midline retro- or transperitoneal approach. An additional midline incision might, however, put the skin at risk where the ilioinguinal and midline approach meet. In a given situation, where the ilioinguinal (or Olerud) approach is already made at the time serious bleeding is encountered, the method described in this article may allow more rapid access to the vessels. Also, even in case the approach has to be extended, it does not burn any bridges for the vascular surgeon in case a midline incision is later needed.

Although significant variations of the pelvic vasculature have been described [1, 4, 6, 8, 11, 20–22, 25, 26, 29, 30], the anatomical relationship at the bifurcation of the common iliac has been found to be fairly constant.

The corona mortis [1, 22, 26, 30] is an anastomotic branch between the inferior epigastric and obturator vessels in the obturator canal. Compression of the internal iliac will not completely stop bleeding from this anomalous artery since it has a contribution from the external iliac artery. Nevertheless, the maneuver described could also be utilized to control any contribution of the internal iliac artery to a corona mortis.

A possible drawback of accessing the internal pelvic vessels with the method described might be the limited exposure of the contralateral side. Although not common, the surgeon might be in doubt as to which side of the body a source of bleeding is to be expected. In these cases, the classic midline approach used by vascular surgeons to control bleeding [5] might be the better way to go.

In conclusion, we have to record that this is a cadaveric study and that in a clinical setting the access might be more difficult due to bleeding. Further investigations are needed to give evidence about the failure rate or the learning curve for an average orthopedic trauma surgeon.

We still think, however, that it represents a valuable alternative to the classic midline transperitoneal approach to the vessels.

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