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Research Article

Anatomical Descriptions of the Inferior Vesical Artery

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Abstract

Systematic Review: The inferior vesical artery is a vessel usually related to the vascularization of the internal iliac artery's anterior division and the knowledge about the anatomical variations from this artery is essential for the surgical practice. A systematic revision from classic anatomy books and indexed articles in the database from SciELO, PubMed and Periodical Portal CAMES/MED, was made in May 2020. As a result, eleven books and twelve articles, characterized by information about the vascularization territory, predominance by sex, origin, and terminal branches were obtained. The most regular origin patterns found for this artery were: from a common trunk to the middle rectal artery that arises from the internal pudendal artery; from a common trunk to the middle rectal artery that arises directly from the anterior division of the internal iliac artery; or directly from anterior division of the internal iliac artery. Its predominant terminal branches are the prostatic artery and the capsular branches from the prostate, the deferential artery, and the accessory pudendal artery, which demonstrates the importance of its preservation in surgical approaches in the pelvic region.

Objective: Identify a possible pattern or predominance regarding the origin, path, irrigation, and branches of the inferior vesical artery.

Keywords: *Anatomic Variations; Iliac Artery; Urinary Bladder; Pelvis; Prostatectomy*

Abbreviations

IVA: Inferior Vesical Artery; IVAs: Inferior Vesical Arteries

Introduction

The anatomy books usually point out the most common pattern with respect to the particularities of the human structure's organism. In some cases, the variation of certain structures inside a context of normality is substantially high, and the most regular pattern is found in less than half of individuals. This situation is verified in most studies about patterns and anatomical variations of the inferior vesical artery (IVA) [1].

The IVA is a vessel normally related to the internal iliac artery's anterior division. Its irrigation area reaches in a more direct way the inferolateral faces of the bladder [2] and can contribute to the nutrition of the posterior part of the bladder, prostate and deferent duct in men and vagina in women [3].

Variations in the morphologic characteristics of the human's body vessels result from a differentiated remodeling process of the embryonic vascular structures. Initially, the primitive embryonic circulation is symmetrical, which is however modified during its development to produce a functional fetal circulation (linked to the placenta). The angiogenesis is the main restructuring way of the initial vessels, and through this event anastomosis are formed and then disappear, and capillaries fuse to originate the arterial vascularization patterns [4]. In some cases, as in the IVA's one, variant models of arterial composition can be more frequent [1].

The knowledge of the typical anatomical variations from IVA is essential to the surgical practice. Techniques such as devascularization, embolization and endoscopic extraperitoneal inguinal hernioplasty - in situations of acute hemorrhage, ureteral injury, and laceration of veins [5] - can compromise the functionality of organs or pelvic structures if there is IVA or its terminal branches injury. In prostatectomy, for example, it is necessary the attention to possible variations of this artery, to preserve it so that the patient can reestablish its erectile function on the postoperative period [3].

Objective of the Study

The objective of this study is to review the different anatomical descriptions presented in scientific literature about the origin, path, irrigation, and branches from the IVA.

Materials and Methods

This systematic review study has utilized as a research instrument the consultation of the databases: SciELO (Scientific Eletronic Library Online), Pubmed (Biblioteca Nacional de Medicina e Instituto Nacional de Saúde) and Periodical Portal CAPES/MEC, in the period of May 2020. Twenty three articles, from the isolated use of the descriptors "inferior vesical artery", "inferior vesical artery variations", "internal iliac artery variations", "pelvic anatomy", "pelvic vascularization" and "hypogastric artery variations", have been found. Periodicals considered irrelevant have been discarded after the reviewing process, such as those which's content did not show congruency with the theme in discussion or were identified in duplicity, which resulted in a final selection of twelve articles.

The description of eleven classical anatomy books were considered to establish possible confirmations or divergences on definitions from their original studies on cadavers, through images (angiographies) and meta-analysis. The figure 1 shows the methodological diagram of research in the database for the study and analysis.

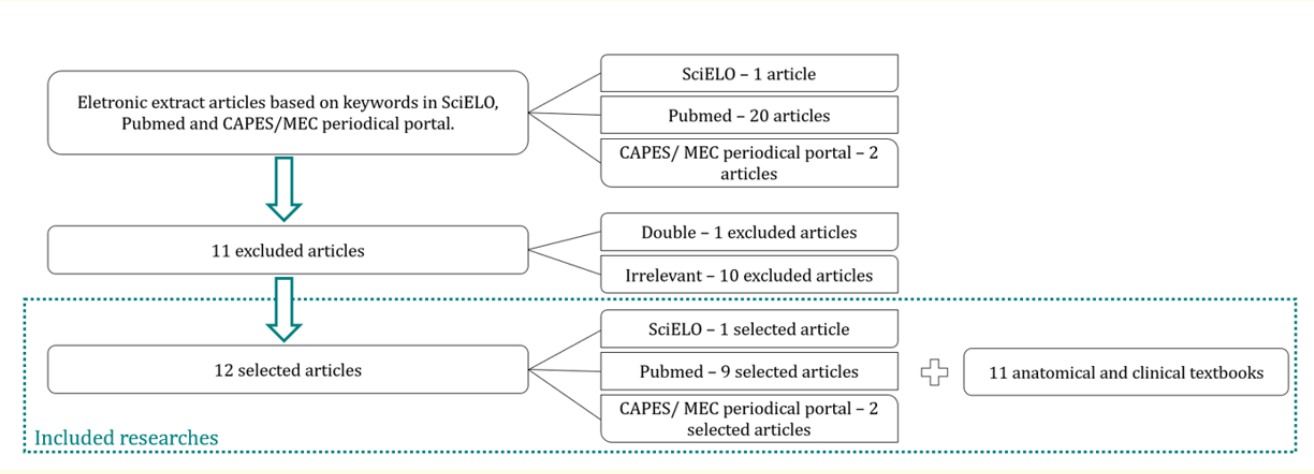

Figure 1: *Diagram of the selection process for the articles and textbooks.*

Results and Discussion

The evidences that were rescued with the systematic analysis of the source references are presented in table 1. It discriminates the characteristics related to the general origins, predominance due to the sex, specific origin by gender and, in some cases, in both genders, terminal branches, as well as additional information for those works with a broader approach.

General sexual predominance

The prevalence of the IVA in different genders was observed in eight publications (Table 1). The pattern of description from the books can be divided into four types: the ones that describe the IVA as a regular vessel common to both genders; the ones that consider that besides being present in both, the IVA and the vaginal artery coexist; and those that are more flexible and describe the vessel as common to the male individual, but possible to be found in women as well.

Treigny OM., *et al*. [3] confirmed three of the four types of listed descriptions. They analyzed fifty hemipelvis of human cadavers, twelve of which were male and thirty-eight female. The IVA has been found in 49,4% of female hemipelvis and in 92% of male hemipelvis. The vaginal artery was observed in all female hemipelvis. Thus, this study shows that the IVA is present in both sexes and coexists with the vaginal artery in at least half of the cases.

Researched literature	Principal results	
Moore, Keith L., et al. [2]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVA is only present in male specimens; in women is supplied by the vaginal artery;
	Specific origin in women	
	Specific origin in men	→ IVA in men: as a individual branch of the anterior division of the internal iliac artery, or originated from a common trunk with the middle rectal artery;
	Specific origin in both genders	→ IVA can take origin from a common trunk of the anterior division of the internal iliac artery with the middle rectal artery.
	Terminal branches	→ IVA gives rise to the prostatic artery and, in some cases to the deferential artery.
Standring, Susan. [4]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVAs are usually found in male specimens, but they are also reported in some female subjects. IVA in female specimens is frequently supplied by a vaginal artery;
	Specific origin in women	→ IVA in women: originated from a common trunk with the vaginal artery;
	Specific origin in men	
	Terminal branches	→ IVA in man gives rise to the deferential artery, in some cases.
Schünke, Michael, et al. [6]	General origin	
	Sexual predominance	
	Specific origin in women	
	Specific origin in men	
	Terminal branches	
	Other information	→ IVA irrigates the urinary bladder.
Sobotta, Johannes, et al. [7]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVA is present in both female and male specimens;
	Specific origin in women	→ IVA in women: originated from visceral branches of internal iliac artery. This vessel can be supplied by the vaginal artery;
	Specific origin in men	
	Terminal branches	
Testut, Jean L., and Latarjet, A. [8]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVAs are usually found in male specimens, but they are also reported in some female subjects.
	Specific origin in women	→ IVAs in women: can be originated from a colateral branch of the uterine artery, frequently in a number of five or six thin branches, or in some cases originated from a common trunk with vaginal arteries;
	Specific origin in men	→ IVA in men: directly originated from the hypogastric artery, or from a unique trunk called genitovesical that arise from another common trunk with the internal pudendal artery.
	Terminal branches	

Tubbs, R. S., et al. [1]	General origin	→ IVA: originated from a anterior division of the internal iliac artery, posterior division of the internal iliac artery, or from the external iliac artery;
	Sexual predominance	→ IVA is present in both female and male specimens;
	Specific origin in women	→ IVA originated from the vaginal artery in 90% of cases and branched directly from the internal iliac artery in 10%, in a Palacios Jaraquemada et al. (2007) study of 39 female urogenital tracts;
	Specific origin in men	→ IVA originated from a common stem of the external iliac artery with the obturator artery; in a case report of a middle-aged indian cadáver, by Pai et al. (2012);
	Specific origin in both genders	→ IVA and middle vesicle arteries were derived from, in order of frequency, the pudendal inferior gluteal, hypogastric, or middle rectal arteries; in a Ashley and Anson (1941) study of 66 cadaveric pelvic halves; IVA in 68.9% of cases aroses independently from the hypogastric trunk, in 22.4% from the anterior division of the internal iliac artery, in 3.5% from the internal iliac artery, in 3.5% with the middle rectal artery and in 1.7% with the superior vesical artery; in a Parsons and Keith (1897) study on 58 observations of the inferior vesical artery; IVA aroses in 34 subjects as a separate branch from the prostatic artery and arose 3 times as a branch of the vaginal, 5 times as a branch of the internal pudendal artery, 8 times as a branch of the umbilical artery distal to the uterine artery, 9 times as a branch of the vesicodeferential artery; in a Lipshutz (1918) study of 181 specimens. IVA originated from an obturator artery arising from the posterior division of the internal iliac artery in 6% of 34 observations from 17 cadavers, in a study of Jusoh et al. (2010); IVA was reported to be absent, supplied by the superior vesical artery; in a study of Badagabettu et al. (2013).
	Terminal branches	→ IVA was reported to give rise to the dorsalis penile, accessory pudendal arteries or deep accessory penis arteries.
Rohen, Johannes W., et al. [9]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	
	Specific origin in women	
	Specific origin in men	→ IVA in men: originated from a unique branch of the anterior division of the internal iliac artery, immediately distal of the obturator artery origin.
	Terminal branches	
Netter, Frank H. [10]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVA is present in both female and male specimens; in women this vessel coexists with the vaginal artery;
	Specific origin in women	→ IVA in women: originated from a common trunk with the middle rectal artery. This trunk arises from the internal pudendal artery, distal in relation to a trunk that gives rise to the uterine artery and vaginal artery;
	Specific origin in men	→ IVA in men: originated from a common trunk with the middle rectal artery. This trunk arises from the anterior division of the internal iliac artery, distal in relation to the umbilical artery.
	Terminal branches	→ IVA gives rise to ureteral branches and capsular branches of the prostate;
Dângelo, José Geraldo, and Fattini, Carlo Américo. . [11]	General origin	→ IVA: bilateral branches originated from different branches or trunks of the internal iliac artery, as the hypogastric artery.
	Sexual predominance	
	Specific origin in women	
	Specific origin in men	
	Terminal branches	
Abrahams, Peter H., et al. [12]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVA is present in both female and male specimens;
	Specific origin in women	→ IVA in women: originated from a common trunk with the middle rectal artery. This trunk arises from the anterior division of the internal iliac artery, distal in relation to obturator artery;
	Specific origin in men	→ IVA in men: originated from the obturator artery, distal in relation to umbilical artery.
	Terminal branches	
Baggish, Michael S., and Mickey M. Karram. [13]	General origin	→ IVA: originated from a anterior division of the internal iliac artery;
	Sexual predominance	→ IVA is present in both female and male specimens, in women this vessel coexists with the vaginal artery;
	Specific origin in women	→ IVA in women: originated from a common trunk with the middle rectal artery. This trunk arises from the internal pudendal artery, distal in relation to a trunk that gives rise to the uterine artery and vaginal artery;
	Specific origin in men	
	Terminal branches	

Table 1: *Main information obtained from the selected textbooks and organized by general origin, sexual predominance, specific origins in women, men or both, and terminal branches.*

Assis AM., *et al*. [14] have analyzed one hundred and forty-three angiographies for procedures of prostatic artery embolization (common branch from inferior vesical artery) and have identified the IVA artery in 93,3% of the studied exams. This result is similar to the one presented by Treigny OM., *et al*. [3], which reinforces the hypothesis that this artery is a branch usually found in men.

Inferior vesical artery stemming from the anterior division of the internal iliac artery and its branches

Ten of the reference workers (Table 1) considers the origin of the IVA as mostly related to the anterior division of the internal iliac artery and its branches.

The internal iliac artery, an important pelvis vascular structure, passes medially over the margin of the pelvis and the iliac body, and at the level of the greater sciatic foramen it forms the anterior and posterior divisions. The anterior branch of the internal iliac artery or hypogastric artery [8], emits branches that usually originates the obturator, umbilical, uterine (in women), vaginal (in women), middle rectal, internal pudendal, and inferior gluteal arteries and the IVA [2].

According to Shehata R., *et al*. [15], the IVA has various origins and can be verified as a branch of any of the previously listed structures that are derived from the anterior division of the internal iliac artery. This supports the results obtained by Jusoh AR., *et al*. [16], while examining fifty hemipelvis of human cadavers. In this investigation, the origin of the IVA was registered from the anterior iliac artery's branches in 94,1% of the cases. Based on this data, it is therefore possible to list the most common specific origins of the vessel highlighted in this review.

In women, the most habitual vessels related to the origin of the IVA are a common trunk to the middle rectal artery [1,2,12] that arises from the internal pudendal artery [1,10,13] or from a common trunk of the vaginal artery [1,4,8]. Other possible origins suggested were directly from the anterior portion of the internal iliac artery [1,7] or as a branch of the uterine artery [8].

In men, the IVA has consistently been originated from a common trunk with the middle rectal artery that originates directly from the anterior division of the internal iliac artery [1,2,10], or a direct branch of the hypogastric artery [1,2,8,9,11]. However, it may emerge less frequently from the obturator artery [1,12], from a branch of the internal pudendal artery [1,8], from the vesicodeferent artery or from the superior vesical artery [1]. In general, these last two cases are responsible for the formation of patterns that may be less functional, due to the arrangement of the vessels and may represent a difficulty in identifying this structure in surgery [18].

In observations of fifty adult human hemipelves, Havaldar PP., *et al*. [18] identified thirty-three cases of IVA that arose from the anterior division of the internal iliac art or its branches. Among these cases, 42% are described as individual branches, 28% have origin related to the internal pudendal artery, and 6% originated along with the middle rectal artery.

By studying sixty human hemipelves, Naveen NS., *et al*. [19] outlined some main IVA patterns of variations, three of which are listed herein: Type Ia, in which a common trunk (present in 76.9% of cases) of the anterior division of the internal iliac artery generates a trunk for the pudendal internal artery, inferior gluteal and IVA; Type Ib, which consists in the presence of a common trunk (present in 6.6% of the cases) from the anterior division of the internal artery, this time, giving rise to the umbilical artery, the superior and IVA; and Type III, in which the IVA emerges from the obturator artery (in 9.9% of the cases analyzed).

Abrahams P., *et al*. [12], found that the IVA ascends from a branch of the obturator artery. This is supported by Mamatha H., *et al*. [20], who studied fifty human hemipelves, in which the obturator artery gave rise to IVA in 8% of cases; and by Faghani M., *et al*. [21], who found the same pattern.

A meta-analysis based on seventy-five papers by Mohammadbaigi H., *et al*. [5] reveals the IVA as part of a common trunk from the anterior division of the internal iliac artery, with the middle rectal artery. Those authors also considered these arteries as branches of the internal pudendal artery, or the inferior gluteal, or together with both, emerging from a single arterial trunk.

Treigny OM., *et al*. [3], observed that in women who presented IVA (47.4%), this vessel emerged from a common trunk with the umbilical artery and the uterine artery (33.3%); directly from the umbilical artery (33.3%); directly from the uterine artery (22.2%); or directly from the obturator artery (11.1%). In the male cadavers under analysis with IVA (92%), this artery originated directly from the anterior portion of the internal iliac artery (72.7%); or from the umbilical artery (27.3%). This research presents some differentiated origins of the IVA such as the origin from the umbilical artery or from a trunk with umbilical and uterine arteries. The referred origin through a common trunk with the umbilical and uterine arteries was not found in any of the books reviewed. The IVA as a branch of the umbilical artery was reported only in Tubbs RS., *et al*. [1], under analysis of a study with one hundred eighty-one cadavers, presenting this conformation in five cases.

A case described in Nayak SB., *et al*. [22], points to the anterior division of the internal iliac artery as the source of the middle rectal arteries, IVA and superior vesical artery. This occurs after sending a common trunk to the internal pudendal and the superior gluteal arteries.

Less common origins of the inferior vesical artery

Other studies, for example Tubbs RS., *et al*. [1], show very unusual variations from the external iliac artery or branches of the posterior division of the internal iliac artery. This last case was also found by Jusoh AR., *et al*. [16], in which 5.8% of the thirty-four hemipelves analyzed presented the obturator artery curiously originating from this dorsal portion. In these atypical cases, the anomalous obturator artery gave rise to IVA.

Except in the work by Tubbs RS., *et al*. [1], the absence of IVA was not reported in any other study.

Terminal branches of the inferior vesical artery

The terminal branches of the IVA reported are generally related to the vascularization of male internal and external pelvic organs. As shown in table 1, this artery usually branches out into the prostatic artery and capsular branches of the prostate [2,10] or deferent artery [2,4]. Alternatively, it can also generate the ureteral artery or the dorsal artery of the penis, accessory pudendal artery, and deep accessory penis artery [1].

The branching of the accessory pudendal artery was described in 29% of the cases compiled in a meta-analysis with twenty-three studies selected (4,945 individuals) by Henry BM., *et al* [23]. Droupy S., *et al*. [17] found a similar result by studying fifteen cases on twenty male corpses. This latest investigation also cites Wassiliew's analysis of 100 male cadavers, in which 17% of the accessory pudendal arteries arose from the IVA.

Droupy S., *et al*. [17] points out that the accessory artery is covered by a periprostatic venous plexus, which makes it difficult to identify it during the ligation procedure of the dorsal venous complex of the prostate apex. This also occurs during the bladder neck in radical prostatectomies, generating possible injuries. In such cases, it is common for patients to suffer from erectile dysfunction due to failure in reacting to intracavernous injections of vasoactive agents.

Conclusion

Although divergent with regard to definitions that claim that IVA is only present in men, the anatomical descriptions mostly report the presence of this vessel in both sexes. In addition, the anterior division of the internal iliac artery is the mostly related to the origin of this artery. The most regular specific patterns of genesis of this artery are: a trunk common to the middle rectal artery that originates from the internal pudendal artery; a trunk common to the middle rectal artery that originates from the hypogastric artery; or directly from the hypogastric artery. In rare cases, this vessel arises from the branches of the external iliac artery or posterior division of the internal iliac artery.

IVA´s predominant terminal branches are the prostatic artery and capsular branches of the prostate, the deferent artery and the accessory pudendal artery. This descriptions confirm the importance of the knowledge, identification and study of anatomical variations referring to the IVA for safe surgical practice in the pelvic region. Its malpractice can be harmful and may be associated with recurrent postoperative erectile dysfunction in men undergoing prostatectomy.

Conflict of Interest

The authors declare that there is no conflict of interest.

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