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Precise anatomy of the vesico-uterine ligament for radical hysterectomy

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Abstract

Objectives. To clarify the anatomy of the vesico-uterine ligament (VUL), we meticulously separated the VUL under magnification (×2.5) during Okabayashi's radical hysterectomy.

Methods. Fifty-nine patients (TNM nomenclature: pTIb: 39, pT2a: 5, pT2b: 7, after trans-arterial anticancer-drug infusion treatment for the cervical cancer: 8) underwent this meticulous operation. Blood loss was recorded at two separate time points: during the separation of the VUL and after removal of the uterus.

Results. After complete separation of the uterine artery and superficial uterine vein from the ureter, we could identify the genuine connective tissue of the anterior leaf of the VUL in which we isolate and divide a distinct bundle of blood vessels: the cervicovesical vessels that cross over the ureter from the bladder to the cervix. The remaining tissues in the anterior leaf is only avascular connective tissue. The posterior leaf of the VUL is the tissue residing under the ureter connecting the posterior wall of the bladder and the lateral cervix/upper lateral vagina. In the connective tissues, we identified the middle and inferior vesical veins connecting with the deep uterine vein. The division of these veins could separate the urinary bladder with ureters completely from the lateral cervix and upper vagina. The mean blood loss during the separation of the VUL was 20± 10 g (N=59) and after radical hysterectomy was 189±91.6 g (N=59).

Conclusion. A precise network of blood vessels in the VUL is identified. The knowledge of this anatomy is important to perform radical hysterectomy.

Keywords: Okabayashi's radical hysterectomy; Anatomy of vesico-uterine ligament; Cervicovesical vessels; Middle vesical vein; Inferior vesical vein

Introduction

Since Ernst Wertheim published a monograph in 1911 on radical hysterectomy entitled "Die erweiterte abdominale Operation bei Carcinoma colli Uteri" based on 500 cases [1,2], his method was introduced as a new radical technique for the treatment of patients with cervical cancer in Japan. Shohei Takayama, professor and chairman (1906–1921) of the Gynecology and Obstetrics, Faculty of Medicine at Kyoto Imperial University, and his student Hidekazu Okabayashi tried to improve the technique of the operation by incorporating a more radical removal of tissue than Wertheim's method. In 1921, Okabayashi published an article entitled "Radical abdominal hysterectomy for cancer of the cervix uteri, modification of the Takayama operation" [3]. Okabayashi's method was characterized by the wide extirpation of the parametrial tissue and the quite novel finding on the separation of the posterior leaf of the vesico-uterine ligament. The novel procedures enabled the surgeon to separate the bladder with the ureter completely away from the lateral side of the cervix and vagina. If we may further separate the bladder and the rectum from the vagina, the uterus with the vagina is only connected by the lateral paravaginal tissue (paracolpium). This dissection allows easy resection of any vaginal length deemed appropriate by the level of cervical disease. This was a quite novel procedure in the optimization of the radical hysterectomy. However, during the separation of the posterior leaf of the vesico-uterine ligament, as Okabatashi himself described: "This tissue connects the posterior aspect of the bladder with the side

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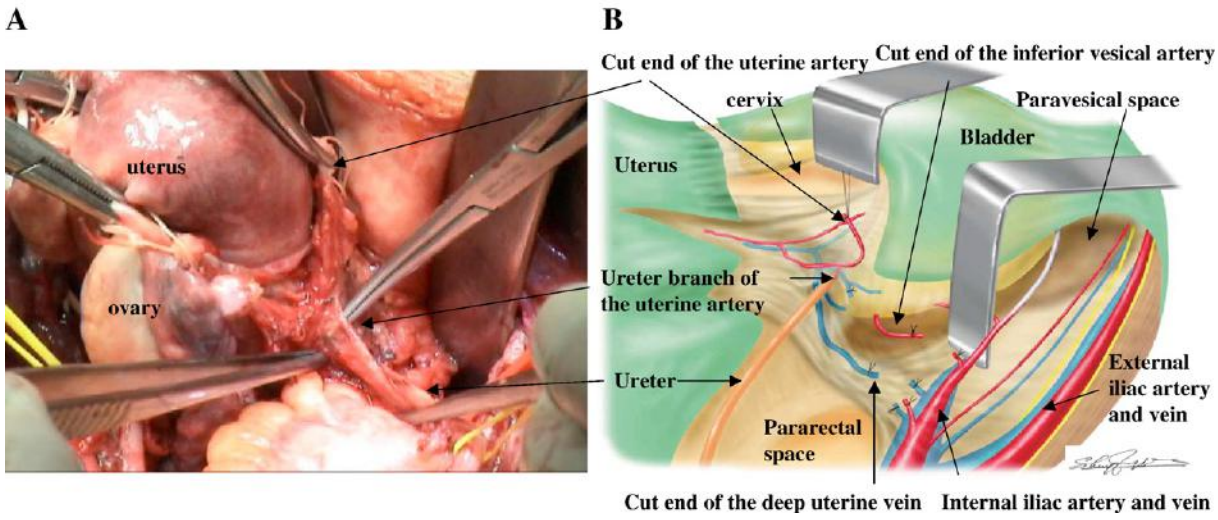

Fig. 1. (A) Isolation of ureteral branch of the uterine artery. (B) Illustration of uterine branch of the uterine artery.

wall of the vagina and the cervix of the uterus and contain many venous vessels. Division of this tissue is a difficult procedure as more or less bleeding is always present and there is always the danger of injuring the bladder especially in advanced cases" [3]. These procedures are often difficult and not popular in western countries.

Because the Wertheim's method separates the anterior leaf of the vesico-uterine ligament [1,2], the operative procedure for separation of the anterior leaf is popular throughout the world. However, many surgeons meet with bleeding during these surgical steps due to the blinded procedures performed along the space of the so-called ureteral tunnel.

Although Yabuki et al. [4–7] tried to show the anatomy of the vesico-uterine ligament, the precise anatomy of both leaves of the vesico-uterine ligament is still to be elucidated. Precise understanding of this anatomy during radical hysterectomy should result of reduced blood loss and less overall morbidity.

As the direct descendant of Takayama and Okabayashi, we meticulously separated the blood vessels in the vesico-uterine ligament under magnification (×2.5) during Okabayashi's radical hysterectomy to describe the precise anatomy of the vesico-uterine ligament.

Methods

Women with operative invasive cervical cancer deemed operable were eligible. During radical hysterectomy (Okabayashi's method), individual blood vessels in the vesico-uterine ligament are meticulously identified and separated under magnification (×2.5). Fifty-nine patients (TNM nomenclature: pTIb: 39, pT2a: 5, pT2b: 7, after trans-arterial anticancer-drug infusion treatment for the cervical cancer: 8) underwent this meticulous separation of the vesico-uterine ligament by one (SF) of the authors. Blood loss was recorded at two separate

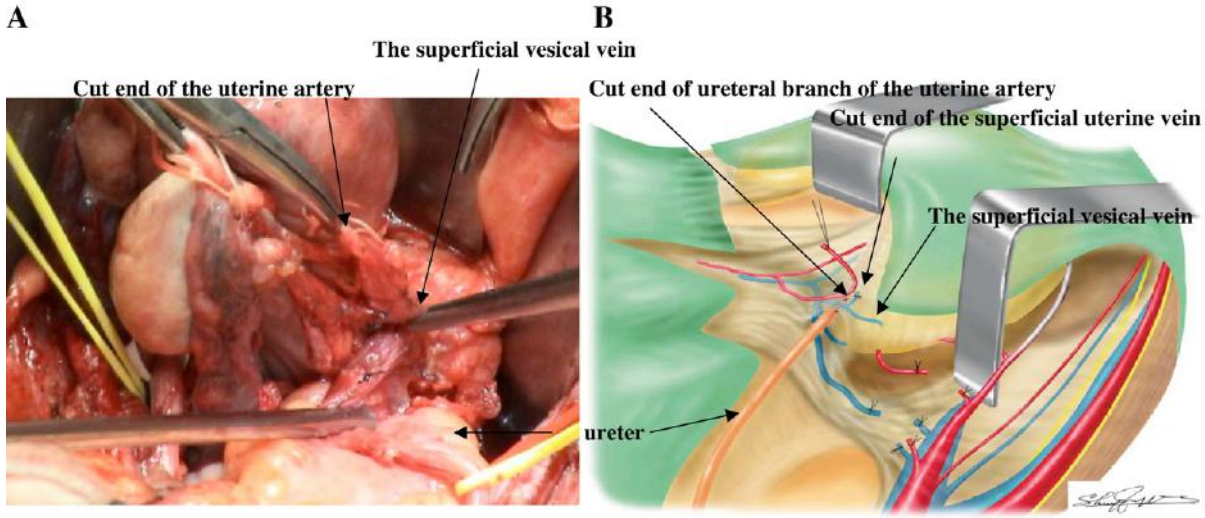

Fig. 2. (A) Separation of the superficial vesical vein that drains into the superficial uterine vein. (B) Illustration of the relationship between the superficial uterine vein and the superficial vesical vein.

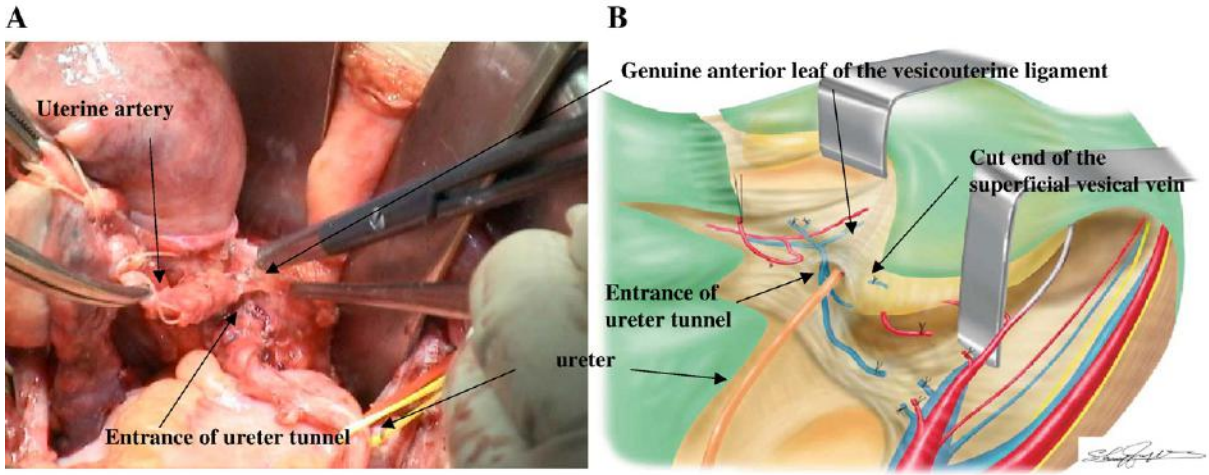

Fig. 3. (A) Genuine anterior leaf of the vesico-uterine ligament and entrance of ureteral tunnel. (B) Illustration of the genuine anterior leaf of the vesico-uterine ligament after separation of the uterine artery and the superficial uterine vein from the ureter by dividing the superficial vesical vein.

time points: during the separation of the vesico-uterine ligament and after removal of the uterus.

Results

Only the operative steps that are necessary to elucidate the anatomy of the vesico-uterine ligament are described.

The blood vessels are identified in the parametrium that have connection with the blood vessels in the vesico-uterine ligament

After pelvic lymphadenectomy, the uterine artery is isolated, ligated and cut close to the internal iliac artery. Then, the pararectal space is developed along the line of the pelvic axis by the separating the connective tissues between the internal iliac artery and the posterior peritoneal layer with the ureter attached within the broad ligament (mesoureter). As well, the paravesical space is developed between the lateral umbilical ligament and external iliac vein. Between the two spaces, we can appreciate a thick bundle of the parametrial connective tissue. Within this parametrial connective tissue, the superficial uterine vein runs parallel to the uterine artery. The superficial uterine vein is carefully isolated, clamped, cut and ligated. Then, the inferior vesical artery is seen coursing from the internal iliac artery to the bladder. The inferior vesical artery is carefully isolated, clamped, cut and ligated. After careful removal of adipose tissues and lymph nodes in the parametrial tissues, we isolate the deep uterine vein that is then clamped, cut and ligated.

The anatomy of the vesico-uterine ligament

The bladder is separated from the central wall of the cervix down to the cranial level of the trigone of the urinary bladder. Connective tissue on the side of the cervix is carefully separated. Then, the cut end of the uterine artery of the uterine side is lifted with a forceps and the connective tissue between the ureter and the uterine artery is carefully separated. In this procedure, we can reveal a ureteral branch of the uterine artery

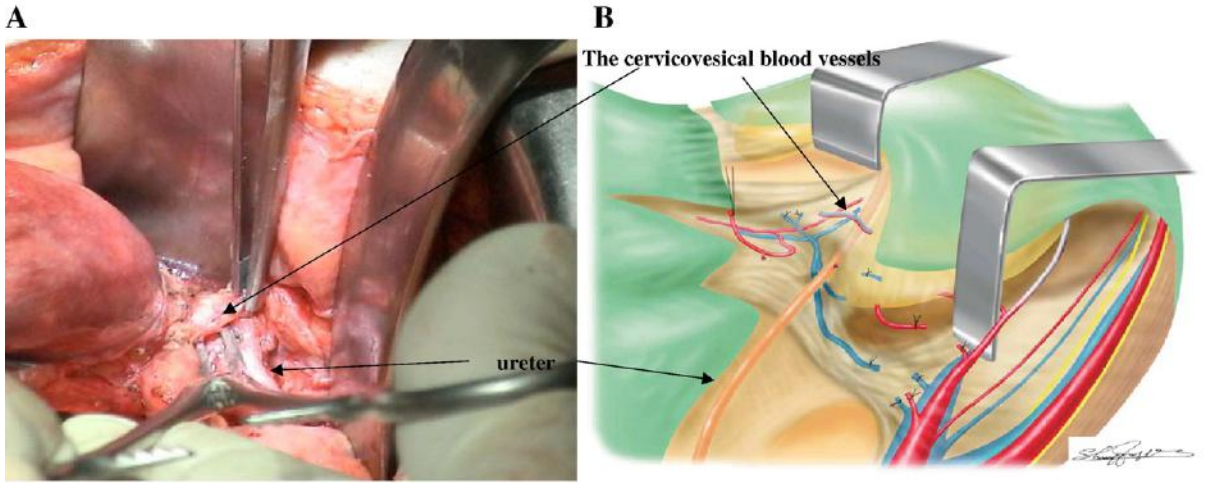

Fig. 4. (A) Isolation of the cervicovesical vessels in the anterior leaf of the vesico-uterine ligament. (B) Illustration of the cervicovesical vessels.

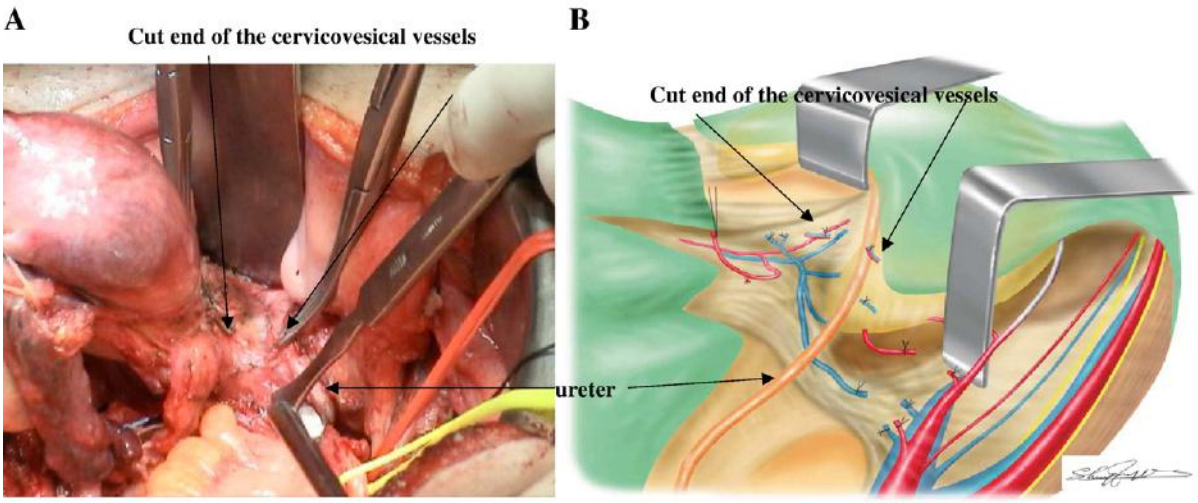

Fig. 5. (A) Division of the cervicovesical vessels. (B) Illustration of the division of the cervicovesical vessels.

(Fig. 1). The ureteral branch of the uterine artery is clamped, cut and ligated. After confirmation of the cut end of the superficial uterine vein of the uterine side, meticulous separation of the connective tissue between the ureter and the urinary bladder reveal that the superficial uterine vein has connection with the bladder. Because this vein is located at the most superficial portion of the urinary bladder, we named this vein as the superficial vesical vein (Fig. 2). The superficial vesical vein is isolated, clamped, divided and ligated. This procedure enables the surgeon to separate the uterine side of the uterine artery with the superficial uterine vein completely from the ureter and reveals the genuine anterior leaf of the vesico-uterine ligament (Fig. 3).

The anterior leaf of the vesico-uterine ligament

In the cranial portion of anterior leaf of the vesico-uterine ligament, the entrance of the so-called ureteral tunnel is identified between the cervix and the ureter (Fig. 3). Instead of developing the ureteral tunnel, the connective tissue of the anterior leaf of the vesico-uterine ligament is carefully divided. Then we could exclusively appreciate a pair of small blood vessels that crossover the ureter from the lateral cervix to the urinary bladder (Fig. 4). Because these blood vessels run between the bladder and the cervix, we named these the cervicovesical blood vessels. The cervicovesical blood vessels are isolated, doubly clamped, divided and ligated (Fig. 5). After cutting the cervicovesical vessels, the connective tissues between the ureter and the cervix were meticulously separated. There were no other blood vessels proper identified in the anterior leaf of the vesico-uterine ligament. By this meticulous separation of the connective tissues in the anterior leaf of the vesico-uterine ligament, the ureter is completely freed of its attachment to the posterior leaf of the vesico-uterine ligament (Fig. 6).

The posterior leaf of the vesico-uterine ligament

Following the meticulous dissection of the anterior vesico-uterine ligament, the connective tissue within the posterior

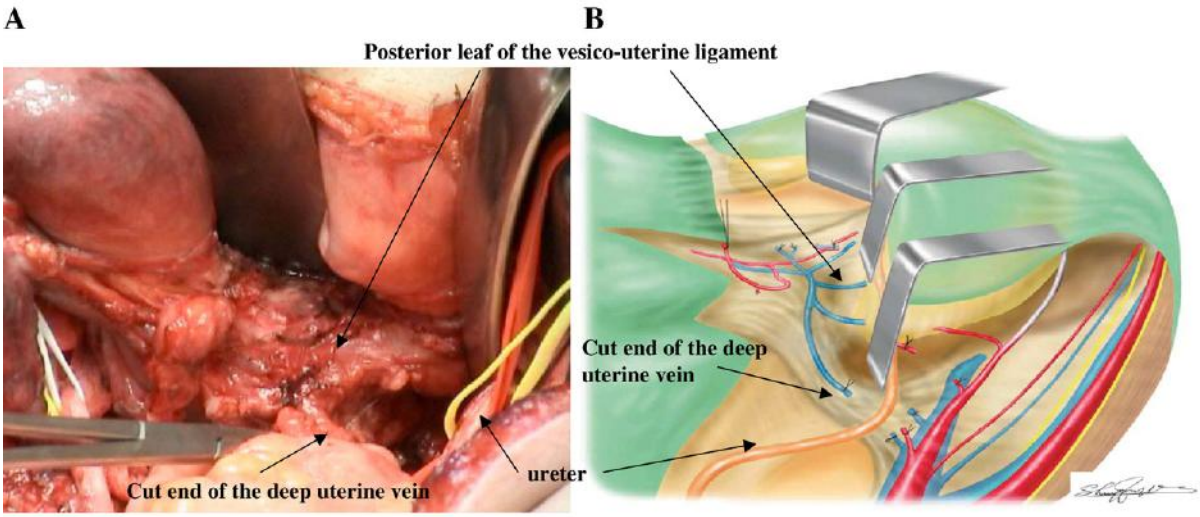

Fig. 6. (A) Posterior leaf of the vesico-uterine ligament. (B) Illustration of the posterior leaf of the vesico-uterine ligament.

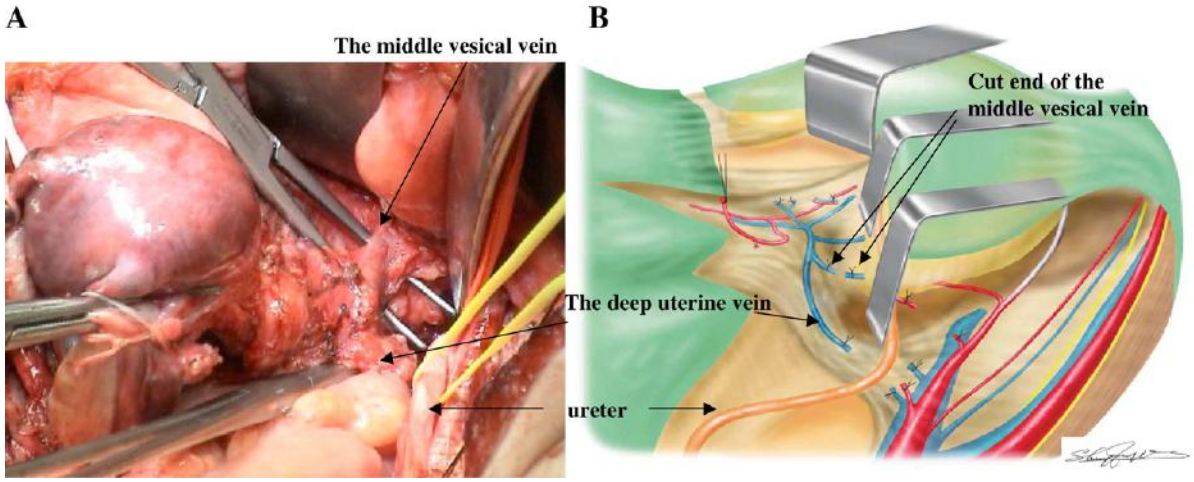

Fig. 7. (A) Separation of the middle vesical vein. (B) Illustration of the division of the middle vesical vein that drains into the deep uterine vein.

leaf of the vesico-uterine ligament is carefully separated. In the cranial portion of the posterior leaf of the vesico-uterine ligament, we can appreciate the middle vesical vein that runs from the urinary bladder to the cervix draining into the deep uterine vein (Fig. 7). The middle vesical vein is doubly clamped, divided and ligated (Fig. 7). In addition, we observed a vein (inferior vesical vein) that runs parallel to the cervix from the posterior portion of the urinary bladder, which also drains into the deep uterine vein (Fig. 8). The inferior vesical vein is doubly clamped, divided and ligated (Fig. 8). Then, the urinary bladder with ureters are completely separated from the lateral cervix and upper vagina.

Blood loss and operation time

The mean blood loss during the separation of the vesico-uterine ligament was 20±10 g (N=59) and the mean total blood loss after radical hysterectomy was 189±91.6 g (N=59). The mean operation time was 330 min (range 280–400 min, N=59).

Discussion

After complete separation of the uterine artery and superficial uterine vein from the ureter, we could identify the genuine connective tissue of the anterior leaf of the vesico-uterine ligament that is the anterior portion of the so-called ureteral tunnel. In this connective tissue, we identified a distinct bundle of blood vessels: the cervicovesical vessels that cross over the ureter from the bladder to the cervix. If we isolate and divide the cervicovesical vessels, the remaining tissue in the anterior leaf is only avascular connective tissue. Therefore, we can divide the anterior leaf of the vesico-uterine ligament without any blood loss. Conventionally, to divide the anterior leaf of the vesico-uterine ligament, either scissors or Pean's forceps is insinuated into the ureter tunnel pushing the ureter laterally from the cervix [8–10]. If we could insert scissors or Pean's forceps into an appropriate space between the ureter and cervix, we can divide the anterior leaf of the vesico-uterine ligament without any blood loss. However, with blind placement that fails to identify the vascular bundles, injury to the blood vessels running near

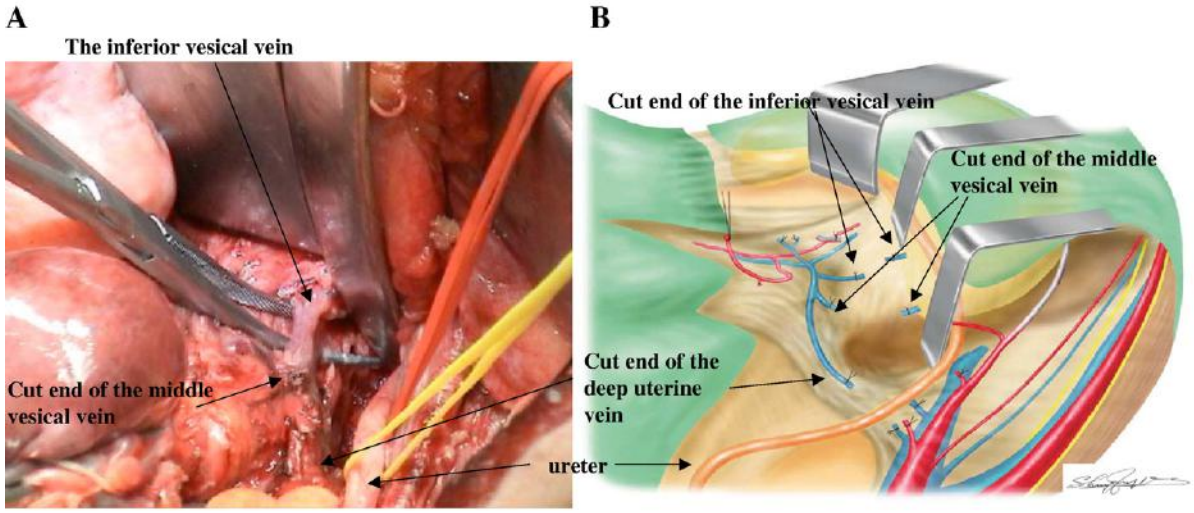

Fig. 8. (A) Separation of the inferior vesical vein. (B) Illustration of the division of the inferior vesical vein which drains into the deep uterine vein.

the ureter can occur. It is usually difficult to stop the bleeding in this area because the bleeding is usually from the venous plexus of the cervix and the upper vagina as well as from the injured cervicovesical vessels. In addition, during the attempts at hemostasis, the surgeon usually tries to avoid injury to the ureter. Therefore, hemostasis often becomes delayed or insufficient resulting in a considerable amount of blood loss. The anatomy of the anterior leaf of the vesico-uterine ligament contains an avascular area which can help avoid injury to the venous plexus of the cervix and that the most appropriate space to separate the ureter in the ureteral tunnel is beneath the cervicovesical blood vessels. The appropriate spaces are from the 9 o'clock position to the ureter on the right side and from the 3 o'clock position to the ureter on the left side of viewed from cranially to caudally.

The posterior leaf of the vesico-uterine ligament is the tissue residing under the ureter connecting the posterior wall of the bladder and the lateral cervix/upper lateral vagina. Conventionally, if we remove the ureter laterally from the posterior leaf of the vesico-uterine ligament, we create a connective tissue triangle formed by the upper vagina/cervix and the ureter draining into the bladder. In this triangle, an avascular loose connective tissue plane can be developed avoiding blood vessels of the upper vagina. Scissors insinuated in this space penetrate the loose connective tissue of the posterior leaf of the vesico-uterine ligament [8–10]. The bundle formed between the posterior wall of the bladder and the lateral cervix/upper lateral vagina is clamped, cut and ligated [6–8]. If the scissors are inserted in the appropriate place, no blood loss occurs. However, if injury occurs to these blood vessels in the posterior leaf of the vesico-uterine ligament, considerable amount of blood loss ensues. By the meticulous separation, we appreciated the middle vesical vein that runs from the urinary bladder to the cervix, draining into the deep uterine vein in the cranial portion of the posterior leaf of the vesico-uterine ligament. In addition, we observed a vein that runs parallel to the cervix from the posterior portion of the urinary bladder, which also drains into the deep uterine vein (inferior vesical vein). Therefore, the posterior leaf of the vesico-uterine ligament contain venous blood vessels that drain from the posterior wall of the urinary bladder to the deep uterine vein. If we separate connective tissues of the posterior leaf of the vesico-uterine ligament stretching the cut end of deep uterine vein, the middle vesical vein becomes visible connecting with the deep uterine vein. Further separation of the connective tissue can reveal the inferior vesical vein. The individual treatment of the vessels in the posterior leaf of the vesico-uterine ligament enables the separation of this ligament without any blood loss. As shown in the results, blood loss during the separation of the both leaves of the vesico-uterine ligament was minimal and after the completed radical hysterectomy the average blood loss was 189 g. Homologous blood transfusion was unnecessary in all cases using this meticulous operation.

In conclusion, a precise network of blood vessels in the vesico-uterine ligament is identified. The knowledge and meticulous dissection of this anatomy creates a safe radical hysterectomy and reduces blood loss during the operation. Moreover, this anatomical knowledge should be helpful for the laparoscopic and/or robotic radical hysterectomy.

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