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Nerve-sparing abdominal radical trachelectomy: a novel concept to preserve uterine branches of pelvic nerves

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ABSTRACT

Objectives: Nerve-sparing techniques to avoid bladder dysfunction in abdominal radical hysterectomy have been established during the past two decades, and they have been applied to radical trachelectomy. Although trachelectomy retains the uterine corpus, no report mentions the preservation of uterine branches of pelvic nerves. The aim of the present study was to introduce and discuss our unique concept for preserving them.

Study design and results: Four cases with FIGO stage Ia2-Ib1 cervical cancer, in which preservation of uterine branches of the pelvic nerves was attempted, are presented. Operative procedures basically followed the previously reported standard approaches for nerve-sparing radical hysterectomy or trachelectomy, except for some points. Before resection of the sacrouterine ligament, the hypogastric nerve was first identified and translocated laterally. Subsequently, the uterine branches of the pelvic nerve were identified as a continuation of the hypogastric nerve and could be scooped with forceps by detachment of the surrounding connective tissues. Further detachment toward the uterine corpus enabled them to be completely separated from the cervix. This separation was extended up to the level of the junction of the upper and lower branches of the uterine artery. Thereafter, standard resection of the parametrium and paracolpium was performed, followed by cervical resection when it was confirmed that the isolated uterine branches of the pelvic nerves were safely translocated and preserved. There were no recurrences of cancer in these patients.

Conclusions: Uterine branches of autonomic nerves can be safely preserved, and the procedure may be considered one of the nerve-sparing techniques for radical abdominal trachelectomy, which may hopefully improve the reproductive outcomes of this operation, although it needs to be evaluated with more patients.

Introduction

Cervical cancer is the second most common malignancy in women. In recent years, the frequency of early-stage cervical cancer has increased in women during their child-bearing years [1]. As a fertility-sparing operation for such patients, conization can be widely used for carcinoma in situ (CIS) or microinvasive cervical cancer with FIGO stage 1a1. However, patients with more advanced disease have usually undergone abdominal or laparoscopic radical hysterectomy as curative operative modalities. Radical abdominal trachelectomy was first described by Smith et al. in 1997 as conservative therapy for the uterine corpus [2]. Patients with FIGO stage Ia2-Ib1 with small tumor size (less than 2 cm in diameter) without retroperitoneal lymph node metastases have been likely to undergo this operation, and the oncologic outcomes have been reported to be satisfactory, comparable with radical hysterectomy [3–5]. However, the reproductive outcomes of this operation appear insufficient, and some reports indicated that radical vaginal trachelectomy, rather than abdominal trachelectomy, shows more favorable reproductive outcomes [3,6–9], while the oncologic outcomes of vaginal trachelectomy appeared to be inferior to those of the abdominal procedure, especially in patients with tumors larger than 2 cm [8,10–12]. The precise cause of the relatively poor reproductive outcomes of abdominal radical trachelectomy remains unclear, but it is possible that disruption of autonomic nerves that innervate the uterine

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corpus may be involved. Nerve-sparing operations have been used not only for radical hysterectomy, but also for trachelectomy, and their techniques have been similar in both operations [13]. Therefore, the historical perspective of nerve-sparing procedures in radical hysterectomy needs to be considered first.

The uterus, vagina, urinary bladder, and rectum are innervated by sympathetic (hypogastric) and parasympathetic (pelvic splanchnic) nerves; the former come from T11-L2, which form the superior hypogastric plexus, and the latter come from sacral nerves (S2-S4) at the pelvic wall. These fibers merge and form the pelvic nerve plexus, the branches of which innervate the uterus and urinary bladder [14]. The concept of nerve-sparing radical hysterectomy was first proposed in the 1980s by Sakamoto et al. and named the "Tokyo method" [15]. They noted that the cardinal ligament only consists of blood vessels and nerve bundles, the soft upper vascular part and the firm lower neural parts, providing a fundamental way to preserve the lower nerve portions at the resection of the cardinal ligament. Thereafter, Yabuki et al. [16] and Kato et al. [17] proposed the novel concept that pelvic splanchnic nerves were distributed dorsolaterally to the cardinal ligament, and the pelvic nerve plexus was arranged almost sagittally in a small plate-like manner and was located near the bottom of the cardinal ligament, indicating that pelvic splanchnic nerves and the plexus were somewhat separated from the vessel portion of the cardinal ligament. Höckel et al. reported that clearing the uterine supporting structures from all fatty and lymphoid tissue using liposuction instruments in the cardinal ligament clearly identified the pelvic splanchnic nerves and the pelvic nerve plexus, contributing to sparing these nerves [18]. Trimbos et al. introduced operative procedures to preserve sympathetic nerves [19]. The sacrouterine dissection plane separates the medial ligamentous tissue and the lateral nerve fibers. The former can then be safely clamped, cut, and ligated without damaging the hypogastric nerves or the proximal part of the pelvic nerve plexus. The problem of sparing autonomic nerves to the bladder in the vesicouterine ligament has been addressed by Kuwabara et al. [20]. Intraoperative electrical stimulation of various parts of the vesicouterine ligament and the simultaneous measurement of intravesical pressure identified that the lateral layer of the posterior part of the vesicouterine ligament was the major pathway of the bladder branches of pelvic nerves. A surgical technique was developed in which a thin membranous layer containing the bladder branches from the lateral surface of the bladder was identified and spared.

Based on these historical studies, a recently established concept to spare autonomic nerves has been classified into 3 major steps in abdominal radical hysterectomy, with preservation of the hypogastric nerves at the presacral portion, of the splanchnic nerves and pelvic nerve plexus at the cardinal ligament, and of the bladder branches from the pelvic nerve plexus at the vesicouterine ligament. This concept has recently been carried over into abdominal radical trachelectomy, based on the results of a comparative study showing that nerve-sparing radical trachelectomy provided disease-free and overall survivals comparable to radical hysterectomy [21]. However, no attention has been paid to sparing uterine branches. Although the precise functions of uterine branches of pelvic autonomic nerves are largely unknown, it is possible that they are essential for good reproductive and obstetrical outcomes postoperatively. This background information prompted us to establish novel techniques for sparing the uterine branches of pelvic nerves in radical abdominal trachelectomy. Four successful cases who underwent this novel procedure are presented and discussed.

Methods and results

Abdominal radical trachelectomy was performed in 4 patients with stage Ia2-Ib1 cervical cancers between October, 2013 and April, 2015, which basically followed the same approach that would be standard for radical abdominal hysterectomy. After opening the retroperitoneal cavity, bilateral pelvic node dissection was performed, including internal/external iliac, cardinal, obturator, and supra-inguinal nodes. The dissected lymph nodes were subjected to intraoperative pathological diagnosis to detect metastases. Bilateral uterine arteries were isolated from the origin to the bifurcation of the superior and inferior branches and preserved. Then, the superficial layer of the vesicouterine ligament was resected using LigaSure™ Small Jaw (Covidien, Dublin, Ireland). The autonomic nerves were preserved by the following procedures in a novel attempt to spare the uterine branches of the pelvic plexus.

Hypogastric nerve isolation

Okabayashi's pararectal space [22] was developed by sharp dissection of presacral visceral pelvic fascia just above the ureter, making a shallow dimple that could be developed bluntly [19]. With the use of forceps, a thin and loose lateral part directly underneath the ureter (named the mesoureter or ureteral leaf) containing the hypogastric nerve was laterally isolated, leaving a firm medial part consisting of the uterosacral fibers. Eventually, the hypogastric nerve was translocated laterally by this maneuver. Then, the medial part consisting of the sacrouterine fibers was resected, while the hypogastric nerve was far from the line of resection and safely preserved.

Isolation of uterine branches of the pelvic nerve plexus

Uterine branches of the autonomic nerves arise from the pelvic nerve plexus, which is formed from the hypogastric and pelvic splanchnic nerves from S2 to S4. After lateral translocation of the hypogastric nerve, an attempt was made to identify the uterine branches of the pelvic nerve. In general, the uterine branches are easily identified as a continuation of the hypogastric nerve, ascending up the uterine cervix toward the uterine corpus, and it can be scooped with forceps by detachment of the surrounding connective tissues. Further detachment of the connective tissue toward the uterine corpus facilitates complete separation of the uterine branches from the uterine cervix. This separation should be performed at least up to the level of the junction of the upper and lower branches of the uterine artery. The typical image of this separation is shown in Fig. 1 in another patient who underwent abdominal radical hysterectomy. In this case, the isolated tissue was resected at the time of hysterectomy and was histologically examined for the presence of nerve tissue. As shown in Fig. 1, the presence of peripheral nerves was confirmed, showing the technical accuracy of our procedures.

Separation of deep uterine veins from the pelvic nerve plexus

The cardinal ligament contains major vessels such as deep uterine veins, some vesical veins, and the middle rectal vein; all these veins converge into the internal iliac vein. These vessels are most clearly exposed by complete dissection of the cardinal lymph nodes with ultrasonic surgical aspirators [18]. The deep uterine vein alone was dissected, leaving more dorsal vessels to LigaSure™ Small Jaw or LigaSure™ Impact (Covidien, Dublin, Ireland). Since the area of the pelvic splanchnic nerves and plexus was anatomically separated from these vessels at the cardinal ligament [17], this dissection did not affect the function of the splanchnic nerves. Thereafter, the uterine side edge of the deep uterine vein was ventrally elevated by detaching the surrounding membranes over the upper border of the hypogastric nerve tract, resulting in complete separation of the deep uterine vein from the pelvic nerve plexus [23]. Since the bladder branch of the pelvic nerves arose