European Journal of Obstetrics and Gynecology 297 (2024) 36–39

Contents lists available at ScienceDirect

European Journal of Obstetrics & Gynecology and Reproductive Biology

journal homepage: www.journals.elsevier.com/european-journal-of-obstetrics-and-gynecology-and-reproductive-biology

Full length article

The minimally invasive sacrospinous fixation under visual guidance: An anatomical study

Gautier Chene [a,b,*], Emanuele Cerruto [a], Stephanie Moret [a], Erdogan Nohuz [a]

[a] Department of Gynecology, Hôpital Femme Mère Enfant, HFME, 59 boulevard Pinel, University hospital of Lyon, 69500 Bron, France
[b] University Claude Bernard of Lyon 1, EMR 3738 CICLY, 69000 Lyon, France

ARTICLE INFO

Keywords:
Sacrospinous ligament
Pudendal nerve
Anatomy
Pelvic organ prolapse
Vaginal vault prolapse
Sacrospinous fixation

ABSTRACT

Objective: Sacrospinous fixation is the gold standard procedure for management of apical pelvic organ prolapse by the vaginal route. However, there may be a relevant risk of neurovascular injury due to the proximity of neurovascular structures. We propose an anatomical study concerning the sacrospinous ligament with a new innovative minimally invasive technology using both a suture capturing device and a chip-on-the-tip endoscope to perform sacropinous fixation.

Study design: Bilateral sacrospinous fixation was performed in three female cadavers, in the course of the anatomical study conducted with a specific device (the Suture Capturing I Stitch™ Device) under real time visual guidance with a chip-on -the-tip endoscope, the NanoScope™ system.

Results: Identification of ischial spine and sacrospinous ligament as well as feasibility of sacrospinous fixation under NanoScope™ control were always possible on both sides.

Conclusions: This new innovative minimally invasive technology using both a suture capturing device and a chip-on-the-tip endoscope is relevant and could be an advantage in terms of safety and better placement of the suture on the sacrospinous ligament.

Introduction

Transvaginal sacrospinous colpopexy is the gold standard procedure for the treatment of vaginal vault prolapse by the vaginal route [1–4]. The use of Suture Capturing Devices (such as the I Stitch™ device) allows a minimally invasive approach to the sacrospinous ligament (SSL) [5,6]. However, this is a blind technique (no visualization of the ligament); only palpation guides the placement of the suture on this ligament. There are several neurovascular structures closer to the ischial spine (IS), including the inferior gluteal nerve and artery, the internal pudendal artery and the pudendal nerve. Several postoperative complications have been described during sacrospinous fixation as hemorrhage (2–8 %), ischioanal hematoma (2.5 %), sciatic neuralgia (1.5 %), dyspareunia and chronic pain (3–15 %) [7–12]. A recent systematic review concerning the rate of complications related to different suture passing techniques has been presented at ICS 2023 (International Continence Society congress 2023) [13]: the authors found the highest complications in Capio™ group (surgical procedures with the Capio™ SLIM Suture Capturing Device) with mainly nerve injuries. On the other hand, higher hematoma formation and transfusion were related to the classical Richter's sacrospinous ligament fixation despite direct visualization likely due to the fact this technique required more dissection [13].

This complex anatomical area is therefore potentially exposed to neurovascular complications. Real-time visualization of the I Stitch™ and SSL could therefore be a valuable aid in passing the needle and suture within 2 cm from the IS to avoid nerve and vascular injury. The development of advanced technology such as chip-on-the-tip endoscopes allow minimally invasive surgery with high resolution and high quality of video. We've chosen the NanoScope™ system; it is a disposable camera with chip-on-tip image sensor technology. It is currently used to perform minimally invasive arthroscopy [14]. As this technology has never been performed in the management of prolapse, we propose a feasibility study on female cadavers.

Materials and methods

The study protocol was exempt from Institutional Review Board approval. All female cadavers came from body donors at the time of death and were obtained from the Department of Anatomy of Rockfeller

* Corresponding author at: Department of Gynecology, Hôpital Femme Mère Enfant, HFME, 59 boulevard Pinel, University hospital of Lyon, 69500 Bron, France.
E-mail address: chenegautier@yahoo.fr (G. Chene).

https://doi.org/10.1016/j.ejogrb.2024.03.039
Received 1 July 2023; Received in revised form 17 December 2023; Accepted 30 March 2024
Available online 31 March 2024

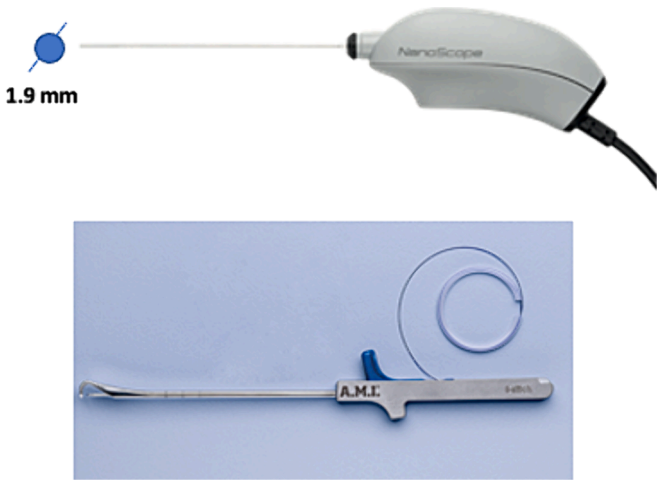

Fig. 1. The i-stitch™ device (ami, austria) and the nanoscope™ imaging system (arthrex, germany).

University (Lyon Est School of Medicine, FRANCE).

Posterior sacrospinous ligament fixation was performed on 3 female cadavers (body donation to science) using the I-Stitch™ device (AMI, Austria) and the NanoScope™ imaging system (Arthrex, Germany). All dissections were carefully performed by two of the authors (Profs. G.C and E.N.).

Briefly, the female cadavers were in the lithotomy position. After a posterior colpotomy, the pararectal fossa were dissected towards the ischial spine (IP). Dissection was performed with Metzenbaum scissors and index finger alongside the NanoScope™ imaging system and this device was finally used to visualize and identify the IP and the sacrospinous ligament (SSL). Sacrospinous fixation was performed using the I-Stitch™ [5,6] device under visual guidance using the NanoScope™ (Fig. 1). The same procedure was performed in the contralateral side. The purpose of the study was to demonstrate the feasibility of the identification of the SSL and IP and the feasibility of the sacrospinous fixation with a specific device (I-Stitch™ device) under visual guidance.

Results

None of the cadavers had evidence of prior reconstructive pelvic surgery. Identification of the IP and SSL with the NanoScope™ in the 3 female cadavers was always possible on both sides (Fig. 2). The IP is visualized as a thin, triangular eminence, whereas the SSL is visualized as a white structure. Finger-guided dissection of the SSL was also visualized in real time. Sacrospinous fixation was always possible using the I-Stitch™ device and the NanoScope™ in both sides (Fig. 3 and watch the video).

Discussion

The sacrospinous ligament (SSL) is a dense connective pelvic ligament (Fig. 3). This thin triangular band is attached from the ischiatic spine (IS) laterally to the lower part of the sacrum and coccyx medially. Its length is about 40 mm (43.04 +/-6.58); its width at its origin on the IP is about 11 mm (11.24 +/- 1.85); Its width is about 34 mm (34.82+/- 4.19) at its insertion on the sacrum [4]. Visual identification of these

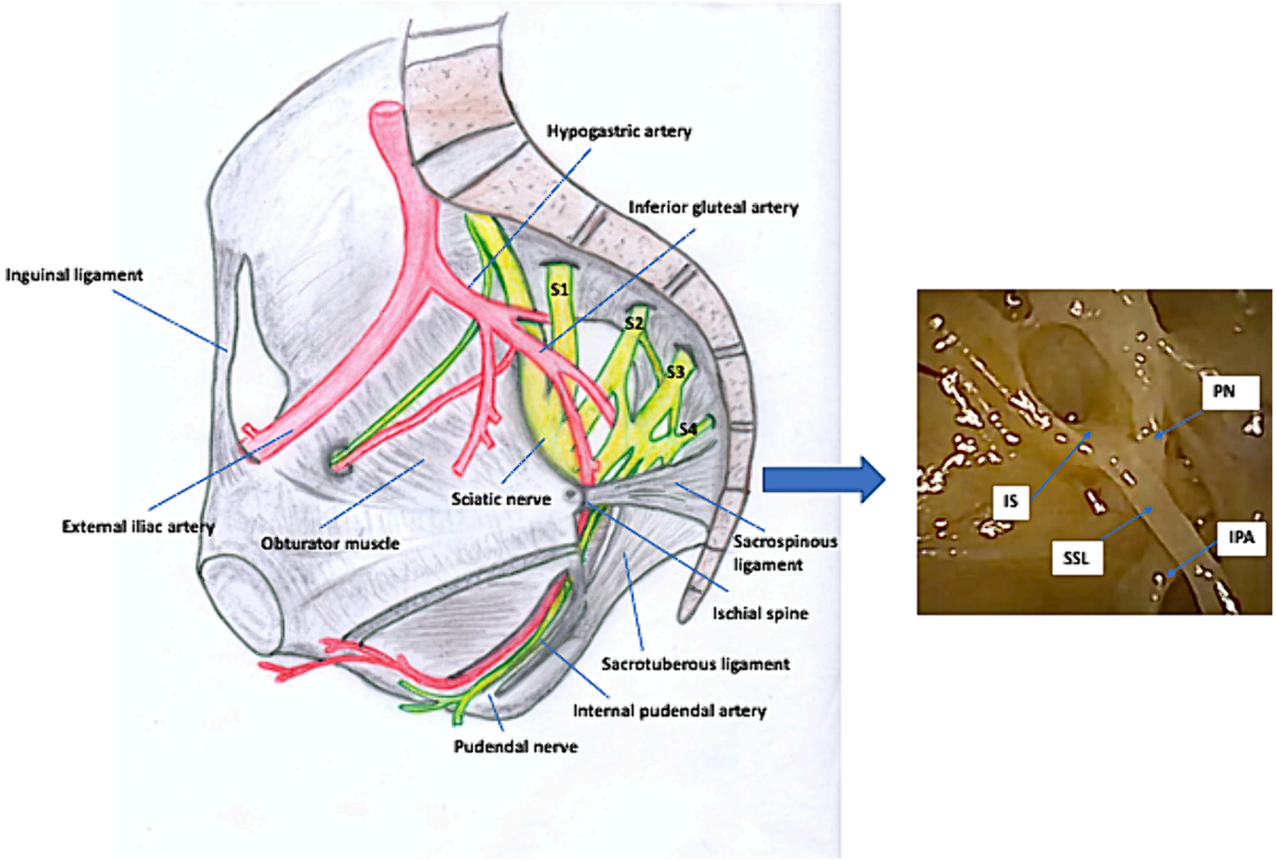

Fig. 2. Neurovascular anatomy of the sacrospinous ligament region in female cadavers. modified from picture from Barbara Hoffman, John Schorge, Joseph Schaffer, Lisa Halvorson, Karen Bradshaw, F. Cunningham, Williams Gynecology, Third edition; McGraw Hill education. See on the right-hand side the corresponding image of the ischial spine (IS) and the sacrospinous ligament (SSL) with the NanoScope™ showing pudendal nerve (PN) and internal pudendal artery (IPA) traveling under the sacrospinous ligament.

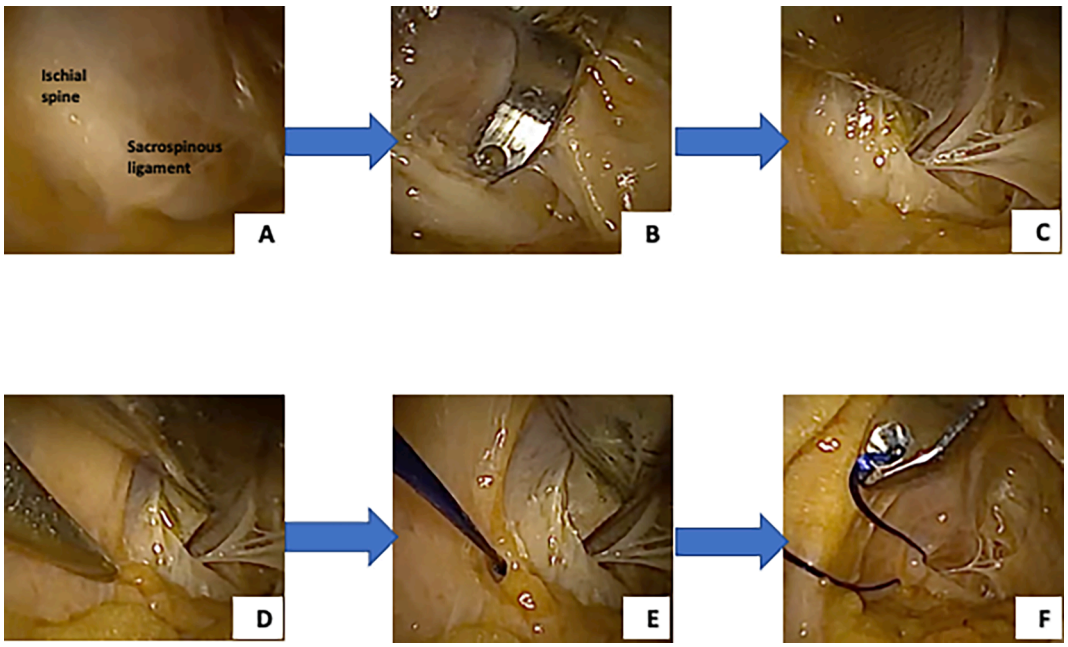

Fig. 3. Description of the technique of the sacrospinofixation: 3A: Visualization with the NanoScope™ of the ischial spine and the sacrospinous ligament 3B: I-Stitch™ device is loaded with the loading unit. I-Stitch™ is guided to intented stuture attachment point. 3C: Tip is pushed into the sacrospinous ligament 3D: the loading unit is pushed forward 3E: suture penetrates tissue 3F: the loading unit is completely removed. The I-Stitch™ is carefully retrieved. Suture will remain firmly in place.

Table 1
Distances between the ischial spine (IP) and adjacent neurovascular structures. IGN: inferior gluteal nerve; IGV: inferior gluteal vessels; PN: pudendal nerve; IPV: internal pudendal vessels; SN: sciatic nerve; PFC: posterior femoral cutaneous nerve Distance in mm (mean +/- standard deviation or range) **Video:** Identification of the IP and SSL with the NanoScope™ imaging system (Arthrex, Germany) and the I-Stitch™ device (AMI, Austria).

	Sagsoz *et al* [4]	Thompson *et al* [8]	Lazarou *et al* [9]	Roshanravan *et al* [10]	Florian-Rodriguez *et al* [11]	Verdeja *et al* [12]
Distance between IP and IGN	13.82 +/-3.5		19+/-7		28.5 (6–53)	
Distance between IP and IGV	8.54 +/-1.72	12 (7–17)		24.2 +/-5.7	19 (4–33)	
Distance between IP and PN	2.98 +/-1.07	<5	6 +/-4		0 (0–8)	
Distance between IP and IPV	3.69 +/-1.07	<5		0 (0–1.5)	4 (0–8)	
Distance between IP and SN	25.14 +/-3.94				24 (13–36)	21.2 (9–33)
Distance between IP and PFC					21 (5–40)	

complex neurovascular structures is not possible under blind palpation intraoperatively. All anatomical studies have shown that this is a high-risk area for complications due to the proximity of nerve and vascular structures [4,7–12].

Sacrospinous fixation should be performed 2 cm from the ischiatic spine (approximately two finger breadths from the ischial spine). Real-time visualization of the SSL allows the medial part of the sacrospinous ligament (between 16 and 32 mm from the IS) to be visualized precisely [3,4]: this is indeed the most appropriate area of the ligament for the placement of the suture during sacrospinous fixation. Suture placement closer to the sacrum may lead to S4 nerve entrapment whereas its placement closer to the IP may generate to vessel and/or pudendal nerve injury [4,7–12] (Table 1).

A recent review of the literature demonstrated several benefits with Arthrex NanoScope™ over conventional arthroscopy: diagnostic accuracy, cost efficiency, timeless of investigation and a visually impactful patient-centred consultation [14]. The NanoScope™ has never been used in gynecology. Because of the very small diameter of the optical fiber (1.9 mm), we had the idea to use it for prolapse surgery. First, our anatomical study demonstrated the feasibility to visualize and identify accurately the IS and the SSL. Secondly, because of the thin thickness of the SSL, suture placement should not be made deeper in the SSL. This could be controlled under direct visualization with NanoScope™. Last but not least, in case of intraoperative hemorrhage, packing is the first recommended option followed if needed by coagulation or clipping or ligation of the vessel [12]. Once again, using the NanoScope™ may be useful instead of a blinded coagulation/ligation.

Study limitations include a small sample size. However, the possibility to visualize the bilateral SSL in real time in all specimens seems promising and may lead to clinical implications. The next step currently underway in our department is to confirm the feasibility of sacrospinous fixation under visual control by the NanoScope™ in live patients operated for apical prolapse. Because this device does not use any CO2 insufflation but may be put in a small sheath with injection of sterile 0.9 % normal saline to explore this restricted space, we don't anticipate any problems.

This vaginal minimally invasive technology could be an advantage in terms of safety and better placement of the suture during sacrospinous fixation [15].

CRediT authorship contribution statement

Gautier Chene: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Emanuele Cerruto:** Investigation, Visualization, Writing – review & editing. **Stephanie Moret:** Conceptualization, Methodology, Writing – review & editing. **Erdogan Nohuz:** Conceptualization, Investigation, Methodology, Validation, Writing –

review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors acknowledge the Department of Anatomy of Rockfeller University (Lyon Est, FRANCE). The authors thank Dr Paul CHENE for the anatomy picture.

Funding

This research received no external funding.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejogrb.2024.03.039.

References

[1] Maher C, Yeung E, Haya N, Christmann-Schmid C, Mowat A, Chen Z, et al. Surgery for women with apical vaginal prolapse. Cochrane Database Syst Rev 2023;7. CD012376.
[2] Richter K. Die chirurgische anatomie der vaginaefixatio sacrospinalis vaginalis. ein beitrag zur operativen behandlung des scheidenblind- sackprolapses. Geburtshilfe Frauenheilkd 1968;28(4):321–7.
[3] Giraudet G, Ruffolo AF, Lallemant M, Cosson M. The anatomy of the sacrospinous ligament: how to avoid complications related to the sacrospinous fixation procedure for treatment of pelvic organ prolapse. Int Urogynecol J 2023;34:2329–32.
[4] Sagsoz N, Ersoy M, Kamaci M, Tekdemir I. Anatomical landmarks regarding sacrospinous colpopexy operations performed for vaginal vault prolapse. Eur J Obstet Gynecol Reprod Biol 2002;101(1):74–8.
[5] Chene G, Cerruto E, Formont C, Lebail-Carval K, Chabert P, Lamblin G, et al. How I do…easily a vaginal sacrospinous colpopexy using an isthmic posterior mesh. Gynecol Obstet Fertil Senol 2019;47:321–3.
[6] Chene G, Cerruto E, Devantay C, Nohuz E. Easy way for elytrocele treatment by the vaginal route without mesh (with video). J Gynecol Obstet Hum Reprod 2021;50(102):172.
[7] Ouzaid I, Ben Rhouma S, de Tayrac R, Costa P, Prudhomme M, Delmas V. Mini-invasive posterior sacrospinous ligament fixation using the capio needle driver: an anatomical study. Prog Urol 2010;20:515–59.
[8] Thompson JR, Gibb JS, Genadry R, Burrows L, Lambrou N, Buller JL. Anatomy of pelvic arteries adjacent to the sacrospinous ligament: importance of the coccygeal branch of the inferior gluteal artery. Obstet Gynecol 1999;94:973–7.
[9] Lazarou G, Grigorescu BA, Olson TR, Downie SA, Powers K, Mikhail MS. Anatomic variations of the pelvic floor nerves adja- cent to the sacrospinous ligament: a female cadaver study. Int Urogynecol J Pelvic Floor Dysfunct 2008;19(5):649–54.
[10] Roshanravan SM, Wieslander CK, Schaffer JI, Corton MM. Neurovascular anatomy of the sacrospinous ligament region in female cadavers: implications in sacrospinous ligament fixation. Am J Obstet Gynecol 2007;197(6). 660.e1–6.
[11] Florian-Rodriguez ME, Hare A, Chin K, Phelan JN, Ripperda CM, Corton MM. Inferior gluteal and other nerves associated with sacrospinous ligament: a cadaver study. Am J Obstet Gynecol 2016;215(5). 646.e1–6.
[12] Verdeja AM, Elkins TE, Odoi A, Gasser R, Lamoutte C. Transvaginal sacrospinous colpopexy: anatomic landmarks to be aware of to minimize complications. Am J Obstet Gynecol 1995;173:1468–9.
[13] Bastani P, Hajebrahimi S, Amiri E, Salehi-Pourmehr H. Complications rate of different suture passing techniques in sacrospinous ligament fixation: a systematic review and *meta*-analysis. ICS 2023 Toronto; https://www.ics.org/2023/abstract/611.
[14] Burt J, Smith V, Gee CW, Clarke JV, Hall AJ. The role of outpatient needle arthroscopy in the diagnosis and management of musculoskeletal complaints: a systematic review of the Arthrex NanoScope. Knee 2023;42:246–57.
[15] Chene G, Cerruto E, Nohuz E. The comeback of vaginal surgery during and after the COVID-19 pandemic: a new paradigm. Int Urogynecol 2020;31:2185–216.