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ARTICLE

Management of stress urinary incontinence in female patients with spinal cord injury by autologous fascial sling: time for a revival?

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STUDY DESIGN: This study is a retrospective chart analysis.
OBJECTIVES: Surgical treatment of stress urinary incontinence (SUI) in women with neurogenic lower urinary tract dysfunction (NLUTD) is a challenge, as minimally invasive procedures do not seem to be effective, whereas synthetic implants are associated with substantial risks. Thus, we evaluated the results of an autologous sling procedure in this group of patients
SETTING: This study was performed at a spinal cord injury rehabilitation center in Switzerland.
METHODS: In this retrospective analysis, we evaluated the objective, subjective, and urodynamic results in women undergoing autologous sling insertion for SUI due to NLUTD at our institution.
RESULTS: The data of 17 women who underwent fascial sling surgery were analyzed. After a median follow-up of 40 months, 8 women (47%) were continent, and another 8 patients (47%) significantly improved (1 pad/day). Median video-urodynamic parameters remained unchanged after sling insertion, but two women developed de novo detrusor overactivity. Postoperative complications occurred in 6 of the 17 patients (35.3%), which required surgical interventions in 2 women (12%) (urethral erosion by the sling and complete occlusion of the urethra after removal of the catheter), which could be resolved without loss of continence.
CONCLUSION: In our case series, autologous fascial slings were effective in the treatment of SUI in women with NLUTD. As they are more effective than minimally invasive procedures, are associated with fewer complications than AUS, and seem to omit possible severe long-term consequences of synthetic slings, they are an excellent treatment option in this group of patients. Urodynamic controls are recommended, as de novo detrusor overactivity may occur after sling insertion.

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INTRODUCTION

Most patients with spinal cord lesions develop neurogenic lower urinary tract dysfunction (NLUTD). Whereas an elevated storage pressure, either due to low bladder compliance or to detrusor overactivity, is the major risk factor for renal deterioration [1], urinary incontinence has the most detrimental influence on the quality of life [2]. Incontinence in persons with NLUTD can be based on detrusor overactivity or on a weak sphincter/pelvic floor (stress urinary incontinence (SUI)). Depending on the underlying pathology, a combination is possible [1].

For the treatment of SUI in women with NLUTD, several procedures have been introduced. Implantation of an artificial urinary sphincter leads to continence in more than 80% of the patients [3]. However, long-term follow-up demonstrates significant complication rates, requiring surgical revision in a substantial percentage of the patients [4]. Within the last decade, minimally invasive sub-urethral slings have been introduced as a treatment for SUI in patients without NLUTD [5]. After an initial phase with increasing popularity, serious concerns have been raised lately, mostly due to significant complications due to the synthetic material used, e.g., vaginal exposure and extrusion of mesh, pain/

sexual dysfunction, urinary complications, and possible autoimmune or systemic effects. As a result, mesh insertion procedures were suspended in Scotland in 2014 and subsequently in the rest of the UK in 2018 [6]. Therefore, techniques using autologous slings, e.g., rectus fascia and regain importance. We evaluated the clinical usefulness of fascial sling procedures in patients with spinal cord lesion and SUI.

METHODS

This study had been approved by the competent ethics committee (Ethikkomitee Nordwest- und Zentralschweiz) and all applicable institutional and governmental regulations concerning the ethical use of the data were followed. All data were encrypted and kept confidential.

The patient database of a tertiary urologic referral center for persons with spinal cord injury was screened for female patients with a NLUTD due to spinal cord lesion (traumatic, ischemic, or inborn) who underwent a fascial sling procedure for the treatment of SUI. Patients who had rejected the further use of their health-related data for retrospective analyses were excluded.

Patient characteristics, data regarding bladder management, urinary incontinence, surgical procedure including complications, medication for

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Table 1. Characterization of NLUTD etiology of evaluated patients.

Variable	Group	N/%
Lesion level	Cervical	2/11.8
	Thoracic	14/82.4
	Lumbar	1/5.9
AIS score	AIS A	10/58.8
	AIS B	1/5.9
	AIS C	2/11.8
	AIS D	4/23.5
SCI etiology	Traumatic	9/52.9
	MMC	4/23.5
	Non-traumatic	4/23.5

NLUTD neurogenic lower urinary tract dysfunction, AIS American Spinal Cord Injury Association Impairment Score, MMC myelomeningocele, N number of patients, % percentage of the patients.

NLUTD as well as urodynamic parameters were collected from electronic and paper patient charts. Data were collected for the time period from 2011 (first fascial sling surgery performed at this institution) to 2021.

Fascial sling procedure
All procedures were performed by one out of three experienced urologic surgeons. In brief, 15–25 cm of the rectus fascia were excised and used for the sling procedure. Care was taken to place the sling under the bladder neck, not at a mid-urethral position. Tension was applied under cystoscopic control until a sufficient closure of the bladder neck was achieved. The sling was fixed with at least three non-resorbable sutures at the rectus fascia. An indwelling catheter was inserted and removed at the second day after surgery.

Diagnostics
Before surgical treatment and at follow-up examinations, all patients underwent video-urodynamic examinations which had been performed according to the International Continence Society standards [7]. Persistent significant (>15 cm H_2O) detrusor overactivity was ruled out in all patients by this examination. In addition, cystoscopy, vaginal examination including a stress test, and urinalysis were performed.

All patients underwent follow-up examinations including video-urodynamics, renal ultrasound, and clinical examination at our department three and 6 months after the implantation and then every 12 months. Subjective continence was assessed by a standardized semi-structured interview. All further complications and surgical procedures were documented in the electronic chart system of our hospital. Cure was stated if no pads or continence aids were used, combined with confirmation of continence during the video-urodynamic examination and a negative stress test at vaginal inspection. Improvement meant that one of these prerequisites was not fulfilled, but the women reported a significant improvement. Otherwise, the result was classified as no success/failure. The subjective severity grade was rated using the Sandvik severity index (SSI) before and after surgery [8].

RESULTS
A total of 19 women who underwent fascial sling surgery were identified. Two women were excluded from analysis as a result of missing data (one woman deceased 2 months after surgery unrelated to the procedure, and another woman was lost to follow-up). Thus, the data of 17 patients were analyzed.

The characteristics of the evaluated patients are presented in Table 1. The median age was 46 years (range 24–65 years) and the median duration of NLUTD was 219 months (range 6–528 months) at the time of surgery. A median of 40 months (3.3 years) (range 3–118 months) had elapsed from surgery to the most recent follow-up evaluation.

Complications
Postoperative complications occurred in 6 of the 17 patients (35.3%). Two women developed de novo detrusor overactivity, one complication (subcutaneous seroma 14 days after surgery) could be managed conservatively, whereas two complications (urethral erosion by the sling and catheterization problems urethra after removal of the catheter 2 days after surgery) required surgical interventions, which resolved the complications without loss of continence. In the first patient, the sling was partially resected from a vaginal approach, an indwelling catheter was applied for 4 weeks, and she became continent after removal of the catheter. In the patient with catheterization problems, these resumed after dilatation of the urethra under anesthesia. Two patients developed urinary retention and started with intermittent catheterization (IC) for bladder evacuation. As the onset of urinary retention as a consequence of the surgery has been discussed in detail with the patients prior to surgery, IC was started without problems.

Bladder management
Before surgery, 14 patients (82%) emptied their bladder by IC at a median frequency of 5 times per 24 h, two women voided spontaneously, whereas one woman was equipped with an indwelling catheter. At follow-up, all patients used IC for bladder management with a median frequency of 5.6 times/24 h.

Before sling insertion, nine patients (53%) were using medical treatment for NLUTD (anticholinergics: $n = 2$; Botox: $n = 3$; Botox plus anticholinergics: $n = 3$; alpha blockers: $n = 1$). After surgery, five women were using anticholinergics, three required Botox injections, three patients combined Botox and anticholinergic, and one patient underwent ileal augmentation for detrusor overactivity.

Incontinence degree
Applying the SSI, prior to surgery, 15 patients suffered from SUI every day and night, and 2 women presented with SUI once or a few times a week. The median number of protective pads/day was 4.2.

After sling insertion, the number of protective devices dropped to 1.25/day. A total of 13 women (76.5%) used no pad or maximum one safety pad. In 11 women, no SUI was present after surgery (Table 2). Of these, 3 women did not report any type of incontinence, 4 women treated with repetitive onabotulinum toxin injections reported incontinence when detrusor overactivity recurred that was successfully treated by reinjection of onabotulinum toxin, and 4 patients reported incontinence due to detrusor overactivity and are awaiting onabotulinum injections ($n = 3$) or sacral neuromodulation ($n = 1$). 5 had a first-degree SUI. In one woman, a third-degree SUI persisted, and she underwent ileal conduit diversion. According to the SSI, 12 women had SUI less than one time a month, 3 reported SUI episodes once or a few times a month, and 1 woman remained incontinent every day and night.

At the most recent follow-up, eight women (47%) regarded themselves as cured of SUI, and another eight patients (47%) reported a significant improvement and were content with their current state, whereas, as aforesaid, one patient underwent ileal conduit diversion. No woman reported any difficulties with IC.

Urodynamic results
Video-urodynamic parameters, such as median bladder capacity, detrusor activity, and compliance, remained unchanged after sling insertion (Table 3). Two patients, however, developed de novo detrusor overactivity after fascial sling insertion and received anticholinergic treatment, resulting in sufficient suppression of detrusor overactivity.

Table 2. Surgical results of evaluated patients.

Variables	Categories	Preop	Postop
SUI (N/%)	na	17/100	6/35.3
Sandvik severity index (N/%)	Less than one time a month	0/0	12/70.6
	Once or a few times a month	0/0	3/17.6
	Once or a few times a week	2/11.8	1/5.9
	Every day/ night	15/88.2	1/5.9
Pads/day (mean ± standard deviation, range in brackets)	na	4.2 ± 1.3 (3–8)	1.25 ± 1.3 (0–8)
Subjective state (N/%)	Cured	na	8/47.1
	Improved	na	8/47.1
	Satisfied (cured/ improved)	na	16/94.1
	No change	na	1/5.9
	Worse	na	0/0

preop pre-operatively, *postop* post-operatively (median 40 months (3.3 years) (range 3–118 months) after surgery), *na* not applicable, *N* number of patients, % percentage of patients.

Table 3. Urodynamic results of evaluated patients.

	Preop	Postop
Median bladder capacity (ml)	384.8 ± 92.2	430.6 ± 111.7
Median compliance (cmH$_2$O/ml)	82.8 ± 123.3	78.3 ± 43.4
Median Pdet max (cmH$_2$O)	17.1 ± 13.1	13.9 ± 9.2
Median reflex volume (ml)	205.7 ± 48.7	310.4 ± 61.0

Data are mean and standard deviation.
preop pre-operatively, *postop* post-operatively (median 40 months (3.3 years) (range 3–118 months) after surgery, *Pdet max* maximal detrusor pressure during storage phase.

DISCUSSION

Our case series demonstrates that fascial slings are an effective treatment option in women with SCI and NLUTD suffering from SUI. As SCI leads to impaired or absent neural control of the pelvic floor, conservative treatment options, like pelvic floor exercises or biofeedback, or drug treatments, are not likely to significantly improve SUI in this group of patients. Therefore, surgical treatment is the mainstay of urologic therapy. The artificial urinary sphincter is regarded as the gold standard [9], but due to relatively high long-term revision rates of up to 85% in 6 years, less invasive surgical measures are sought [10]. Bulking agents are the least invasive surgical technique for SUI treatment. Collagen and polytetrafluoroethylene, used in the initial studies available, were withdrawn due to side effects. The results with dextanomer/ hyaluronic acid, the most frequently used substance today in women with SCI are neither satisfying nor long-lasting. After a follow-up of 8 years, merely two of 89 women with SUI due to NLUTD were continent [11]. As primary injection of bulking agents has proven to be of limited value in treating SUI in NLUTD, they are predominantly, if at all, applied in children, in which definitive surgery can possibly be postponed by this technique [12].

For other minimally invasive options, like the ATOMS procedure or the Pro-ACT technique, very few or virtually no data exist in treating female SUI due to NLUTD. exist. In a population of men and women with NLUTD, Mehnert et al reported a continence rate of 38.9% and an improvement rate of 54.5% after 48 months after Pro-Act insertion [13]. These results were confirmed by a second study [14], whereas we did not find data on the ATOMS procedure in women with NLUTD and SUI.

Historically, pubovaginal fascial slings were known to be an effective procedure for the treatment of SUI in neurologically intact women since the 1980ies [15]. Data in patients with NLUTD, however, were scarce, but the few case series available reported satisfactory results [16]. Prior to the introduction of modern synthetic sling procedures, autologous fascial slings have been frequently used with substantial success, whereas earlier synthetic slings, e.g., the Zoedler sling [17], were abandoned due to their high complication rates [18]. The so-called tension-free synthetic slings were regarded as an easy-to-perform, minimally invasive procedure. The tension-free insertion was thought to prevent long-term complications, especially erosion, known from the Zoedler sling, which was not applied tension-free. Although synthetic slings were not primarily developed for the treatment of neurogenic SUI due to sphincter insufficiency, they have been used for this purpose, and initial results were promising in this group of patients. Due to the relatively low number of female patients suffering from SUI, the size of the study groups was rather small (9–27 patients), and thus results were unequivocal, with success rates between 33 and 85% using either the tension-free vaginal tape technique [19] or transobturatoric tapes [20, 21]. The most recent study, presenting the cumulative results of different mid-urethral sling techniques in 38 females, reported an overall patient-reported success rate of 52.6%. A total of 68.4% felt the quality of life to improve. Nine patients developed tape-related complications, including five women with de novo urgency, one with vaginal extrusion, one with frequent dysreflexia, and one with worsening incontinence. Thus, synthetic slings seem to be effective in more than 50% of the patients, with comparatively low rates of short-term complications [22]. Lately, however, concerns about long-term complications of the synthetic slings have been raised, including, but not limited to, vaginal exposure and extrusion of mesh, and urinary complications [6].

Thus, autologous slings may regain importance in SUI treatment in women with SCI. Despite the long time period in which fascial slings are in use, robust data are scarce in women with NLUTD. In the most recent case series, including 33 women with a follow-up of 52 months, 90.9% were successfully treated and satisfied with the outcome of the operation, as they were either totally continent (75.75%) or markedly improved (15.15%). The complication rate was 15.20% [23]. In the only comparative study, evaluating time to treatment failure in women with SUI due to NLUTD treated either with synthetic or with fascial slings, cure rates were comparatively high (80 versus 85%, respectively), and subjective as well as objective treatment outcomes were comparable [24]. Our own series, with 94% of the women being either continent or vastly improved, and a complication rate of 35%, provides comparable results.

Even at a specialized center, fascial sling procedures in women with SUI and NLUTD are comparatively rare. This is reflected by the complications reported above. The catheterization difficulties and the erosion of the urethra may have occurred due to over-tightening of the slings, which took place although the procedure was performed under cystoscopic control, and catheterization was performed without any problems in the operating theater. The ileal conduit formation was performed due to persisting SUI despite fascial sling insertion, as the patient refused to insert an

artificial sphincter. Furthermore, her hand function worsened due to a plexus lesion, making IC impossible.

As fascial slings are used for the treatment of SUI, but 53% of the women in our study suffered from both SUI and neurogenic detrusor overactivity (NDO), NDO treatment had to be continued in all nine women who were treated prior to surgery. Noteworthy, two women developed de novo NDO after surgery; thus, 11 women required NDO treatment after fascial sling insertion. De novo detrusor overactivity has been described in up to 30% of patients undergoing surgical SUI treatment [25, 26]. Thus, the onset of NDO after SUI treatment is not unusual, underlying the need for urodynamic controls after surgery.

The retrospective nature of our study and the relatively small number of patients pertaining to the limitations of our study. Of today, no randomized controlled trial exists, and the body of evidence concerning incontinence surgery in women with SUI due to NLUTD is small, our study is an important contribution to the existing evidence, especially as recent data using fascial slings are missing, as this procedure was driven-out of the armamentarium of the urologic surgeons for more than a decade by synthetic slings. In contrast to the latter, they have stood the test of time, and therefore may regain importance in this group of patients.

In conclusion, in our case series, autologous fascial slings were safe and effective in the treatment of SUI in women with NLUTD. As they are more effective than minimally invasive procedures, are associated with fewer complications than AUS, and seem to omit possible severe long-term consequences of synthetic slings, they are an excellent treatment option in this group of patients.

DATA AVAILABILITY
Additional data are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS
JP: project development, manuscript writing, and data collection. JW: manuscript editing and data management.

COMPETING INTERESTS
The authors declare no competing interests.

ADDITIONAL INFORMATION
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