

## Research Article

# Neovaginal Healing after Penile Inversion Vaginoplasty with Full-Thickness Skin Grafting in Transwomen: A Descriptive Study

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**INTRODUCTION**

In 1956, Dr. Georges Burou independently developed the anteriorly pedicled penile skin inversion vaginoplasty, a technique that would later become the gold standard for skin-lined vaginoplasty [1]. The procedure involves creating a space between the rectum and the prostate, followed by lining of that space [1]. Traditionally, the lining is achieved by using the remaining penile skin, but in cases with limited skin due to factors like pubertal hormone therapy, suppression, circumcision, or obesity, full thickness skin grafts can be taken from the residual scrotum or abdomen [2-4]. Alternative techniques, such as peritoneal flaps, not only present increased complexity and higher costs compared to established techniques, they are also less extensively supported by evidence [5,6]. Given that surgery has shown to improve the quality of life and sexual health for transgender patients [7,8], it is crucial to continually evaluate common techniques to ensure a standardized approach that minimizes complications and maximizes patient satisfaction. The objective of this study was to assess the wound healing after gender affirming surgery, specifically focusing on the neovaginal cavity and it's lining with full thickness skin grafts (FTGs) from the scrotum.

**MATERIALS AND METHODS**

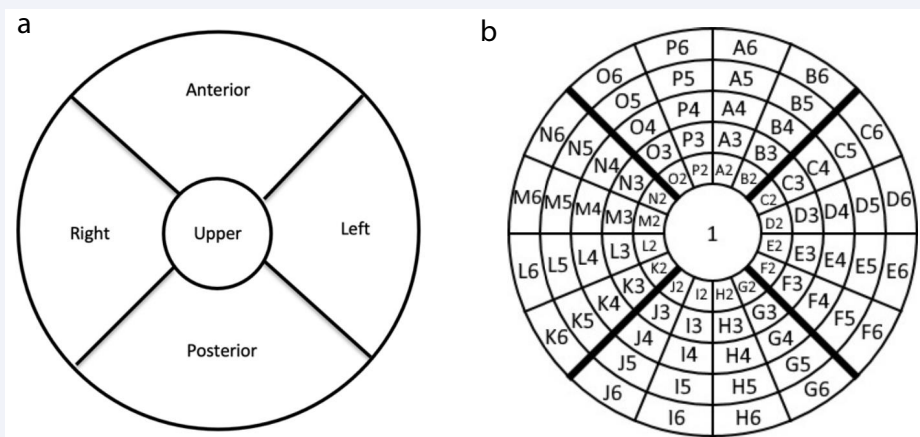
This prospective study, conducted at the University Hospital of Gent in Belgium from October 2020 to February 2023, aimed to assess wound healing after gender affirmation surgery in transwomen who underwent penile inversion vaginoplasty with the addition of scrotal FTGs. The study received ethical approval, and participants provided informed consent voluntarily. All data was encrypted for privacy.

The cavity created between the rectum and bladder in the Denonvilliers space always measured 13cm as an epithesis of

this size is used to create the last part of the cavity, up until the peritoneal fold or until it can be fully inserted. Post-surgery, the epithesis is secured with a compressive bandage to prevent the cavity from closing and providing compression within the lined cavity. Patients are encouraged to ambulate on the third day, and on the fifth day after surgery, the bandage, epithesis, and transurethral catheter are removed. Patients received a dilation schedule and were instructed to rinse the neovagina with gynecological iso-Betadine solution. Follow-up visits were scheduled at three weeks, three months, six months and one year after surgery. During these visits, physical examinations were conducted, and patients completed three questionnaires to evaluate self-image, vaginal function, and pain experience. The neovagina was divided into five compartments (top, anterior, posterior, left and right) using a specially designed dartboard figure. Each compartment was further subdivided into smaller 'complication units' (CU) and was uniquely numbered (Figure 1). If a complication, such as penile skin alterations, wound dehiscence, hematoma, necrosis or tissue granulation, occurred, it was noted and the corresponding unit was colored.

Thereafter, the evaluator provided an overall score for the healing process and measured the depth of the neovagina. Statistical analysis was performed to assess differences between the compartments using the one-way analysis of variance (ANOVA), with a significance level (p value) below 0,01. Afterwards, the Tukey's Honestly Significant Difference (HSD) test was performed for specific region comparisons. This test was chosen due to the multiple pairwise comparisons and the higher risk of Type I errors (false positives).

Next, patients were asked to complete three questionnaires. The first is the Female Genital Self-Image Scale (FGSIS), developed by Herbenick et al., which assesses female genital self-image through seven question [9]. It is originally developed for cisgender



**Figure 1** a). The vaginal cavity divided into an upper, anterior, posterior, left and right compartement. b). Dartboard method dividing the vaginal cavity into smaller complication units, enabling a more precise registration of the complications.

women but it has been used in studies in transwomen [10]. The maximum score on a 4-point scale is 28, with higher scores indicating a more positive self-image. The second questionnaire is the Female Sexual Function Index (FSFI), developed by Rosen et al. in 2000 [11]. It addresses potential female sexual dysfunction and consists of questions across six categories: sexual desire, arousal, lubrication, orgasm, satisfaction and pain. Each category has a maximum of 6, resulting in an overall maximum score of 36. For ciswomen, a cutoff score of 26,55 is indicative of sexual dysfunction [12]. Similar to the FGSIS, this questionnaire was initially designed for cisgender women but can also be used for transwomen. The third questionnaire is the Amsterdam Hyperactivity Pelvic Floor Scale – Women (AHPFS-W). It consists of 30 questions assessing pelvic floor hypertonicity and various symptoms related to pain. Higher scores indicate a greater presence of pelvic problems and an overall score exceeding 10.99 indicates pelvic floor dysfunction [13,14].

**RESULTS**

A total of twenty-two transwomen were initially included and evaluated at the first three follow-up moments. However, at the one-year follow-up, only nineteen patients were assessed as three patients did not show up for the evaluation.

The changes in neovaginal depth are shown in Table 1. Despite all patients initially receiving a vaginal depth of 13cm at the time of surgery, a consistent decrease in depth was observed during subsequent follow-up visits. The greatest depth was observed at the three-week follow-up, with each subsequent visit showing further decline. Ultimately, the overall depth measured was 8,2cm at the one-year follow-up. Patient satisfaction scores remained relatively stable over time, with a slight increase observed from week 12 to week 52. The scores ranged from 8,5 (±1,3) at week three, 8,0 (±1,1) at week twelve to 8,4 (±1,6) and 8,7(±1,7) at week 26 and week 52, respectively. Patients consistently rated

**Table 1:** Evolution in neovaginal depth

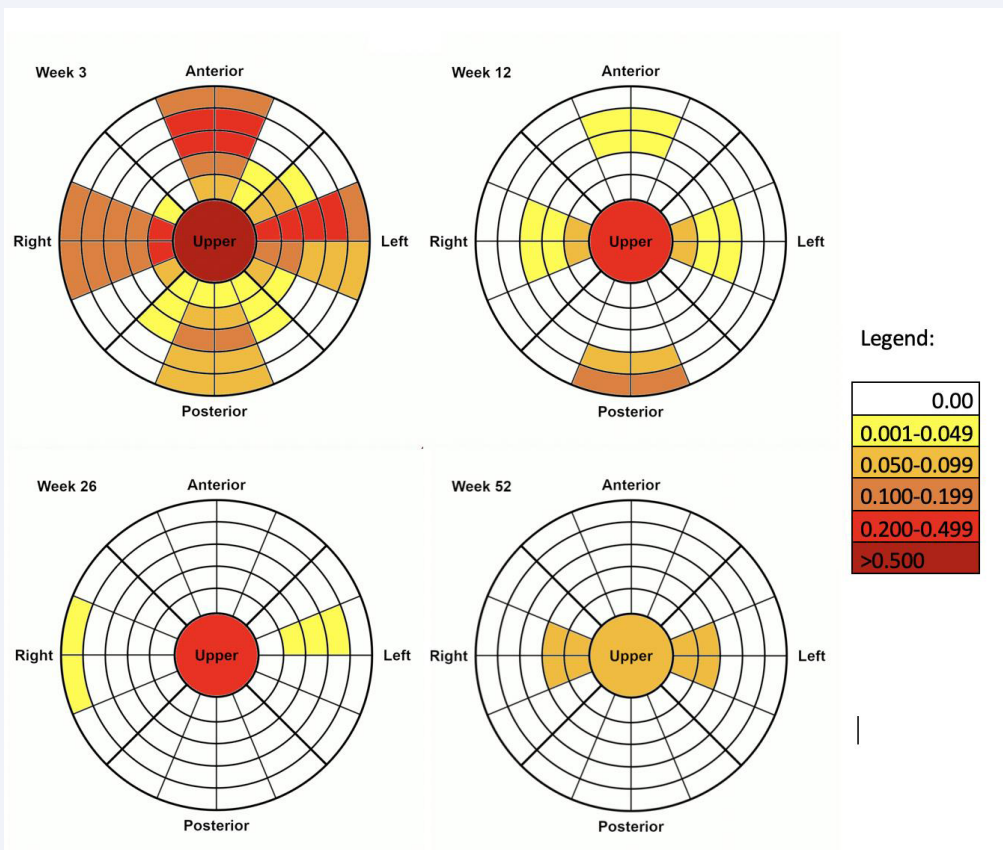
Depth at follow-up (cm) (m ± SD)		
week 3	11,6	(±1.4)
week 12	9,9	(±1.7)
week 26	8,8	(±2.5)
week 52	8,2	(±2.5)

their genitals with relatively high satisfaction scores throughout the entire follow-up period. Similarly, the overall expert score showed a gradual increase from week 3 to week 26, reaching its peak at 9.2 (±0.7) at week 26, and then slightly decreased to 9.0 (±1.0) at week 52. The expert ratings also remained consistently high throughout the entire follow-up period, closely aligning with the patients’ scores.

Using a speculum, a comprehensive examination of the neovaginal cavity was conducted, and the overall graft take was assessed; results are depicted in Table 2. The lowest percentage of graft take was observed at week 3, while the highest percentage was recorded at 12 weeks. Follow-up at 26 and 52 weeks showed slightly lower graft take than at week 12, but remained high, with both follow-up periods yielding a similar outcome of around 90%. Importantly, no grafts were lost during the follow-up period.

Subsequently, each region of the neovagina was further evaluated using the dartboard figure. The complication unit (CU)-value was utilized as an indicator of the extensiveness of the complication(s); a higher CU-value signified either a widespread complication or multiple smaller locations with similar complications.

Figure 2 illustrates a graphical representation of the complication units and their corresponding frequencies at each follow-up moment. As anticipated, the initial follow-up exhibited the highest number of complications and the lowest wound healing percentages. Specifically, the top compartment had the lowest wound healing rate, with a mean of 89,32%. Additionally,



**Figure 2** The dartboard figure with complication units for every follow-up moment. The deeper red the unit becomes the more affected it was during this evaluation.

**Table 2:** Evolution of total graft take

Follow-up week		
week 3	63,64%	(n=22)
week 12	100,00%	(n=22)
week 26	90,91%	(n=22)
week 52	89,47%	(n=19)

this area had the highest percentage of participants experiencing complications, notably tissue granulation formation (45,45%). In contrast, the other compartments showed relatively similar mean wound healing percentages, ranging from 93,64% and 95,45%. Analyzing the specific complications in each compartment, the posterior compartment had the fewest complications during the first follow-up with only three out of 22 patients affected, two of which involved the formation of tissue granulation. The right, left and anterior compartment had slightly higher numbers of complications, but their rates were quite comparable, with 8, 8 and 7 out of 22 patients, respectively, experiencing at least one type of complication. Tissue granulation also predominated in these regions.

At week twelve, there was a significant decrease in the mean healing percentage of the top compartment, dropping to 82,50%, while the other compartments reached almost complete wound

healing. Subsequently, at the third check-up, the top compartment exhibited a new high in healing percentage (91,25%), while the other compartments approached nearly complete wound healing. At the final follow-up, the mean wound healing percentage of the top compartment reached 98,89%. However, complications persisted at this one-year follow-up, with adjacent complications units appearing in the left and right compartment. Throughout all follow-up moments, granulation tissue was the most commonly observed complication and also the most extensive. Additionally, the first follow-up also showed wound dehiscence and necrosis, but these complications resolved spontaneously and were not present anymore in the subsequent check-ups.

The statistical analysis investigated the differences between the compartments through a one-way analysis of variance (ANOVA) test at each follow-up moment. The results indicated a significant p-value

( $p < 0,01$ ) at three weeks, three months, and 6months. However, at the one-year follow-up, the p-value was 0,53, indicating no significant difference between the groups. Subsequently, the post-hoc test, Tukey's Honestly Significant Difference (HSD), was performed to evaluate the differences between the compartments. Following the pairwise comparison

of each compartment at every follow-up moment, we found that the top compartment exhibited a significant difference in complications compared to the others ( $p < 0,01$ ), except for the last check-up at one year. During this final follow-up, no significant difference was observed between any compartment. On the other hand, the pairwise comparison of the other four quadrants (B,C,D and E) did not reveal any significant differences at any follow-up time Table 3.

### The Female Sexual Function Index

The results depicted in Table 4 demonstrate the progression of mean FSFI scores along with their standard deviations over the course of one year. It is crucial to acknowledge that the sample size decreased from 22 patients at week 3 to 18 patients at week 52, which might have an impact on the results. Overall, the total FSFI scores showed improvement over time, rising from 7,53 at week three to 20,46 at week 52. However, it is noteworthy that the scores did not reach the cut-off value of 26,55 which is indicative of sexual dysfunction. When examining each domain of FSFI, we observed improvement over time in all aspects. The most significant improvement was seen in the arousal domain, with scores increasing from 0,93 at week 3 to 4,00 at week 52. Scores for lubrication, orgasm, satisfaction, and pain also improved over time, although to a lesser extent.

### The Female Genital Self-Image Scale

Table 5 shows the evolution over one year in the mean FGSIS score for our group of patients. The total score increased steadily over time from 20,56 ( $\pm 3,32$ ) at week three to 23,44 ( $\pm 3,61$ )

at week 52. The score for each question also increased over time, indicating that patients were feeling more positive about their genitals, were more satisfied with the appearance of their genitals, and felt more comfortable letting a sexual partner or healthcare professional examine them.

### Amsterdam Hyperactivity Pelvic Floor Scale – Women

The Amsterdam Hyperactive Pelvic Floor Scale for Women (AHPFS-W) showed a consistent improvement in symptoms over the course of one year, with a decrease in the total score from 12,85 ( $\pm 5,10$ ) at week 3 to 9,30 ( $\pm 2,93$ ) at week 52. The most significant improvement was observed in the category of provoked vulvodynia, with a decrease in score from 4,13 ( $\pm 0,90$ ) at week 3 to 2,13 ( $\pm 0,93$ ) at week 52.

## DISCUSSION

The penile inversion vaginoplasty is widely considered the gold standard, but controversy surrounds the use of additional

Table 4: Evolution over 1 year in mean FSFI score

	week 3	week 12	week 26	week 52
Patient group	22	22	21	18
Total score (m $\pm$ SD)	7,53 ( $\pm 4.38$ )	16,25 ( $\pm 9.01$ )	17,62 ( $\pm 9.04$ )	20,46 ( $\pm 8.17$ )
Score per domain (m $\pm$ SD)				
desire	2,43 ( $\pm 1.10$ )	3,05 ( $\pm 1.16$ )	3,17 ( $\pm 1.04$ )	3,47 ( $\pm 1.10$ )
arousal	0,93 ( $\pm 1.42$ )	3,12 ( $\pm 1.96$ )	3,34 ( $\pm 1.98$ )	4,00 ( $\pm 1.72$ )
lubrication	0,40 ( $\pm 1.21$ )	2,50 ( $\pm 2.37$ )	2,77 ( $\pm 2.15$ )	3,68 ( $\pm 1.92$ )
orgasm	0,27 ( $\pm 0.80$ )	2,29 ( $\pm 2.31$ )	2,72 ( $\pm 2.22$ )	3,71 ( $\pm 2.09$ )
satisfaction	2,74 ( $\pm 1.48$ )	3,38 ( $\pm 2.06$ )	3,47 ( $\pm 1.80$ )	3,16 ( $\pm 1.59$ )
pain	0,77 ( $\pm 1.84$ )	1,91 ( $\pm 2.46$ )	2,13 ( $\pm 2.28$ )	2,44 ( $\pm 2.38$ )

Table 3: The Tukey HSD test results for comparison of every quadrant at every follow-up moment. (Top quadrant is A, anterior quadrant is B, posterior quadrant is C, left quadrant is D and right quadrant is E).

Treatment pairs	6 MONTHS			One year		
	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD significance	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD significance
A vs B	5,535	0,001	** p<0.01	2,152	0,545	insignificant
A vs C	5,535	0,001	** p<0.01	2,152	0,545	insignificant
A vs D	5,369	0,002	** p<0.01	1,721	0,715	insignificant
A vs E	5,424	0,002	** p<0.01	1,721	0,715	insignificant
B vs C	0	0,9	insignificant	0	0,9	insignificant
B vs D	0,166	0,9	insignificant	0,43	0,9	insignificant
B vs E	0,111	0,9	insignificant	0,43	0,9	insignificant
C vs D	0,166	0,9	insignificant	0,43	0,9	insignificant
C vs E	0,111	0,9	insignificant	0,43	0,9	insignificant
D vs E	0,055	0,9	insignificant	0	0,9	insignificant
Treatment pairs	3 WEEKS			3 MONTHS		
	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD significance	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD significance
A vs B	6,871	0,001	** p<0.01	5,813	0,001	** p<0.01
A vs C	7,426	0,001	** p<0.01	5,412	0,002	** p<0.01
A vs D	6,801	0,001	** p<0.01	5,613	0,001	** p<0.01
A vs E	6,697	0,001	** p<0.01	5,613	0,001	** p<0.01
B vs C	0,555	0,9	insignificant	0,401	0,9	insignificant
B vs D	0,069	0,9	insignificant	0,201	0,9	insignificant
B vs E	0,174	0,9	insignificant	0,201	0,9	insignificant
C vs D	0,625	0,9	insignificant	0,201	0,9	insignificant
C vs E	0,729	0,9	insignificant	0,201	0,9	insignificant
D vs E	0,104	0,9	insignificant	0	0,9	insignificant

**Table 5:** Evolution over 1 year in mean FGSIS score

Patient group	week 3		week 12		week 26		week 52	
	20	(±3.32)	22	(±3.36)	20	(±3.33)	17	(±3.61)
Total score (m ± SD)	20,56	(±3.32)	22,42	(±3.36)	22,51	(±3.33)	23,44	(±3.61)
Score per question (m ± SD)								
I feel positively about my genitals	3,25	(±0.64)	3,42	(±0.55)	3,33	(±0.61)	3,56	(±0.63)
I am satisfied with the appearance of my genitals	3,06	(±0.71)	3,30	(±0.64)	3,40	(±0.57)	3,49	(±0.58)
I would feel comfortable letting a sexual partner look at my genitals	2,92	(±0.95)	3,20	(±0.68)	3,43	(±0.71)	3,41	(±0.68)
I think my genitals smell fine	2,29	(±0.79)	2,73	(±0.56)	2,83	(±0.60)	2,96	(±0.60)
I think my genitals work the way they are supposed to work	2,46	(±0.80)	2,97	(±0.69)	2,66	(±0.82)	2,94	(±0.91)
I feel comfortable letting a healthcare professional examine my genitals	3,35	(±0.59)	3,40	(±0.79)	3,43	(±0.80)	3,56	(±0.83)
I am not embarrassed about my genitals	3,23	(±0.70)	3,41	(±0.68)	3,45	(±0.58)	3,53	(±0.60)

**Table 6:** Evolution over 1 year in mean AHPFS-W score

Patient group	week 3		week 12		week 26		week 52	
	21	(±5.10)	22	(±2.97)	20	(±3.35)	17	(±2.93)
Total score (m ± SD)	12,85	(±5.10)	10,66	(±2.97)	9,91	(±3.35)	9,30	(±2.93)
Score per category (m ± SD)								
provoked vulvodynia	4,13	(±0.90)	3,10	(±1.19)	2,38	(±1.11)	2,13	(±0.93)
irritable bowel symptoms	1,99	(±1.09)	1,74	(±0.81)	1,55	(±0.83)	1,59	(±0.72)
lower urinary tract symptoms	1,88	(±1.10)	1,61	(±0.63)	1,61	(±0.73)	1,40	(±0.45)
urinary tract infections	1,43	(±0.88)	1,25	(±0.59)	1,18	(±0.34)	1,24	(±0.53)
rectal problems	1,69	(±1.16)	1,43	(±0.54)	1,42	(±0.78)	1,33	(±0.54)
stress	1,73	(±1.01)	1,52	(±0.53)	1,78	(±0.79)	1,62	(±0.78)

full-thickness skin grafts. Critics argue that FTGs are insensate and more prone to contraction, which may impact functionality. However, advocates claim that they lead to a more aesthetically pleasing result, as more penile skin is available, resulting in a more natural appearing vulva [15]. In 2017, Buncamper et al., compared satisfaction with genital aesthetic outcome, sexual function and changes in neovaginal depth between transwomen who underwent penile inversion vaginoplasty with or without additional use of a full-thickness skin graft. They refute the latter statements and concluded no more contraction or associated loss of vaginal depth in the compared groups, as well as no superior aesthetic result in either groups [15]. At our center and many others, additional FTGs are used in 90% of vaginoplasties. We believe this to be the first study to investigate intravaginal graft take and its subsequent healing process. Additionally, we assess this healing pattern and its connection with sexual function using three distinct questionnaires. The success of graft take depends on establishing arterial connections and proper venous drainage with the graft bed. Regenerative processes occur in three phases after graft placement: the inflammatory phase, plasmatic imbibition and the inosculation phase [16]. These phases of graft take can vary depending on the size and location of the graft and wound bed, as well as the health of the patient. Understanding this makes it possible for physicians to monitor the healing process and take appropriate measures, ensuring the best possible outcome for the patient. Patients at our center receive an epithesis after surgery to secure the skin grafts, provide adequate pressure, reduce swelling and minimize hematoma. Early monitoring is not feasible as the epithesis is only removed on day five. Visualization on that day is also not performed as it's often too painful and inserting a speculum could harm the skin

graft. Visual evaluation of the cavity and graft take is performed at the first postoperative checkup, three weeks after surgery. Vaginal depth decreased from 13cm during surgery to a mean of 8,2cm (± 2,5cm) at one-year follow-up. Other data on vaginal depth is scarce but long term follow up ranged from 10 to 14 cm, resulting in a rather short vaginal length in our study [15,17-20]. One possible explanation for the immediate reduction in depth may be that patients are initially measured under anesthesia, in a state of complete relaxation, while follow-up measurements are not, resulting in a more tensed patient. Patient satisfaction scores were high, with both experts and patients rating the results as excellent.

Looking at the overall graft take, week three showed the lowest score at 63,64%. However, by week twelve, the total take was 100%, indicating full success in all patients. The relapse we see in the following contacts (to around 90%) could be attributed to the ongoing remodeling phase and the patients' return to their regular activities around three months, such as work, hobbies, and sports. Due to increased activity, more friction might be experienced, resulting in small wounds and hypergranulation. Additionally, the time required to maintain the rinsing and dilation schedule becomes more limited, which may also contribute to this decline. Although full thickness grafts result in less secondary contraction, it is important to note that postponing the dilation sessions, or not doing them at all, will result in more contraction of the neovaginal lining and the cavity itself. Introducing a dilator in a contracted cavity will result in crackling of the skin, thinning of the dermis and can lead to additional issues such as fissures and open wounds. If wounds appear, patients are more reluctant to dilate due to pain and a vicious circle will ensue resulting in a

declined vaginal depth. Adhering to the dilation schedule is vital, as postponing or skipping sessions can lead to more contraction and potential complications. Dilating is vital to maintaining depth, not doing so can lead to more contractions.

After evaluation of the wound healing results, we believe the top compartment remains a point of concern due to its anatomical differences compared to the other compartments of the neovaginal cavity. The neovagina is shaped like a cone while the epithesis is a flattened cylinder, giving the needed compression in the other compartments yet not enough at the top. There will be a dead space created were the skin grafts are not compressed between the epithesis and the surrounding tissues. The dead space at the top will fill with hematoma/exudate, creating a layer between the skin graft and the tissues at the top. This layer will prevent the skin graft from adhering to the donor bed, resulting in lower take, more tissue granulation and more contraction. Furthermore, the top is the narrowest part of the vagina while experiencing the most pressure from surrounding tissues and organs. Less graft take and more compression leads to more pain while dilating. Patients might start using smaller, less deep devices or lower the intensity of dilating, resulting in more primary closure and therefore a shorter cavity.

The FSFI showed improvements over time, in parallel with improvements in wound healing of the vaginal cavity. Overall, we can state that the results are rather low, yet it is important to note that there was no data available on the preoperative sexual function of the included patients, making it impossible to evaluate the general effectiveness of neovaginoplasty surgery and improving sexual dysfunction. Furthermore, it is essential to note that sexual function is complex and multifactorial, and surgery doesn't guarantee improved sexual function. The same evolution was seen in the FGSIS scale, where the total score increased steadily over time even though the external genitalia were often healed within the first weeks postoperatively. In our view, this suggests that not only physical healing plays a crucial role, psychological factors like acceptance and increased confidence also contribute to the higher FGSIS scores even long after the genitalia have fully healed. It's important to consider that this scale solely assesses the external genitalia, so we cannot make any conclusions regarding the wound healing of the cavity. The AHPFS-W demonstrated steady improvements, particularly in the category of provoked vulvodynia. Improved internal cavity healing and reduced wound complications may contribute to these results.

## CONCLUSION

We believe this to be the first study to investigate the intravaginal graft take and its subsequent healing progression. The evaluation revealed a decrease in vaginal depth from 13 cm preoperatively to a mean of 8,2cm ( $\pm 2,5$ cm) at the one-year follow-up. Overall, the assessment of the vaginal cavity indicated no graft loss, with a take of 89,47% at the one-year evaluation. However, assessing the different compartments of the vagina, we observed a significant difference at the top part of the vagina, with higher complication rates over an extended period. We

believe these wound healing challenges are due to the anatomical shape of the neovagina together with the highest pressure from surrounding tissues at this point, over time resulting in a shortening of the vaginal cavity.

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