

Neurosensory Re-education following Gender-affirming Phalloplasty: A Novel Treatment Protocol

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Background: Sensory nerve transfers are performed as part of phalloplasty surgery. Despite this, sensory re-education to rehabilitate these nerve transfers has not been employed. Additionally, little attention has been paid to the role of the central nervous system in experienced sensation following phalloplasty. The purpose of this article is to report on the development of a targeted rehabilitation protocol to integrate and optimize peripheral and central contributions to sensation following phalloplasty.

Methods: This neurosensory re-education protocol was constructed over four phases by a multi-disciplinary team (phalloplasty/peripheral nerve surgeon, reconstructive urologist, pelvic floor physiotherapists, nerve therapist, sex therapist, sexual medicine physician) and individuals with lived phalloplasty experience. The final protocol was approved by all team members and is supported here by qualitative narratives from people with lived phalloplasty experience.

Results: The protocol is built to follow each stage of phalloplasty surgery. In each stage, exercises are grouped into three core themes: visualization, tactile stimulation, and sexual/erogenous stimulation. Visualization exercises progress from static to dynamic. Tactile exercises start at simple touch and progress toward targeted sensory stimulation. Sexual stimulation focuses on developing erogenous sensation in the phallus that is separate from erogenous sensation in the natal clitoral tissue. By recommendation of individuals with phalloplasty, the protocol is now integrated into our center's phalloplasty care pathway for all individuals undergoing phalloplasty surgery.

Conclusion: We introduce a novel protocol targeting peripheral and central contributions to sensation to provide a tool to help optimize experienced sensation for transmasculine individuals undergoing phalloplasty. (*Plast Reconstr Surg Glob Open* 2022;10:e4616; doi: [10.1097/GOX.0000000000004616](https://doi.org/10.1097/GOX.0000000000004616); Published online 24 October 2022.)

INTRODUCTION

Gender-affirming phalloplasty improves the quality of life of transmasculine individuals with gender dysphoria due to the absence of a phallus of sufficient dimensions and function.¹ The degree of tactile and erogenous sensation present in the phallus has been shown to be an important factor that will directly affect sexual well-being following surgery.^{1,2} However, much of the early

experience in the field has focused on urologic outcomes and the ability to achieve penetration with the aid of an erectile device.^{3,4} Comparably little attention has been paid to sensory outcomes.^{5,6} Current strategies reported in the literature to optimize sensation following phalloplasty address mainly the peripheral components of sensation, focusing on the peripheral nerve coaptations that are performed during surgery.⁷

In order to best optimize outcomes, a comprehensive and systematic approach that targets all components contributing to the sensory experience following phalloplasty is ideal.⁸ There are several variables contributing to sensation following phalloplasty that can likely be optimized: choice of donor and recipient nerves for coaptation, nerve regeneration, and the role of the central nervous system.⁸ Significant and ongoing work has been done

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addressing the choice of donor and recipient nerves used in phalloplasty and targeted strategies to enhance nerve regeneration.^{9–13} Notably these strategies focus mainly on the peripheral contributions to sensation. The role of the central nervous system in the sensation experienced following phalloplasty has yet to be fully understood and may have the potential to assist in further enhancing our current sensory outcomes.

A recent study assessed sensory experience following phalloplasty, demonstrating a discordance between objective and subjectively measured sensation.² Objective sensation is what can be measured or clinically detected with traditional sensory testing, whereas subjective sensation is what a person experiences or reports. Objective sensation is more binary in that it is either present or absent based on peripheral sensory re-innervation and detected sensation by established means such as semmes-weinstein monofilament testing or two-point discrimination. Despite relatively poor measurements of objective sensation, the majority of patients reported to have subjective tactile and erogenous sensation present in the phallus. These findings suggest that the overall sensory experience following phalloplasty has both an objective and subjective component involved. The subjective contribution to sensation is less well defined. It is likely that there is a central mechanism contributing to the subjective sensation experienced following phalloplasty beyond what is objectively measured through the peripheral nerve coaptations. This subjective component of sensation may reflect cortical integration and centrally-mediated sensation of the phallus. The contribution of a central mechanism to the sensation experienced following phalloplasty is substantiated by reports of transmasculine individuals that experience a “phantom penis” [the presence of tactile and erogenous sensation in the distribution of a penis that is not (yet) physically present] prior to any genital gender-affirming surgery. This suggests a strong and innate component of gender-specific body image that may be cortically represented even prior to undergoing surgical intervention.¹⁴

Additional considerations beyond this preexisting central mechanism may be also important. Notably, the peripheral nerve coaptations performed in phalloplasty are best thought of as sensory nerve transfers. Outcomes following nerve transfers in other domains of peripheral nerve surgery have been demonstrated to be optimized by targeting central cortical re-mapping through sensory re-education: a foundational and fundamental component of rehabilitation following nerve repairs.^{15–17} These same lessons may be applicable in phalloplasty to yield new strategies to further optimize sensory outcomes following this procedure.

Anecdotally, in our experience with gender-affirming phalloplasty, some patients continue to localize sensory stimuli of the penis to the territory of the donor nerve, whereas others more easily integrate and map the phallus centrally and experience sensation as phallic-only. These observations, patient demands/requests, and the current literature on cortical integration following nerve transfers in addition to the possibility of a central mechanism prompted the development of a phalloplasty-specific sensory rehabilitation protocol. The purpose of this article is

Takeaways

Question: It is under-recognized that the nerve coaptations performed in phalloplasty are sensory nerve transfers. Current evidence supports sensory rehabilitation following nerve transfers in addition to the role of centrally mediated phallic sensation.

Findings: We present a neurosensory re-education protocol constructed by a multi-disciplinary team, including individuals with lived phalloplasty experience.

Meaning: Current evidence suggests a role for sensory re-education and central rehabilitation to support sensory recovery following phalloplasty. We present this protocol to provide a framework to support individuals and care teams in sensory and sexual recovery following phalloplasty surgery.

to report on the development of a targeted rehabilitation protocol to help integrate and optimize both peripheral and central contributions and support individuals in their sensation experienced following gender-affirming phalloplasty. In this article, we discuss the formation of and implementation of this protocol, which we refer to as neurosensory re-education.

METHODS

This study was approved by our institutional review board. The neurosensory re-education protocol was constructed over four phases. In the first phase, the initial draft of the protocol was constructed by the senior author and a peripheral nerve therapist, based on a typical framework used for sensory re-education following peripheral nerve repair.^{16,17} In phase 2, a multi-disciplinary team was identified and recruited to incorporate expert opinions and insights across different relevant scopes of practice. This team included a phalloplasty and peripheral nerve surgeon, a peripheral nerve therapist, two pelvic floor physiotherapists, a sexual therapist, a urologist specializing in sexual medicine, and a reconstructive urologist. This protocol was sequentially distributed to each specialist and modified according to their input and expert opinions, yielding version 2 of the protocol. Phase 3 involved the recruitment of individuals with lived phalloplasty experience. In Phase 3, the protocol was provided to four transmasculine individuals while they underwent their own phalloplasty surgery, ranging in age from 29 to 44 years. This protocol was used and modified in real time. Qualitative feedback was gathered in the form of a 1-hour interview with each of the individuals after their phalloplasty surgery was complete (all stages). All feedback from this group was incorporated into the fourth and final version of the protocol. The final protocol was then distributed to all multi-disciplinary and lived-experience stakeholders for ultimate approval. Following final approval, the protocol has since been made available to all individuals undergoing gender-affirming phalloplasty at our institution. The protocol has been integrated into our phalloplasty program’s overall care pathway in the

following ways: it is mentioned in a standard intake presentation at all phalloplasty consults and is mentioned and included in our program’s phalloplasty information booklet that is provided to all patients (physical and pdf copies). The protocol has also been made available through our institution’s transgender health program website and provided to online patient support groups.

Different phalloplasty centers vary regarding the number and combination of nerve coaptations performed in phalloplasty. At our center, we employ a comprehensive approach to phalloplasty sensation, which in radial forearm phalloplasty, includes coapting the dorsal nerve of the clitoris to the lateral antebrachial cutaneous nerve and the ilioinguinal nerve to the posterior antebrachial cutaneous nerve based on size match, territory of flap innervations, and donor:recipient axon ratios in addition to the use of brief intraoperative electrical nerve stimulation and targeted nerve therapy in the form of the protocol to enhance nerve and sensory outcomes.

RESULTS

The neurosensory re-education protocol follows each stage of phalloplasty surgery as performed at our institution. We utilize the “Big Ben” staging method for phalloplasty with urethral lengthening: creating the phallus and phallic urethra at stage 1, then performing vaginectomy, urethral lengthening, clitoroplasty (burial), scrotoplasty, and glansplasty at stage 2. Insertion of an erectile device takes place at stage 3 (Fig. 1).¹⁸ The multi-disciplinary team identified three key areas or “themes,” around which the protocol was ultimately structured: visualization, tactile stimulation, and sexual/erogenous stimulation. The final protocol can be viewed in full as Supplemental Digital Content 1. (See figure, Supplemental Digital Content 1, which displays the complete neurosensory re-education protocol. <http://links.lww.com/PRSGO/C220>.)

In each stage of the protocol, exercises are grouped according to the three core themes discussed above: visualization, tactile stimulation, and sexual/erogenous stimulation. Visualization exercises progress from static to dynamic. Static exercises include visualizing the penis in pants, without clothing on etc., while dynamic visualization exercises focus on visualizing the penis during specific activities. These may include standing urination or sexual penetration, depending on patient goals. When performing visualization exercises, patients are asked to focus on what their phalloplasty will look like, not a natal penis. Tactile exercises progress from simple touch and progress toward targeted sensory stimulation exercises. This includes stimulation with light touch, deep pressure, different soft and rough textures, vibrations, and temperatures. As sensation enters the phallus from the regenerating nerves, patients are asked to increase the frequency of tactile and sensory stimulation exercises. Sexual stimulation or “sexual mirroring” focuses on developing erogenous sensation in the phallus that is separate from the erogenous sensation in the natal clitoral tissue. This phase begins with concomitant stimulation of the phallus and the clitoral tissue together. Over time the aim is to rely more and more on the erogenous sensation from phallic stimulation in order to achieve orgasm, while relying less on clitoral stimulation. The purpose of this phase is to maximize erogenous sensation in the penis and integrate the erogenous zones of the genitals.

Direct input from individuals undergoing phalloplasty provided several key insights and considerations. Overall the protocol was felt to be a valuable and helpful resource while recovering from phalloplasty. Common themes expressed were dysphoria in the early postoperative course, when standing urination and sexual penetration were not yet possible. It was felt that the protocol provided a way to connect with and still explore the phallus while working toward the next stages of surgery. It was

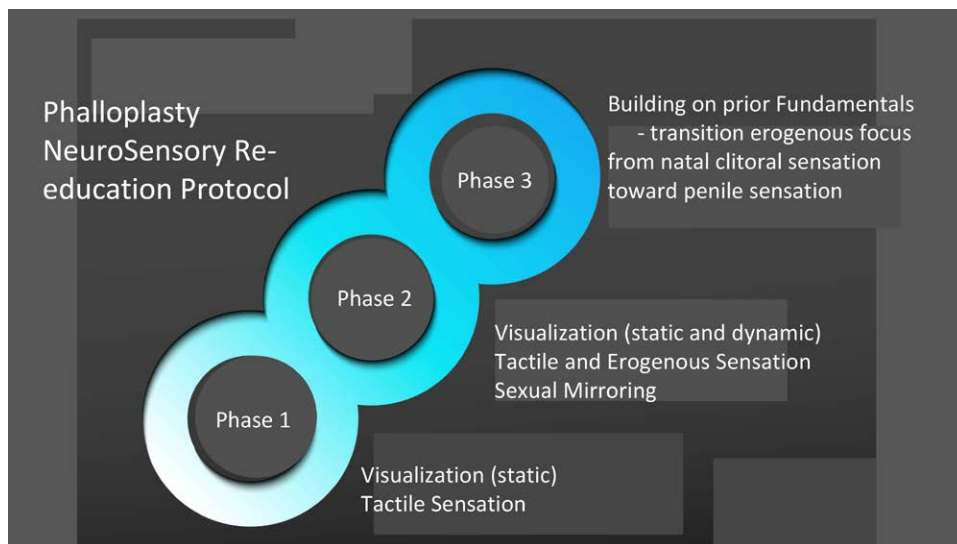


Fig. 1. Summary of the phalloplasty neurosensory re-education protocol by phase. Note that exercises in each phase are grouped based on the core themes of visualization, tactile stimulation, and erogenous/sexual mirroring.

Table 1. Expressed Themes and the Qualitative Experience of Transmasculine Individuals Using the Neurosensory Re-education Protocol during Phalloplasty**Theme: Clinical Support and Guidance**

“Before the creation of this protocol there hasn’t been any trans-specific academic literature out there for post-op phalloplasty patients to refer to when trying to relearn how to stimulate oneself erogenous. While I’m grateful to have community members to reach out to with sensation-related post-op questions, I’ve found it extremely useful to have a universal protocol to use as a template for my individual nerve regeneration goals.”

Theme: Addressing Ongoing Dysphoria and Connecting with the Penis

“While phalloplasty provides so much gender euphoria for patients, being in-between stages can produce feelings of mind-body disconnect and dysphoria. For example, after stage one I finally had a phallus, a reality I had dreamed of for years. However, I was still unable to micturate from it, nor become erect for penetrative sex- my two main goals with having phalloplasty. Not being able to accommodate these two actions continued to produce dysphoria for me. The nerve protocol provided me with a way to connect with, and explore my new member while waiting for additional affirming phalloplasty surgeries. Having a plan and assignments for nerve regeneration kept me occupied and excited about new sensation in my phallus, instead of just focusing on what I still lacked. I’m grateful to have it as a resource along my bottom surgery journey.”

“Although sensation wasn’t my priority with phalloplasty, I worked on a lot of these things between stages simply trying to connect with my new penis prior to having any functional ability. This protocol is a great resource to build a foundation to cultivate integration of your body and the new sensations you experience through the journey.”

Theme: Sensory Engagement and Participation

“Gaining sensation after phalloplasty has always been a top goal of mine, but because sensation varies so much from person to person, I didn’t know what things I could do to help optimize my nerve regrowth. This protocol has helped give me peace of mind that I’m doing as much as I can on my end to rehabilitate my nerves and strengthen the mind-body connection.”

also felt that the protocol helped an individual stay excited about new sensation entering the phallus and encouraged additional interaction with the phallus, in addition to aiding integration of the phallus and evolving sensation into sense of self. For individuals highly focused on sensation, the protocol provided peace of mind that everything was being done to optimize nerve rehabilitation and strengthen the mind-body connection. Quotes provided by transmasculine individuals that summarize their experience using the neurosensory re-education protocol during their phalloplasty course are summarized in [Table 1](#).

DISCUSSION

Many transmasculine individuals report erotic sensation as one of their highest priorities following gender-affirming phalloplasty, in some cases, placing greater importance on genital sensation than standing urination.¹⁹ Although demonstrated to improve many aspects of sexual function, phallic sensation continues to be a persistent issue for some patients with recent studies reporting sensory outcomes that did not match patient expectations.^{1,2} Notably, sensation is not expected to occur in the phallus for several months following surgery due to the time needed for nerve regeneration to occur. This clinical scenario means that sensation is often overlooked and minimally discussed in the early postoperative course. As patients progress months and years post phalloplasty and achieve their urologic and aesthetic goals, it is not uncommon for sensation to become an area of increased focus or concern. Suboptimal sensation can have a significant impact on sexual function, emotional connection to, and integration of the penis into sense of self. If realized sensation does not meet expectation, this can become the dominant concern or a source of persistent dissatisfaction and dysphoria following phalloplasty.

It is clear that sensory outcomes are improved when direct nerve coaptation is performed; however, little granularity in current data is available beyond the presence

or absence of sensation and ability to achieve orgasm, making quantification of sensory outcomes difficult.^{6,7} A recent study reported results that often did not match patient expectations.² Other studies have demonstrated a range of sensory outcomes, with some patients reporting increased erogenous sensation and orgasmic intensity with hypersensitivity, and others reporting decreases in these same outcome measures.² It is worth noting that the flaps used in phalloplasty have a finite number of sensory receptors available for re-innervation: approximately 10% of the sensory-receptor density of genital tissues.⁵ This suggests a possible “ceiling effect” in regard to the achievement of experienced sensation through peripheral nerve regeneration alone. If such a peripheral ceiling effect truly exists, then the experienced sensation demonstrated in many patients following phalloplasty may stem from contributions and mechanisms beyond solely peripheral nerve regeneration. The range of outcomes demonstrated in the literature may also reflect a varying individuals ability to harness, map and integrate central contributions to phallic sensation. These central mechanisms may present an additional opportunity to further improve upon what has been achieved regarding sensation after phalloplasty.

A pre-existing central framework for the experience of phallic sensation in the transmasculine population has been proposed.¹⁴ One study of transmasculine individuals found that 18 of 29 (62%) experienced a “phantom penis,” despite a lifetime of visual absence and tactile absence of a phallus. Based on these findings, the authors suggested the potential for targeted conscious development of a volitional phantom penis by use of visual and tactile reinforcement, two strategies that are frequently used in sensory re-education following peripheral nerve transfers, and thus built into our neurosensory re-education protocol.²⁰ Phalloplasty creates a phallus that is both seen and touched. Therefore, it provides visual and tactile reinforcements to these sensations, especially as nerve regeneration

occurs and stimuli can be detected through direct tissue stimulation. Recent laboratory work in a mouse model assessed the impact of sexual activity on the genital cortex, demonstrating that early sexual interactions are a unique physical experience that create long-lasting memories that alter the genital cortex, suggesting that these experiences alter somatosensory body maps.²¹ This type of activity-dependent model proposes that early engagement with and interaction with the phallus may be an important factor during recovery that will ultimately affect sensation. The qualitative feedback (Table 1) from those with lived phalloplasty experience in our study suggests a potential benefit of the protocol in its ability to encourage earlier and maintain more intensive engagement with the phallus, both factors that may ultimately affect long-term sensation.

It should not be overlooked that phalloplasty results in the creation of a new appendage. Therefore, sensory re-education may be even more critical in phalloplasty than in many other areas where sensory nerve transfers are commonly performed. The best evidence to support the role of sensory re-education following the transfer of an appendage comes from the literature on toe-to-hand transplant.²² In this setting, sensory re-education has demonstrated not only significant gains in sensory function, but is listed as essential for optimal recovery, based on a reliance of cortical plasticity following the sensory nerve transfers.^{23–25} In addition to the need to rehabilitate these nerve transfers, gender-affirming phalloplasty will often shift the sexual and erogenous focus away from the clitoris to the phallus itself. The clitoral tissue is often buried at the base of the phallus to allow for stimulation. Integrating the erogenous sensation from the clitoral tissue into the sensations experienced in the phallus is a complex process. Providing a framework for an individual to explore and integrate these sensations may be beneficial to long-term sensory outcomes and overall sexual and sensory experiences following surgery. Currently there are no tools or maps provided to people who undergo phalloplasty to help assist with this complex process. This may be an oversight in our current approach to phalloplasty care and offer an arena to improve patient experience and outcomes. Ultimately, this protocol provides individuals a guide and a framework to assist with this critical process of self-exploration.

Significant limitations exist in this study. Most notably, it does not assess the actual effectiveness of this protocol. Future directions will include validating the effectiveness of this protocol through patient-reported outcome measures and objective measures of phallic sensation. However, in our experience treating individuals undergoing phalloplasty, there is a huge need and demand for support and guidance in sexual rehabilitation following surgery. Currently, the largest limitation in our understanding of erogenous sensation following phalloplasty is the lack of a validated outcome measure. Although some studies report on two-point discrimination thresholds, there still exists a need for a population-specific tool in addition to a standardized approach to accurately measuring phallic sensitivity, including erogenous sensation. Without such a tool, quantifying the benefit of interventions to improve sensation will continue to be somewhat elusive. Despite these challenges, we believe this

protocol is timely and an important step to support patients and advance the discussion and progress towards optimizing sensory outcomes seen following gender-affirming phalloplasty. There is minimal risk to use of such a protocol with real potential value that is supported by significant volumes of research from other fields of plastic and peripheral nerve surgery. Current evidence suggests that we should be rehabilitating these nerve transfers. Additionally, this protocol is based on accepted principles of sensory re-education and cortical plasticity in addition to input from multi-disciplinary experts across the fields of gender affirming surgery, peripheral nerve surgery, nerve therapy, pelvic floor physiotherapy, urology, sexual health, and sexual therapy. Most importantly, this protocol was constructed with the direct participation, input, feedback, and approval of transmasculine individuals who have undergone phalloplasty themselves. As new insights develop over time, it is expected that this protocol will evolve. Although this protocol was formed based on the staging technique used for phalloplasty at our institution, the exercises and principles in this protocol can easily be adapted for all staging approaches to gender-affirming phalloplasty, including shaft only phalloplasty variations. As many different variations of phalloplasty exist, the protocol was carefully constructed to be easily adaptable to each unique situation, regardless of staging, donor sites, and management of the natal clitoral tissue. As validated outcome metrics become available, future directions will include the assessment, refinement, and validation of this or similar protocols. Ultimately, our understanding of genital sensation and sexual health following gender-affirming phalloplasty is still in its early stage. However, the critical role of central mechanisms in the experience and interpretation of sensation in our body of literature should not be ignored. With the current evidence we have available, it is timely that strategies to target and harness both the peripheral and central mechanisms of sensation were introduced.

CONCLUSIONS

Sensory outcomes experienced following gender-affirming phalloplasty may have subjective and objective components. Current strategies to optimize sensation have targeted the objective components of sensation achieved through nerve regeneration at the level of peripheral nerve coaptation. Growing evidence exists to support the importance of centrally-mediated mechanisms, cortical mapping, and integration to achieve optimal sensory outcomes following nerve injuries and repairs. Thus far, these strategies have not been applied to gender-affirming phalloplasty. The authors introduce a novel and comprehensive protocol targeting peripheral and central contributions to phallic sensation to provide a tool and framework to help optimize experienced sensation for transmasculine individuals following gender-affirming phalloplasty surgery.

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