SCRIPTA MEDICA (BRNO) - 81 (1): 23–30, *April 2008*

AN OBJECTIVE EVALUATION OF THE CONTRACTION POWER OF A NEOPHALLUS RECONSTRUCTED WITH FREE REINNERVATED LD IN FEMALE-TO-MALE TRANSSEXUALS

RANNO R.[1], HÝŽA P.[1], VESELÝ J.[1], DESSY L.A.[2], KADAŇKA Z.[3]

[1]Department of Plastic and Cosmetic Surgery, St. Anne's Faculty Hospital, Masaryk University, Brno, Czech Republic
[2]Department of Plastic Surgery, University "La Sapienza", Rome, Italy
[3]Department of Neurology, Faculty Hospital, Faculty of Medicine, Masaryk University, Brno, Czech Republic

Received after revision April 2008

A b s t r a c t

Objective evaluation of the contraction power of a neophallus reconstructed with a novel technique in female-to-male transsexuals.

From December 2001 to September 2005, 22 patients with gender identity disorder underwent neophalloplasty with a reinnervated latissimus dorsi free flap. All the patients were subjected to an early rehabilitation protocol of the transferred muscle; the beginning time of neophallus voluntary contraction was recorded in 18 patients. Fourteen patients who came for examinations were objectively evaluated for the strength of transplanted muscle contraction in the neophallus by electromyography and measurement of the maximum weight lifted.

Eighteen patients were able to voluntarily contract the neophallus after an average period of 4.11 months. In 14 of them, the average weight lifted was 1129 grammes. After electromyography, the mean number of positive peaks in the 100 ms period was 31.5; the mean amplitude from 10 highest positive peaks, measured peak-to-peak, was 0.99 mV.

The advantage of this technique is non-requirement of the prosthesis for sexual activity due to the development of strong voluntary contraction of the neophallus. Our findings document objectively the strength of voluntary contraction of the neophallus as a consequence of reinnervation of the transferred muscle. Furthermore, the data represent a useful tool for clinical assessment and comparison.

K e y w o r d s

Phalloplasty, Reinnervated latissimus dorsi flap, Electromyography

INTRODUCTION

Despite the anatomical and clinical advantages of current techniques for phalloplasty, the outcome of reconstruction is still far from an optimal result. Particularly, the natural sexual function of the neophallus is not easily achievable. The use of transplants and implants in order to obtain sufficient rigidity for penetration has often led to complications and failures of different free and pedicle flaps (*8, 10, 12*).

Autologous cartilage and bone transplants, used to avoid these complications, cause permanent rigidity, which is embarrassing to the patient. Moreover, these tissues could tend to reabsorb, bend or fracture (*8*). Alloplastic prostheses have the possibility of giving an erection to the neophallus, although they are expensive and have a tendency to tissue erosion and extrusion, infection, tissue atrophy, penile fibrosis, and mechanical failure.

In an attempt to reduce complications, the surgeons modified the existing techniques or introduced new ones (*2,3,4–7,9,11,13,16,18,24,26*). Adamian was the first to use a reinnervated latissimus dorsi (LD) free flap for total phalloplasty (*1*).

In the meantime, various techniques have been used for total phalloplasties in female-to-male transsexuals at the Plastic and Cosmetic Surgery Department of Masaryk University in Brno *(26–29)*. Since 2001, the free reinnervated LD musculocutaneous flap has been applied in order to obtain sufficient rigidity of the neophallus for sexual intercourse due to voluntary contraction of the LD muscle and a soft flaccid penis in the quiescent phase. Some patients are able to have sexual intercourse with this type of reconstruction, while others are not. The conditions under which the reconstruction is successful are not fully understood and the contraction strength of the muscle, which provides rigidity of the neophallus, might be a significant factor.

The aim of this study was an objective evaluation of the contraction power of the transplanted muscle in the neophallus for further assessment of functional results.

MATERIALS AND METHODS

From December 2001 to September 2005, twenty-two female-to-male transsexuals underwent neophalloplasty using the above-mentioned technique at the Department of Plastic and Cosmetic Surgery of the St. Anne's Faculty Hospital in Brno. The mean patient age was 28.6 years (ranging from 24 to 38 years) and the average follow-up was 26.4 months. All the operated patients were invited for examinations; 14 of them collaborated and were included in this study; the contraction power of the neophallus was objectively evaluated (*Tab. 1*).

Surgical technique

The penis was built on the back of a musculocutaneous latissimus dorsi flap by rolling up the cutaneous part of the flap into a cylindrical shape. A longitudinal strip of the muscle inside the neophallus constituted the motoric unit of the neophallus. The vascular pedicle and the motoric nerve of the free flap were anastomosed end-to-end to the main vascular pedicle of the gracilis muscle and its motoric nerve coming from the obturator nerve on the left thigh.

Rehabilitation

Staring after skin healing, all the patients were subjected to a rehabilitation protocol of the transferred muscle. The protocol included electrostimulation of the motor nerve and the LD muscle of the neophallus at a frequency of at least 3 times a week for at least 6 months. After the beginning of active muscle movement, electrogymnastic continued 3 times a week until satisfactory voluntary movement of the muscle was obtained.

Table 1

Patients	**Number of positive peaks** (APs)	**Mean amplitude** (mV) **from 10 highest positive peaks**	**Power** (grammes lifted)
1	23	3.4	1000
2	34	0.176	100
3	33	0.76	950
4	31	1.2	600
5	30	0.3	550
6	30	0.39	800
7	33	0.35	950
8	31	1.3	1150
9	29	0.41	1815
10	29	1.08	1000
11	30	1.04	1250
12	37	0.78	2750
13	35	0.82	1700
14	36	1.9	1200
Mean value	31.5	0.993286	1129.643

Objective data obtained through EMG and power assessment in the group of patients studied.

Physical examination

Postoperatively, the patients were examined by the surgeon in regular intervals of 2 to 3 months. The patients were asked to perform several contractions of the neophallus by adducting the thigh and flexing the calf. The onset of voluntary contraction of the neophallus was recorded.

Objective evaluation

In the patients studied, the neophallus contraction power was objectively evaluated by measuring the maximum weight lifted, and by electromyography (EMG). For power evaluation, the patients were asked to voluntarily lift different weights with the neophallus. The weights started from 50 g up to the maximum possible weight; the elevation of at least 2 cm was considered as successful contraction which had lifted a given weight.

Electromyography

The neophallus muscle activity was registered using a Keypoint electromyograph (Dantec, Denmark), with a bipolar needle electrode, settings 10 ms/div., 0.1, and 1 mV/div. The number of positive peaks (APs) from the record of 100 ms and the amplitude values (in mV) of 10 highest positive peaks were counted.

A conventional physical examination test revealed the viability of the transplanted muscle in this series of patients, being able to contract and elevate the neopenis (*Figs. 1a,b*). Flexion of the calf and adduction of the thigh induced muscle contraction with shortening and widening of the neopenis; repeated contractions were possible for at least 3 minutes in all patients who demonstrated muscle contraction. The onset of muscle movement was noted after an average of 4.25 months (ranging from 3 to 13 months). Electrostimulation was continued to obtain a satisfactory voluntary movement of the muscle for an average period of 5.5 months (ranging from 3 to 10 months).

Objective evaluation

In the 14 patients studied, the average weight lifted was 1129 g (min 100 g, max 2750 g) (*Figs. 2a,b*). After electromyography, the mean number of APs in the 100 ms period was 31.5 (min 23, max 37, *Fig. 3*). The mean amplitude from 10 highest positive peaks, measured peak-to-peak, was 0.99 mV (min 0.176 mV, max 3.4). (*Fig. 3*).

The goals of total phalloplasty represent a continuous challenge for plastic surgeons. These aim at both cosmetic and functional results, but none of the techniques reported in the literature can fully satisfy them.

An ideal neophallus should permit the patient to urinate in a standing position and to engage in sexual intercourse with erogenous sensations. In addition, a one-stage predictably reproducible procedure with minimal donor site morbidity is the desired goal of this reconstruction.

The need of a proper penile stiffness for the sexual intercourse has been managed in two ways: prosthetic devices (penile implants, external stiffeners, temporary stiffeners) or autologous materials. The prosthesis has the possibility of giving a voluntary erection to the penis, and so permitting to engage in sexual intercourse, although it has certain disadvantages as mentioned above.

Resorption, softening or fracture of autologous materials such as cartilage or bone grafts led to unsatisfactory results (*8*). Also, a permanent rigidity can make the patient uncomfortable or embarrassed. However, a recent study by Sengezer showed persuasive results and long-term stability of the vascularised fibular flap used for penile reconstruction (*22).*

We think that the best reconstruction should be done with autologous tissues. Another requirement is the ability of the neophallus to voluntarily change its stiffness to allow sexual intercourse.

In this study, the voluntary contraction power of the neophallus reconstructed with a reinnervated free LD flap was analysed with objective instruments to provide data for assessment and comparison.

The first successful functional muscle transplantation was reported in 1970 *(25).* We selected a functional LD free flap for the amount of the skin and the

Fig. 1
Movement of the neophallus: a) Relaxed neophallus; b) Contracted neophallus

Fig. 2
Measurement of the muscle power by elevation of the weight:a) Relaxed neophallus;
b) Contracted neophallus

muscular paddle, as well as for the length of the pedicle. Besides, the scar on the back is usually well accepted by the patients. We believe that the most critical part of the functional muscle transfer is the nerve selection and adjustment (*14, 15, 17*). In order to minimise the time of muscle denervation, the nerve coaptation was placed as closely as possible to the neuromuscular junction. As the recipient nerve, the anterior branch of the obturator nerve proved to be the best on account of its proximity. To achieve the best functional result, electrostimulation began soon after the surgery and continued until satisfactory voluntary contraction was obtained. Then, the electro-stimulation was followed by the electrogymnastic for several months to improve muscle movement. The contraction of the adductors and gracilis muscles permits deliberate contraction of the transplanted muscle and causes negligible involuntary movements during walking.

Electromyographic findings document that contraction and movement of the artificial penis are based on reinnervation and subsequent contraction of the transferred muscle in it. The contraction power reached makes the neophallus suitable for sexual intercourse by its stiffening and movement, although the muscle contraction shortens and widens the neophallus. This voluntary "paradox erection" enables sexual intercourse by inserting either contracted or non-contracted neophallus into the vagina and by subsequent repeated intermittent contractions and releases of the muscle. This fact is one of the reasons that nowadays make the neophalloplasty with a reinnervated LD free flap the method preferred by most of our patients.

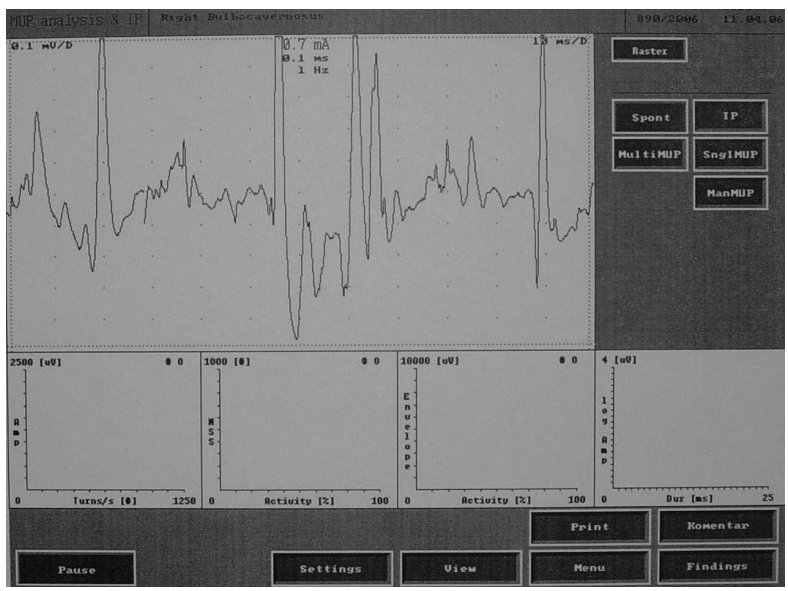

Fig. 3
Electromyographic record of muscle contraction

CONCLUSION

In conclusion, this neophalloplasty technique gives the patient the ability to have sexual intercourse without the need for prosthesis. The voluntary contraction of the neophallus appears soon after the surgery. We believe that an early rehabilitation protocol is one of the necessary conditions for successful reinnervation of the transplanted muscle. Our findings document objectively that this voluntary contraction of the artificial penis is a consequence of reinnervation of the transferred muscle and that the contraction is strong enough to stiffen the neophallus. Also, the data obtained represent a useful tool for clinical assessment and comparison.

REFERENCES

1. *Adamian R, Zelyanin N, Milanov NO.* Total phalloplasty in the treatment of transsexuals. In: Proceedings of 8th Annual Meeting of European Association of Plastic Surgeons Euraps, Amsterdam, The Netherlands: May 15–17, 1996.
2. *Akoz T, Kargi E.* Phalloplasty in a female-to-male transsexual using a double-pedicle composite groin flap. Ann Plast Surg 2002; 48: 423.
3. *Chen YB, Chen HC.* Penile reconstruction for a victim of electrical injury with bilateral below-elbow amputations. Plast Reconstr Surg 1991; 87: 771.
4. *Davies DM, Matti BA.* A method of phalloplasty using the deep inferior epigastric flap. Br J Plast Surg 1988; 41: 165.
5. *Gilbert DA, Horton CE, Terzis J-K, et al.* New concepts in phallic reconstruction. Ann Plast Surg 1987; 18: 128.
6. *Gilbert DA, Schlossberg SM, Jordan GH.* Ulnar forearm phallic construction and penile reconstruction. Microsurgery 1995; 16: 314.
7. *Hage JJ.* Metaidoioplasty: an alternative phalloplasty technique in transsexuals. Plast Reconstr Surg 1996; 97: 161.
8. *Hage JJ, Bloem JJAM, Bouman FG.* Obtaining rigidity in the neophallus of female-to-male transsexuals: a review of the literature. Ann Plast Surg 1993; 30: 327.
9. *Hage JJ, de Graaf FH, van den Hoek J, Bloem JJ.* Phallic construction in female-to-male transsexuals using a lateral upper arm sensate free flap and a bladder mucosa graft. Ann Plast Surg 1993; 31: 275.
10. *Hage JJ.* Dynaflex prosthesis in total phalloplasty. Plast Reconstr Surg 1997; 99: 479.
11. 11. Harashina T, Inoue T, Tanaka I, et al. Reconstruction of the penis with free deltoid flap. Br J Plast Surg 1990; 43: 217.
12. *Jordan GH, Alter GJ, Gilbert DA, et al.* Penile prosthesis implantation in total phalloplasty. J Urol 1994; 152: 410.
13. *Koshima I, Tai T, Yamasaki M.* One-stage reconstruction of the penis using an innervated radial forearm osteocutaneous flap. J Reconstr Microsurg 1986; 3: 19.
14. *Manktelow RT, Zuker RM.* The principles of functioning muscle transplantation: Applications to the upper arm. Ann Plast Surg 1989; 22: 275.
15. *McKee NH, Kuzon MW Jr.* Functioning free muscle transplantation: Making it work? What is known? Ann Plast Surg 1989; 23: 249.
16. *Mutaf MA.* New surgical procedure for phallic reconstruction: Istanbul flap. Plast Reconstr Surg 2000; 105: 1361.
17. *Ninkovic M, Sucur D, Starovic B, Markovic S.* A new approach to persistent traumatic peroneal nerve palsy. Br J Plast Surg 1994; 47: 185.
18. *Perovic S.* Phalloplasty in children and adolescents using the extended pedicle island groin flap. J Urol 1995; 154: 848.
19. *Sadove RC, Sengezer M, McRoberts JW, Wells MD.* One-stage total penile reconstruction with a free sensate osteocutaneous fibula flap. Plast Reconstr Surg 1993; 92: 1314.
20. *Sasaki K, Nozaki M, Morioka K, et al.* Penile reconstruction: combined use of an innervated forearm osteocutaneous flap and big toe pulp. Plast Reconstr Surg 1999; 104: 1054.
21. *Semple JL, Boyd JB, Farrow GA, Robinette MA.* The “cricket bat” flap: a one-stage free forearm flap phalloplasty. Plast Reconstr Surg 1991; 88: 514.

22. *Sengezer M, Vztrk S, Deveci M, Odabas Z.* Long-term follow-up of total penile reconstruction with sensate osteocutaneous free fibula flap in 18 biological male patients. Plast Reconstr Surg 2004; l14: 439–450.
23. *Shenaq SM, Dinh TA.* Total penile and urethral reconstruction with an expanded sensate lateral arm flap: case report. J Reconstr Microsurg 1989; 5: 245.
24. *Sun GC, Huang JJ.* One-stage reconstruction of the penis with composite iliac crest and lateral groin skin flap. Ann Plast Surg 1985; 15: 519.
25. *Tamai S, Komatsu S, Sakamoto H, et al.* Free muscle transplants in dogs, with microsurgical neurovascular anastomoses. Plast Reconstr Surg 1970; 46: 219.
26. *Vesely J, Barinka L, Santi P, et al.* Reconstruction of the penis in transsexual patients. Acta Chir Plast 1992; 34: 44.
27. *Vesely J, Procházka V, Válka J, et al.* Use of two microsurgical flaps in one stage reconstructive surgery. Acta Chir Plast 1994; 36: 99.
28. *Vesely J, Kucera J, Hrbaty J, et al.* Our standard method of reconstruction of the penis and urethra in female transsexuals. Acta Chir Plast 1999; 41: 39.
29. *Vesely J, Haage J.* From the history of penis reconstruction. Acta Chir Plast 1999; 41: 43.