INDEX

1. INTRODUCTION  pag. 3
2. HISTORY OF PHALLOPLASTY  pag. 9
3. AIM OF STUDY  pag. 21
   3.1. EXPERIMENTAL TEST  pag. 22
   3.2. METHODS  pag. 28
   3.3. SURGICAL TECHNIQUE  pag. 28
   3.4. PHYSICAL EXAMINATION AND QUESTIONAIRE  pag. 33
   3.5. OBJECTIVE EVALUATION AND ELECTROMYOGRAPHY  pag. 35
4. RESULTS  pag. 39
5. COMPLICATION  pag. 50
6. DISCUSSION  pag. 52
7. CONCLUSION

8. BIBLIOGRAPHY
1. INTRODUCTION

Gender dysphoria, also known as ‘gender identity disorder’, is a medical term for anxiety, confusion or discomfort about birth gender. Those who feel they have been born into the wrong gender are often aware there is ‘something wrong’ early in childhood. Because society places great emphasis on sexual and gender classification, and on gender-appropriate behaviour, such a child will feel very different from their peers, and uncertain about their identity.

This feeling of being the wrong gender may come and go over the years, but it creeps into all aspects of life. Milder forms of gender dysphoria can mean occasional feelings of belonging to the opposite sex, and may cause people to dress as the opposite sex once in a while. For others, anxiety about being ‘in the wrong body’ can be the major driving force in their lives, leading them to seek gender reassignment, commonly known as a sex-change or transsexualism. Others question the rigidity of gender roles, and seek to establish a ‘transgender’ identity.

To diagnose gender identity disorder, according to the DSM-IV (the commonly used diagnostic manual), there has to be evidence of a strong and persistent ‘cross-gender identification’, meaning the person wants to be, or is insistent they already belong to the opposite sex. They must be persistently uncomfortable in their current gender role, and feel that it’s quite inappropriate to them. It’s not about wanting to get some cultural advantages out of changing sex.
Nor would the diagnosis necessarily be made, for instance, if someone has one of the rare physical ‘intersex’ conditions, such as, androgen insensitivity syndrome or congenital adrenal hyperplasia, with some of the physical characteristics of the other sex. There has to be evidence of clinically significant distress, or damage to important aspects of the person’s life to diagnose gender identity disorder.

People with gender dysphoria are often afraid to express their feelings publicly, because they fear being rejected or because they feel guilty or ashamed. They can develop anxiety problems, which deepen over time, and this can lead to long-term depression. Some people may even consider or attempt suicide, as a result.

Treatment is self-rehabilitation through a multidisciplinary team approach, with the final step of the traditional triadic sequence being sex reassignment surgery. Plastic and reconstructive surgeons most familiar with body image change surgery and its psychology often provide the ultimate step in this complete human transformation. Plastic and reconstructive surgical applications in this field are far-reaching, encompass the entire body, and in effect provide the mechanism for total body transformation for sex to meet body image. Improved function and appearance in accordance with the patient’s perceived gender enhance dignity, self-confidence, productivity, and overall happiness.

Penis reconstruction in female-to-male transsexual is common operation in specialized centres, but we have to confirm, that not all of the transsexuals require
this surgery. Needs of the patients are different in the concepts of expected result of penis reconstruction.

Hoopes in 1969 thought that from the view of the patient, a simple abdominal tube pedicle flap phallus not containing a urethra provides considerable physiological security, a phallus serving a urinary function is entirely satisfactory, and a phallus capable of sexual activity is too much to be hoped for. He considered the “fear of discovery” a strongly motivating factor in many of these patients (1,2).

Edgerton and Meyer in 1973 stated that some patients express an interest only in achieving the ability to function sexually like a male, whereas others are more concerned with obtaining patterns of voiding like a male (3).

Later on, in 1983, Edgerton reported to have experienced that virtually all patients undergoing this type of reconstruction wish, almost equally, to be able to 1- stand voiding, 2- have sufficient rigidity in the penile shaft that they may engage in sexual intercourse (4).

Although there appears to be an evolution in the wishes and goals of the patients, the boundaries of technical expertise have always influenced the interpretation by the surgeon of the patient’s desire (5-6). Davies and Matti for example, in 1988 still commented that from patient’s interviews, the operations provide a major goal for female gender reassignment, giving a patient the male symbol of a phallus even if it does not function correctly (7).
The goals of penile reconstruction according to Gilbert et al. (8), Hage et al. (9) are:

1. reconstruction in one-stage operation
2. an aesthetically appearing neo-phallus with erogenous and tactile sensation
3. permit patient to void standing up
4. to have sexual intercourse like a natural male
5. the reconstructive surgery should be predictably reproducible
6. the procedure should leave the patient with minimal scaring or disfigurement

Until now, accomplishment of all these conditions in one stage procedure is not achievable.

Since its first report (10,11), the radial forearm free flap has represented the gold standard procedure in phallus reconstruction for many years. One-stage surgery has indisputable advantage of a procedure. However, limits in sex function became more evident after several years of the application of this, and similar procedures. Also, the forearm donor site scars represent sign of recognition of female-to-male transsexual patients and motivated surgeons to search for other donor areas.
Despite the anatomic and clinical advantage of current techniques for phalloplasty the outcome of reconstruction is still far from an optimal result. Particularly, natural sexual function of the neo-phallus 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 (12,13). Autologous cartilage and bone transplants, used to avoid these complications, cause a permanent rigidity which is embarrassing to the patient. Moreover, these tissues could tend to resorb, bend or fracture (12). Alloplastic prostheses have the possibility to give an erection to the neo-phallus, although they are expensive and have a tendency to tissue erosion and extrusion, infection, tissue atrophy, penile fibrosis and mechanical failure. These complications led surgeons to modify the techniques (14,15) and adopt new ones (16-30).

Adamian was the first to use re-innervated latissimus dorsi free flap for total phalloplasty (31). Since its first description, the latissimus dorsi has been widely used in reconstructive surgery and its employ to restore muscular function continuously shows new horizons particularly as a free innervated flap (32,33).

Various methods, mostly radial forearm free flap, were used for total phalloplasties in female-to-male transsexuals at the Clinic of Plastic and Aesthetic Surgery, Masaryk University in Brno (34-38). Recently, free re-innervated latissimus dorsi musculocutaneous flap has been employed in order to obtain
sufficient rigidity of neo-phallus for sexual intercourse and soft flaccid penis in quiescent phase.
2. HISTORY OF PHALLOPLASTY

The development of procedures for phalloplasty has followed those of the reconstructive surgery. Bogoras (39) first reported a total penile reconstruction in 1936. After him, several different procedures with local flaps have been described and published by different authors (40-45). In the 1980s, the introduction of microvascular free flaps transfer has started a new era of reconstructive surgery with a great impact in phalloplasty. Free flap phalloplasty now represents the condition to obtain the best result in this procedure (10,11,46-50). Nevertheless, some authors have described useful techniques with local flaps recently. They are mainly used for those cases of neo-phalloplasty where microsurgery is not possible (51,52).

The following techniques in years for phalloplasty in female-to-male transsexuals are briefly described:

1. Bogoras’ bipedicled abdominal tubed flap
2. Maltz-Gillies’ tube-within-a-tube bipedicled flap
3. Stanford bipedicled infra-umbilical skin flap
4. Single pedicled infra-umbilical flap
5. Single subcutaneous pedicled infra-umbilical flap
6- Pedicled groin flaps  
7- Pedicled thigh flaps  
8- Pedicled myocutaneous flaps  
9- Island Tensor Fasciae Latae flap  
10- Free microsurgical forearm flaps  
11- Anterolateral thigh flap  
12- Metaidoioplasty  

1- Bogoras’ bipedicled abdominal tubed flap

Originated by Bogoras (39,53), the use of a single abdominal tube has been applied by others as well. Transplants and implants have been inserted primarily in these tubes to obtain rigidity. It is a multi-stage technique necessitating the secondary construction of a urinary conduit if a neo-urethra is desired. McIndoe (54) improved the technique by constructing the neo-urethra while raising the pedicled tube, employing an inlaid skin graft.

2- Maltz-Gillies’ tube-within-a-tube bipedicled flap

While Maltz (55) introduced the concept of inserting an outside-in tubed flap within a ‘normally’ tubed abdominal pedicle graft to reconstruct a phallus with a
urethra. Gillies popularized this technique, adding a costal cartilage graft as a stiffener (Fig. 1) \((56,57)\). He was also the first to report using this method in a transsexual patient \((57)\). Since then, it has long been the principal method of phalloplasty.

Fig. 1

*Phalloplasty according to Gillies using an abdominal tube-within-a-tube bipedicled flap (after Gillies 1957)*
3- Stanford bipedicled infra-umbilical skin flap

The Stanford team devised a technique, tubing an infra-umbilical abdominal flap outside-in, in order to create a skin lined tunnel to receive a temporary baculum. The flap is said to survive on the superficial external pudendal vessels and is initially raised on an inferior and a superior pedicle (58-60). Instead of covering this tube with a second tube, it was wrapped in a skin graft. Compared to the techniques described by Bogoras and by Maltz and Gillies, this method reduced the number of stages necessary for phalloplasty. The Stanford technique has been used also by Biber (61) and by Redman (62). A free flap neo-urethra also covering the glans may be added in order to obtain sensitivity (58,63).

4- Single pedicled infra-umbilical flap

Snyder (64,65) described the use for phalloplasty in intersex subjects, of a single-pedicled infra-umbilical skin flap in which a preconstructed superficial skin-lined conduit was incorporated. This skin lined tunnel was meant to become the phallic part of the neo-urethra (Fig. 2). Subsequently to preconstruction of this neo-urethra, instead of raising the flap as a bipedicled flap, Snyder raised and hinged the flap on a single pedicle. Although he did not mention it, from his
drawings one may conclude that this pedicle included the superficial external pudendal vessels.

Song (66) used an infra-umbilical midline pedicled flap in which the superficial epigastric vessels were included bilaterally, in the reconstruction of the penis in a male patient. To reconstruct the phallic part of the urethra he used either a scrotal flap or a small extension at the distal end of the abdominal flap. As in Snyder’s and the Stanford technique, the skin pedicle reached the final pubic acceptor area.

Fig. 2

Phalloplasty according to Snyder using a single-pedicled infra-umbilical skin flap in which a preconstructed superficial skin-lined tunnel to become the phallic part of the neo-urethra, is incorporated.
5- Single subcutaneous pedicled infra-umbilical flap

Hester performed a penile reconstruction in one stage using a vertical superficial inferior epigastric artery flap with a subcutaneous pedicle in a male patient born with ambiguous genitalia (67). He (1987) applied a similar technique. Bouman (68) reported employing bi-axial superficial inferior epigastric midline infra-umbilical flaps for phalloplasty in female-to-male transsexuals. He stressed the importance of incorporating in the flap’s pedicle both the superficial external pudendal and superficial inferior epigastric vessels. He based the flap on a pedicle of subcutaneous tissue only (69), so as to leave the pubic hairy zone unharmed.

6- Pedicled groin flaps

Following the introduction of the groin flap by McGregor in 1972 (70), Hoopes (2) commented that “the groin flap may prove the method of choice for phallus construction”. Puckett and Montie (71) were the first to report its use for phalloplasty and it has since been applied for this purpose by various authors. Exner (72,73) uses bilateral groin flaps to cover a rectus abdominis muscular flap with which he covers a rigidity prosthesis.
7- **Pedicled thigh flaps**

Morales and co-workers (74), and later Julian et al (75) raised a single tubed skin flap from thigh because the abdomen of their patients was often scarred by previous operations or radiotherapy. Morales closed the donor area, either by primary closure or using a split skin graft from the opposite thigh.

Kaplan and Wesser in 1971 described the use of a superior pedicled thigh flap to reconstruct a sensitive phallus (76). They suggested the use of this flap in combination with labial skin flaps to provide for a neo-urethra in female-to-male transsexual. Unfortunately, they had no experience in this group of patients.

8- **Pedicled myocutaneous flaps**

Orticochea in 1972 reported the use of a gracilis myocutaneous flap in a five-stage phalloplasty procedure with which he claimed to obtain cosmetically and functionally superior results in his patients (41). This method has since been labelled “rather elaborate” (77), “exceedingly complex” (78), “spectacular” (79), “monumental” (2) and even “heroic” (71).

The Norflok team also has experience with the use of unilateral gracilis myocutaneous flaps for phalloplasty (80).
In order to obtain more phallic bulk Persky (81) used bilateral myocutaneous gracilis flaps for a one-stage phalloplasty. Hester et al (82) and Hanash and Tur (83) devised a single-stage phalloplasty using gracilis muscle without overlying skin, in order to reduce the scarring in the donor area.

Chang (11) refrained from using the gracilis because of “disappointing postoperative results owing to cicatricial retraction of the migrated gracilis muscle”.

Apart from the gracilis myocutaneous flap, the rectus abdominis musculocutaneous flap has been used for phalloplasty by various authors.

9- Island Tensor Fasciae Latae Flap

Santanelli and Scuderi in 1997 reported a procedure for neophalloplasty using a long tensor fasciae latae island flap (51), which is a neurovascular flap that is able to create a sensate neophallus of adequate size with very little donor-site disfigurement. The Authors performed this operation on one patient without pre-expansion of the flap and on four subsequent patients with pre-expansion, thus increasing flap vascularization and size and enhancing donor-site closure. The pars fixa of the neourethra was reconstructed with local flaps at the time of the radical excision of the vagina, uterus, fallopian tubes, and ovaries, which was performed through a vaginal access. The proximal part was created by tubulizing
a skin strip disposed vertically from the external urethral meatus to the clitoris, whereas the distal part was made using a subcutaneous island flap obtained from the preputial apron and rolled into a tube per Scuderi’s urethroplasty. The rigidity was allowed using a prothesis Dynaflex (American Medical Systems, Minnetonka, Minn) (Fig. 3).

Fig. 3
(Left) Urethroplasty of the pars pendulans by tubulization of a full-thickness skin graft harvested from the lateral shaft of the thigh. (Right) Dissection of the cutaneous femoral nerve (CFN) from the anterior superior iliac spine (ASIS) distally into the flap. The tensor fasciae latae (TFL) flap raised on its neurovascular pedicle. The tensor fasciae latae flap tunneled into the pubic area, passing under the rectus femoris (RF) muscle. The tensor fasciae latae flap after tubulization. VL, vastus lateralis muscle; rubber band indicates the lateral circumflex artery and vein.
10- Free microsurgical forearm flaps

Originally described by Song in 1982 (84), the use of this flap in phalloplasty was first published in 1984 by Chang and Hwang (Fig. 4) (11). Kao and co-workers in the same year reported the use of an identical technique, which they had applied since June 1981 (85).

Biemer in 1988 reported to have been using this flap for phalloplasty since 1981 as well. He devised an alternative way to roll the flap in order to become a tube-within-a-tube, as well as an extra long “urethral” part to span the width between the base of the phallus and the female external urethral orifice (10). However, limits in sex function became more evident after several years of the application of this, and similar procedures. Also, the forearm donor site scars represent sign of recognition of female-to-male transsexual patients and motivated surgeons to search for other donor areas.
Felici used the anterolateral thigh flap for phalloplasty in a one phalloplasty procedure with which he claimed to obtain cosmetically and functionally superior results in his patients. Six phalloplasties with free anterolateral thigh flap (ALT) had been performed. He saw encouraging results. The shape and the consistency of the neo-phallus were suitable, the flap can be sensate and an erectile prosthesis
can easily be implanted. Penile urethral reconstruction was possible in the same operative stage (86).

12- Metaidoioplasty

It is a technique for creating a neophallus from an enlarged clitoris in female transsexuals.

Durfee and Rowland (89) were the first to report penile substitution with clitoral enlargement and urethral transfer in female-to-male transsexuals. Indeed, the use of androgen for a fairly long period of time stimulates growth of the clitoris, in some patients to the point were this organ can suffice as a phallus.

The surgical techniques, resembling the procedures for correction of microphallus (88,89), have been refined and named “metaidoioplasty” by Laub (6,58,90,91). Eicher (92) preferred “Clitoris-penoid” as a term.
3. AIM OF STUDY

At the beginning of PhD study, these purposes were established:

- To present a novel technique for neophalloplasty using a reinnervated myocutaneous free flap with active movements.

- In experimental study to assess the effectiveness of reinnervation using end-to-side neurorrhaphy in the low extremity of the rat and comparing this with the nerve regeneration through end-to-end neurorrhaphy.

- To objective the muscle movement inside of the reconstructed penis.

- To objective the muscle power inside of the reconstructed penis.

- To evaluate the correlation between movements of the penis and muscle power of the penis and possibility of sexual intercourse.
3.1. EXPERIMENTAL TEST

Recent studies suggest that suturing the distal portion of the cut nerve to the side of an intact nerve could reinnervate muscle in the lower limbs (93-96). The potential recovery of motor function following end-to-side neurorrhaphy is still controversial. This is attributed to the fact that the majority of this previous studies were conducted using two antagonistic muscles, such as the muscle innervated by the peroneal nerve and the posterior tibial nerve in the hindlimbs of rats (97).

The aim of this study was to assess the effectiveness of reinnervation using end-to-side neurorrhaphy in the low extremity of the rat and comparing this with the nerve regeneration through end-to-end neurorrhaphy.

Materials and methods

In total 40 healthy white rats (250-300 g.) were used in the experiments. They were housed maximal four in a cage and before the experiments were kept under conventional laboratory conditions. General anaesthesia was accomplished by an intraperitoneal injection of a mixture of ketamina (90 mg/Kg), xylazine (10 mg/Kg), and atropine (0.05 mg/Kg). The rats were randomly divided into four
groups. In all of them the vastus medialis was separated and the posterior division of the femoral nerve was cut and sutured immediately with the anterior division of the femoral nerve (Fig. 5a,b).

Fig. 5a

the distal insertion of the vastus medialis is cut and the muscle elevated
Fig. 5b

Femoral nerve repertation

A end-to-end suture nerve was used in 20 rats and controlled after 1 month in 10 rats and after 2 months in other 10. This group was correlated with other 20 rats with end-to-side neurorrhaphy using a perineurotomy window of the intact nerve. The observation was made in the first group of 20 rats at 1 month (10 rats with end-to-end suture nerve and in 10 with end-to-end suture nerve); and in the
second group of 20, after 2 months (10 rats with end-to-end suture nerve and in 10 with end-to-end suture nerve).

The entire area at the site of end-to-side nerve coaptation was carefully harvested and prepared for trasversal section. The nerve section was placed in zamboni fixation for all night. After it was cleaned in 10 % of saccarosium in PBS (phosphates buffer saline), and cut into 12-µm trasversal section. After the incubation was made with primary antibody against neurofilament, than a secondary antibody GOAT was used before the last procedure of washing and covering.

Results

In 40 rats used in this experiment, unfortunately only few histological results of all sent were made by Institute of Anatomy Medical faculty of Masaryk University. After this unprofessional collaboration we can only demonstrate the happened reinnervation (Fig. 6a,b). But we are not able to compare and quantify the axonal regeneration.
Fig. 6a

*Amplification x 40. Presence of neurofilaments*
The preliminary results in this experiment suggest that end-to-side nerve coaptation could have potential clinical applications in carefully selected cases, particularly when a proximal nerve segment is unavailable. In our new neophallus technique, this neurorrhaphy could be used instead of traditional end-to-end nerve suture, avoiding the gracilis muscle denervation.

**Fig. 6b**

*Amplification x 40. Presence of neurofilaments*
3.2. METHODS

Since 1989, overall 86 neophalloplasties using various free flap techniques were performed in the Clinic of Plastic and Aesthetic Surgery, Masaryk University in Brno.

From December 2001 to September 2005, neo-phalloplasty with re-innervated latissimus dorsi myocutaneous free flap was performed in 22 patients for female-to-male gender dysphoria. Mean age of the patients was 28.6 years (ranged from 24 to 38 years) and patients were followed up for mean 23.9 months (ranged from 11 to 44 months).

3.3. SURGICAL TECHNIQUE

Briefly, a longitudinal lazy “S” or transverse incision along the medial region of the thigh is done to expose recipient vessels and motor nerve of gracilis muscle (medial circumflex femoral vessels and a branch of the obturator nerve to gracilis). A myocutaneous latissimus dorsi free flap of both length and width approximately 14 cm with approximately 12 x 4 cm calf of muscle is designed on back (Fig. 7a,b).
Fig. 7a:

The preoperative drawing of the flap. In this case, the skin paddle 14 x 14 cm was designed. The dimension of the flap is adopted according to patients’ wishes and fat thickness on the back.
Distance of the skin paddle is set about 13 cm from axilla. The pedicle is elongated by intramuscular dissection of the lateral branch of thoracodorsal artery from the entry of thoracodorsal artery to the latissimus dorsi muscle for about 3 to 4 cm. The skin paddle is designed over lower three-quarters of the muscle calf; the upper quarter of the muscle, which remains outside the cutaneous paddle is later used for attachment to the pubic area. Lateral branches of the thoracodorsal...
vessels are carefully protected. After the flap is harvested, it is rolled into a cylinder to obtain the desired shape. Skin margins are sutured together with absorbable intradermal running suture (3-4/0 braided lactomer 9-11) (Fig. 8).

Fig. 8
The flap is checked for perfusion and is rolled into a cylinder and sutured

The neurovascular thoracodorsal pedicle is divided at its origin or elongated with subscapular vessels. The donor site is sutured directly in part; and area of
average 5 x 8 cm is skin mesh grated. The patient is then turned into supine position and the flap is transferred and sutured to the recipient pubic area (Fig. 9).

**Fig. 9**

*Neo-phallus with its pedicle*

The clitoris is usually maintained during this procedure unless the patient wishes to have it removed. The muscle calf is attached with non-absorbable stitches (2-3/0 polypropylene) to the anterior layer of rectus abdominis sheath. The thoracodorsal pedicle is passed through a subcutaneous tunnel to the thigh.
and anastomosed to recipient vessels; motor nerve suture is sutured to the anterior branch of obturator nerve which runs to the gracilis muscle.

Postoperatively, the patients are advised to do electrostimulation of motor nerve as well as muscle of the flap in frequency at least 3 times a week for at least 6 months. After beginning of active muscle movement, electrogymnastics continued 3 times a week until satisfactory voluntary movement of the muscle was obtained.

3.4. PHYSICAL EXAMINATION AND QUESTIONNAIRE

Postoperatively, the patients were examined by the surgeon in regular intervals of 2 to 3 months. Patients were asked to perform several contractions of neophallus by adducting the high and flexing the calf; the presence of muscle movement was documented by the physician. Also, capability of repeated muscle contraction for 3-minute interval was recorded. Patients were asked in questionnaire about overall satisfaction, onset of muscle contractions and ability to have sexual intercourse. Also, the strength of muscle contraction was subjectively assessed by the patients in four grades – strong, middle, weak, or no contraction. Nineteen patients were included in final evaluation (Fig. 10); 3 patients who did not answer the questionnaire were excluded from evaluation of the function.
**QUESTIONNAIRE**

Name ___________  
Age _____  

Muscle electrostimulation:  
How long time ____ (months)  
Frequence ____ (times a week)  

Onset of muscle movement ______ (months)  

Duration of muscle contraction ____ (minute)  

Strength of muscle movement:  
☐ No  
☐ Weak  
☐ Middle  
☐ Strong  

Do you have sensibility in neo-phallus?:  
☐ No  
☐ Little  
☐ Yes  

Do you have partner?:  
☐ No  
☐ Yes  

Sexual intercourse:  
☐ I did not try  
☐ No  
Why (describe): ____________________________  
----------------------------------------------------------------------------------------------------------------------------------------  
☐ Yes  
How (describe): ____________________________  
----------------------------------------------------------------------------------------------------------------------------------------  

What would you change and what is the most important limitation?:  
----------------------------------------------------------------------------------------------------------------------------------------  

**Fig. 10** Questionnaire for the patients evaluation.
3.5. OBJECTIVE EVALUATION AND ELECTROMYOGRAPHY

In 14 patients, the neo-phallus dimensions (length and circumference) were measured in the relaxed and contracted positions and data recorded (Fig.11a,b).

Fig. 11a

*Measure of neo-phallus length*
The ability of having sexual intercourse and onset of muscle movement was examined by the questionnaire. Also the neo-phallus contraction power was
objectively evaluated by measuring the maximum weight lifted (Fig. 12), and by electromyography (EMG).

Fig. 12

*Measure of neo-phallus contraction power*
The neo-phallus muscle activity was registered using an electromyograph Keypoint (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.
4. RESULTS

All the flaps used for penile reconstruction in female to male transsexuals during given period survived.

Convectional physical examination test revealed the viability of the transplanted muscle that 18 cases (95%) were able to contract and elevate the neo-penis (Fig. 13a,b).

Fig.13a Neo-phallus in relax
Fig. 13b

Contraction of the muscle moves, shortens and widens the penis and can simulate copulatory movements.

Flexion of the calf and adduction of the thigh included muscle contraction with shortening and widening of the neo-penis; repeated contractions were possible for at least 3 minutes in all patients who demonstrated muscle contraction.
One patient did not show any muscle movement, yet he did not requested revision. The onset of muscle movement was noted at mean 4.11 months (ranged from 3 to 13 months). Muscle contraction was assessed subjectively as strong in 9 (47%) cases and middle in 9 cases (47%); 1 patient had no contraction of the transplanted muscle. 8 (42%) out of the 19 patients performed sexual intercourse; all those patients had muscle movement and used muscle contraction to stiffen the penis and/or move the penis during sexual intercourse. 2 (11%) patients (nr. 13 and 16) were able to penetrate but were not able to keep the penis inside because of its short length. 3 (16%) patients have had no opportunity for sexual activity at all. Other cases (n=6; 31%) reported that the penis was too wide, too small, or too soft for successful penetration (tab. 1).
Tab. 1 Overview of the results

<table>
<thead>
<tr>
<th>Patient Nr.</th>
<th>Age (yr)</th>
<th>Follow up (months)</th>
<th>Muscle contact</th>
<th>Onset of muscle movement (months)</th>
<th>Sexual intercourse</th>
<th>Duration of electrostimulation (months)</th>
<th>Size of the skin paddle (length x width in cm)</th>
<th>Complications donor site</th>
<th>Complications recipient site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38</td>
<td>44</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>14x16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>41</td>
<td>Strong</td>
<td>4</td>
<td>yes</td>
<td>6</td>
<td>13x15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>41</td>
<td>Middle</td>
<td>13</td>
<td>yes</td>
<td>15</td>
<td>13x14</td>
<td></td>
<td>swelling of neopenis</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>35</td>
<td>No</td>
<td>no</td>
<td>no</td>
<td>9</td>
<td>13x14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>33</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>10x14</td>
<td></td>
<td>partial necrosis, swelling</td>
</tr>
<tr>
<td>6</td>
<td>33</td>
<td>31</td>
<td>Middle</td>
<td>7</td>
<td>yes</td>
<td>10</td>
<td>14x15</td>
<td>skin graft loss</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>27</td>
<td>29</td>
<td>Strong</td>
<td>3</td>
<td>yes</td>
<td>6</td>
<td>12x14</td>
<td>haematoma</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>32</td>
<td>27</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>13x15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>27</td>
<td>26</td>
<td>Middle</td>
<td>3</td>
<td>no</td>
<td>4</td>
<td>11x13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>26</td>
<td>21</td>
<td>Strong</td>
<td>3</td>
<td>yes</td>
<td>2</td>
<td>14x17</td>
<td>haematoma</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>27</td>
<td>20</td>
<td>Strong</td>
<td>6</td>
<td>no</td>
<td>5</td>
<td>20x17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>24</td>
<td>20</td>
<td>Strong</td>
<td>3</td>
<td>no</td>
<td>6</td>
<td>10x17</td>
<td>haematoma</td>
<td>haematoma</td>
</tr>
<tr>
<td>13</td>
<td>25</td>
<td>20</td>
<td>Middle</td>
<td>3</td>
<td>no</td>
<td>6</td>
<td>12x14</td>
<td>haematoma</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>28</td>
<td>19</td>
<td>Strong</td>
<td>3</td>
<td>no</td>
<td>6</td>
<td>12x16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>27</td>
<td>19</td>
<td>Strong</td>
<td>3</td>
<td>no</td>
<td>4</td>
<td>15x16</td>
<td>arterial thrombosis</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>35</td>
<td>17</td>
<td>Middle</td>
<td>3</td>
<td>no</td>
<td>2</td>
<td>12x17</td>
<td>swelling of neopenis</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>29</td>
<td>17</td>
<td>Strong</td>
<td>3</td>
<td>no</td>
<td>1</td>
<td>12x18</td>
<td>venous thrombosis</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>32</td>
<td>14</td>
<td>Strong</td>
<td>3</td>
<td>no</td>
<td>5</td>
<td>15x18</td>
<td>haematoma</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>29</td>
<td>14</td>
<td>Middle</td>
<td>3</td>
<td>no</td>
<td>4</td>
<td>13x16</td>
<td>haematoma</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>27</td>
<td>14</td>
<td>Middle</td>
<td>3</td>
<td>yes</td>
<td>3</td>
<td>15x14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>24</td>
<td>12</td>
<td>Middle</td>
<td>3</td>
<td>yes</td>
<td>5</td>
<td>14x17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>27</td>
<td>11</td>
<td>Middle</td>
<td>5</td>
<td>yes</td>
<td>7</td>
<td>12x18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>28.6</td>
<td>23.9</td>
<td></td>
<td>4.11</td>
<td></td>
<td>5.57</td>
<td>13x15.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The onset of muscle movement, in the 14 patients studied, was noted at mean 4.25 months (ranged from 3 to 13 months). The range of neo-phallus length in relaxed position was between 7 and 17 cm (mean 12.2 cm) (Fig. 14).

Fig. 14

*Neo-phallus length in relaxed position*
Its circumference in the same position had a range between 13 and 20 cm (mean 13.7 cm) (Fig. 15).

Fig. 15

*Neo-phallus circumference in relaxed position*
All examined patients were able to voluntarily contract the transferred LD muscle with an average length reduction of 3.08 cm (Fig. 16).

**Fig. 16**

*Neo-phallus length in contraction*
and an average circumference augmentation of 4 cm which represents augmentation of 0.6 cm in diameter. The ability of sexual intercourse is also shown in Tab. 2.

**Tab. 2**

*Neo-phallus dimension in relax and contraction position and its correlation with sexual intercourse ability.*

<table>
<thead>
<tr>
<th>Patient</th>
<th>Length relax/contraction</th>
<th>Circumference relax/contraction</th>
<th>Sexual intercourse</th>
<th>Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 M.F.</td>
<td>12cm/9cm</td>
<td>14.5cm/16.5cm</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2 J.L.</td>
<td>11cm/8cm</td>
<td>13cm/14cm</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3 T.H.</td>
<td>17cm/15cm</td>
<td>20cm/21cm</td>
<td>Did not try</td>
<td>No</td>
</tr>
<tr>
<td>4 N.S.</td>
<td>7.5cm/5.5cm</td>
<td>17cm/18cm</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>5 M.K.</td>
<td>9cm/8cm</td>
<td>17cm/17.5cm</td>
<td>Yes</td>
<td>?</td>
</tr>
<tr>
<td>6 M.K.</td>
<td>10cm/7.5cm</td>
<td>16cm/18cm</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7 S.L.</td>
<td>12cm/10cm</td>
<td>18cm/20cm</td>
<td>Did not try many time</td>
<td>No</td>
</tr>
<tr>
<td>8 D.K.</td>
<td>13cm/11cm</td>
<td>14cm/15cm</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>9 Z.V.</td>
<td>15cm/10cm</td>
<td>18cm/21cm</td>
<td>Did not try- No opportunity</td>
<td>---</td>
</tr>
<tr>
<td>10 T.V.</td>
<td>15cm/10cm</td>
<td>16cm/19cm</td>
<td>No opportunity</td>
<td>No</td>
</tr>
<tr>
<td>11 M.V.</td>
<td>10cm/8cm</td>
<td>13cm/14cm</td>
<td>So-so</td>
<td>?</td>
</tr>
<tr>
<td>12 M.M.</td>
<td>12cm/9cm</td>
<td>18.5cm/20cm</td>
<td>Only partially</td>
<td>?</td>
</tr>
<tr>
<td>13 J.A.</td>
<td>13cm/9cm</td>
<td>15.5cm/16.5cm</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>14 I.P.</td>
<td>14.6cm/8cm</td>
<td>14cm/17cm</td>
<td>Yes</td>
<td>Wife</td>
</tr>
<tr>
<td>Main</td>
<td>12.22/9.14</td>
<td>13.68/17.68</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For power evaluation, patients were asked to voluntarily lift different weights with the neo-phallus.

The weights started from 50 gr. up to the maximum possible weight; the elevation of at least 2 cm was considered as successful contraction which had lifted given weight. In the 14 studied patient, the average weight lifted was 1129 gr (min 100 gr, max 2750 gr) (Fig. 17).
Fig. 17

Neo-phallus in contraction during the measurement of its power muscle.
After electromyography, the mean number of APs in the 100 ms period was 31.5 (min 23, max 37). The mean amplitude from 10 highest positive peaks, measured peak-to-peak was 0.99 mV (min 0.176 mV, max 3.4) (Fig. 18).

Fig. 18
Electromyography of the neo-phallus during muscle contraction
5. Complications

No flap has been completely lost but 1 (5%) out of 22 flaps suffered partial necrosis. Haematoma of recipient site developed in 5 (23%) cases, revision due to arterial or venous thrombosis was necessary in 2 (9%) patients. Excessive swelling of neo-phallus required temporary release of longitudinal sutures in 3 (14%) patients.

In the donor site we had 1 patient (5%) with a partial skin graft loss which required secondary skin grafting (Fig. 19) and haematoma in 3 cases (14%).

Fig. 19

*Partial skin graft loss in the neo-phallus extremity*
Only minor seromas on the back were presented in several patients and none required evacuation.

Among the group of patients who completed long-term follow-up (n=18), 15 (83%) considered donor site morbidity as acceptable (fig. 20), 3 patients were unsatisfied with the appearance of the grafted donor site (17%).

**Fig. 20**

*Donor site 10 months after operation*
6. DISCUSSION

The ideal goal of total penile reconstruction makes the neo-phalloplasty particularly challenging. A naturally looking and functioning man’s phallus does not seem to be achievable yet as mentioned above. All actual methods of reconstruction are associated with problems. The cosmetic result is remarkably demanding but it might be easier to obtain appearance rather than to fulfil functional requirements of this organ. An ideal neo-phallus should permit the patient urinate in a standing position and engage in sexual intercourse with erogenous sensations. In addition, one-stage predictably reproducible procedure with minimal donor site morbidity is the desired goal of this reconstruction.

The first mentioned function, in female-to-male transsexuals, addresses the passage of urine in the neo-urethra (11, 98-100). Advantages of using a full thickness skin graft inside the main flap remain theoretical because stenoses can frequently appear. Previous experiences convinced us for the use of a separate free flap (35, 37, 39). Radial forearm free flap achieved this objective with minimal donor site morbidity and high overall satisfaction. However, only some of the patients requested subsequent reconstruction of the urethra after the neo-phalloplasty with latissimus dorsi free flap to date. Majority of them were satisfied with neo-phalloplasty itself having “something more in the pants”. Also, the prospective multiple procedures (free flap transfer, anastomosis of neo-
urethra, fistula closure) were discouraging. In this point of view, the importance of urinate standing up for the transsexual patients may be overestimated by some surgeons, because the cases of males who void sitting for they consider it more comfortable are know in Czech households.

The second function, the need of a proper penile stiffness for sexual intercourse is more difficult to obtain. It has been managed by surgeons in two ways: prosthetic devices (penile implants, external stiffeners, temporary stiffeners) or autologous materials. The prosthesis has the possibility to give a voluntary erection to the penis, and so permitting to engage in sexual intercourse, although they have certain disadvantages discussed above. Resorption, softening or fracture of autologous materials such as cartilage or bone grafts led to unsatisfactory results (13). Also, a permanent rigidity can make the patient uncomfortable or embarrassed. However, recent study of Sengezer showed persuasive results and long term stability of vascularized fibula flap used for penile reconstruction (101).

In our opinion, the best reconstruction should be done with an autologous material which enables neo-phallus to change in stiffness for sexual intercourse. The functional muscle tissue largely answered to these requirements.

The first successful functional muscle transplantation was reported in 1970 (102). Since then neurovascular muscle transplantation has been used in different areas to restore facial expression (103), improve limb motion (104,105), increase cardiac function (106), and restore sphincter function (107). We selected the
functional latissimus dorsi free flap for the amount of the skin and 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 \((104,105,108)\). In order to minimize the time of muscle denervation, the nerve coaptation was placed as closely as possible to the neuromuscular junction. As a recipient nerve the anterior branch of the obturator nerve proved to be the best for its proximity. To achieve best functional result, the electrostimulation began soon after the surgery and continued until satisfactory voluntary contraction was obtained. Then, the electrostimulation was followed by electrogymnastics for several months to improve muscle movement. The contraction of the adductors and gracilis muscle permits deliberate contraction of the transplanted muscle and cause negligible involuntary movements during walking. Although the muscle contraction shortens and widens the neo-phallus, it becomes suitable for sexual intercourse by its stiffening and movement. This “paradox” or “reverse” erection enables sexual intercourse by inserting either contracted or non-contracted neo-phallus into vagina and subsequent repeated intermittend contractions and releases of the muscle. However, certain limitation may be expected from fading of the muscle after prolonged repeated contractions.

Several disadvantages of this procedure were noted. A multi-stage character of the surgery in the case of urethral reconstruction discourages some patients from
urethra reconstruction as discussed above. On the other hand, other patients do not feel this fact to be essential in decision making for the type reconstructive procedure if the relative disadvantage of the three stage procedure is balanced by the benefit from the sexual function of neo-phallus. The preferences of the patients vary from one individual to the other and that is why the choice of reconstructive method is matter of both patient’s and surgeon’s preferences. The size of the neo-phallus has shown to be crucial in the view of the ability of penetration. Some difficulties arose in overweight patients when the neo-phallus was too thick even if the subcutaneous tissue of the flap had been thinned. In this case, the liposuction is offered after the neo-phalloplasty or lately, different method of reconstruction is advised to the patient. The smaller penis was mostly seen as a result of partial necrosis of the flap and can be rather considered as complication than a limitation of the procedure.

Although the erogenous sensation is being mentioned as one of the goals of neo-phalloplasty, it has not been emphasized in this study, because only deep sensation is expected in the non-sensory free flap. Only deep sensation was present in the patients and area of projection was mostly localized to the upper medial thigh at the area over the gracilis muscle. Lack of erogenous sensation is a matter to discuss, because no patient complained of lack of penis sensation. However, this matter had better be properly discussed with the patient before surgery.
Complications of the neo-phalloplasty such as haematoma might have been partially caused by the learning curve of the procedure or abundant use of anticoagulants postoperatively. Also, even minor haematomas were considered for the revision, to prevent impairment of circulation in the neo-phallus. The partial necroses on the tip of the neo-phallus were caused by the impairment of microcirculation as a result of relative imbalance between the volume inside the skin envelope and total volume of the fat and muscle of the neophallus with subsequent increase of the tissue pressure (analogy to compartment syndrome). For this reason, the longitudinal suture was released temporarily to relieve increased pressure in 3 cases and re-suture was done after the swelling subsided. This procedure helped to salvage the flaps. Lately, we prefer neo-phalloplasty with radial forearm free flap in patients, whose subcutaneous tissue on the back is more than approximately 2 cm thick. In case that patient does not wish to have visible scar or skin graft on the forearm, the parascapular free flap is being used.

Both latissimus dorsi musculocutaneous free flap and radial forearm free flap are used for neo-phallopasties in our clinic. Both of the methods are offered to the patients and decision is done after pros and cons have been discussed with the patient. Although radial forearm free flap is a well established one-stage procedure for neo-phallus and urethra reconstruction and gives good results, the neo-phalloplasty with re-innervated latissimus dorsi is nowadays the method preferred by most of our patients. Advantage of less conspicuous donor site of the
musculocutaneous latissimus dorsi free flap is the most commonly mentioned factor for decision making, because conspicuous donor site on the forearm is considered as a sign of recognition of transsexual patients. Possible risk of fistulation and repetition of the procedures are the reasons for not undergoing urethra reconstruction in some patients.
7. CONCLUSION

In conclusion, this neo-phalloplasty technique gives the patient ability for having sexual intercourse without the need for prosthesis. The voluntary contraction of the neo-phallus appears soon after the surgery, this leads to the changes of diameter length and shape – the “paradox erection” (stiffening but widening and shortening of the neo-penis); some patients are able to take advantage of these properties for sexual intercourse. Our findings document objectively, that this voluntary contraction of the artificial penis is a consequence of the re-innervation of the transferred muscle and the contraction is strong enough to stiffen the neo-phallus. Also, the data obtained represent useful tool for clinical assessment and comparison. The described technique allows for subsequent reconstruction of the urethra if patient desires.
8. BIBLIOGRAFY


9. Hage JJ, De Graaf FH. Addressing to ideal requirements by free flap phalloplasty: some reflections on refinements of technique. Microsurgery 1993;14: 592 – 598


Plast. Surg., 1948, 1: p. 8
57. Gillies, HD. Millard DR Jr. The principles and art of plastic surgery, 
volume 2. London, Butterworth, 1957 pp 368 – 84
58. Laub DR, Eicher W, Laub DR II, Hentz VR. Penis construction in 
female-to-male transsexuals. In Eicher W (ed): Plastic surgery in the 
59. Dias AD. The superficial external pudendal artery (SEPA) axial-
60. Patil UA, Dias AD, Thatte RL. The anatomical basis of the SEPA flap. 
61. Biber SH. A method for constructing the penis and scrotum. Presented 
at the VIth international symposium on gender dysphoria, San Diego 
1979
63. Hentz VR, Pearl RM, Grossman JAI, Wood MB, Cooney WP. The 
radial forearm flap: a versatile source of composite tissue. Ann Plast 
64. Snyder CC. Hermaphroditism. In Broadbent TR (ed): Transactions of 
Amsterdam, Excerpta Medica, 1964 pp 912 – 20


70. McGregor IA, Jackson IT. The groin flap. 1972 25:3 – 16


90. Laub DR. Metaiodoioplasty. Presented at the IXth international symposium on gender dysphoria, Minneapolis 1985


