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CASE REPORT
Reconstructive

fMRI after Phalloplasty with Nerve Anastomosis in a Trans-Man Patient

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Summary: We report on a case of a trans-man patient, who underwent penile reconstruction with the use of a radial forearm flap, urethroplasty, vaginectomy and scrotoplasty, insertion of testicle implants, and penile erection implants, similar to previously described methods. One of the requirements for an ideal phalloplasty is the preservation of erogenous sensitivity, which is often demanded by the patients for fulfilling their sexual well-being. For the first time known to us, we use a functional magnetic resonance imaging following radial forearm flap phalloplasty with nerve anastomosis to assess the cortical activation after clitoral stimulation. The patient was poked with a plastic pen on the neophallus and the groin. Regular block design with T1 and BOLD-T2* images were used. The results contradict the classic Penfield and Rasmussen homunculus, that is, the activations in the primary somatosensory cortex (S1) were bilateral with a left-sided dominance in the lateral parts of the medial postcentral gyrus (same region as the groin), and no activations were observed in the mesial parts of the postcentral gyrus. We also reported bilateral activations with a left-sided dominance in the secondary somatosensory cortex (S2) and near Broca's area at the sylvian fissure just posterior to ramus ascendens. Our findings are similar to previous studies reporting on imaging related to genital sensitivity. *(Plast Reconstr Surg Glob Open 2017;5:e1353; doi: 10.1097/GOX.0000000000001353; Published online 16 June 2017.)*

INTRODUCTION

One of the requirements for an ideal phalloplasty is the preservation of erogenous sensitivity, which is often demanded by the patients for fulfilling their sexual well-being.[1] Sensation of the neophallus was subjectively demonstrated with a Semmes-Weinstein monofilament and vibration test[2]; however functional magnetic resonance imaging (fMRI) might objectively confirm it.

The well-known Penfield and Rasmussen homunculus depicts the somatotopic arrangement of genital sensations in the mesial part of the primary somatosensory cortex (S1),[3] recently confirmed using fMRI.[4] However, other studies on genital stimulation present controversies regarding the precise neuroanatomical localization showing bilateral activations with a left-sided dominance lateral to the midline of S1, that is, the groin region.[5–7] Therefore, a recent review has proposed 2 distinct S1 regions for genital sensations.[8]

Imaging studies have also demonstrated bilateral activation with a left-sided dominance of the secondary somatosensory cortex (S2) and the posterior insula[4,6,7] when stimulating the clitoris.

The following research questions are considered: Which cortical areas are activated by stimuli of the neophallus following anastomosis of a genito-femoral nerve to the clitoral nerve and do the activations differ?

METHODS

Patient

A case report on a trans-man patient, who between 2013 and 2015 underwent phalloplasty with the use of ra-

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dial forearm flap (RFF), urethroplasty, vaginectomy, scrotoplasty with insertion of testicle and erection implants, and 6-monthly epilation treatments postoperatively.

The RFF phalloplasty with nerve anastomosis was similar to previously described methods by Chang and Hwang[9] and Gilbert et al.[10] with refinements described by the Ghent Gender Team.[2,11–15] Figure 1 offers a more comprehensive explanation.

When receiving local anesthesia before epilation to the left and right side of the neophallic shaft, pain was referred to the clitoris and to the right superior groin, respectively. The patient reported a satisfactory sexual life with capability of orgasm during masturbation and penetrative coitus and reported erogenous sensation from the neophallus.

fMRI

Scan was performed 30 months postoperatively using a 32-channel head coil (Philips Medical Systems, The Netherlands) 3T MRI-system. T1-weighted images were acquired with $1 \times 1 \times 1\,mm^3$ resolution. BOLD fMRI images were acquired using T2*-weighted single shot, GE-EPI, TE = 35 ms, TR = 3000 ms, $2.8 \times 2.8 \times 2.8\,mm^3$ resolution. Six stimulation paradigms made with a plastic pen were performed:

1. Poking the left side of the neophallus.
2. Poking the right side of the neophallus.
3. Poking the right groin.
4–6. Stroking the left and right sides of the neophallus and the right groin.

We used block design (15-second stimuli followed by 15-second rest, totally 480 seconds). The data were analyzed using nordicBrainEx NordicNeuroLab AS, Bergen, Norway. (v2.2.1). Co-registered, Gaussian filtered ($4 \times 4 \times 4\,mm^3$), and motion corrected. Results were visually inspected with pixel t scores ≥ 4 considered to show activation.

RESULTS

Results showed overlapping activation patterns from stimuli 1–3, without obvious regional differences observed. Patterns from stimuli 4–6 were diffuse and considered nonassessable, thus not further analyzed.

Significant activations were found in: (1) the postcentral gyrus, lateral to the midline (S1). All 3 stimuli showed bilateral activations with left-sided dominance (Fig. 2). (2) The sylvian fissure, gyrus supramarginalis (S2). All 3 stimuli showed bilateral activations with a left-sided dominance (**see figure, Supplemental Digital Content 1**, which shows activation found in the sylvian fissure, gyrus supramarginalis (S2), ***http://links.lww.com/PRSGO/A457***). (3) The sylvian fissure, posterior to ramus ascendens. Left-side activation for stimuli 2 and 3, and bilateral activation for stimuli 1 (**see figure, Supplemental Digital Content 2**, which shows activation found in the sylvian fissure, posterior to ramus ascendens, ***http://links.lww.com/PRSGO/A458***).

Also, nonsignificant activations from stimuli 1 and 2 in left insula (not shown) were found.

DISCUSSION

This is the first fMRI study on clitoral stimulation following RFF phalloplasty with nerve anastomosis, known to us. We observed pain in the groin and clitoris when injecting a needle during epilation, suggesting a successful nerve anastomosis.

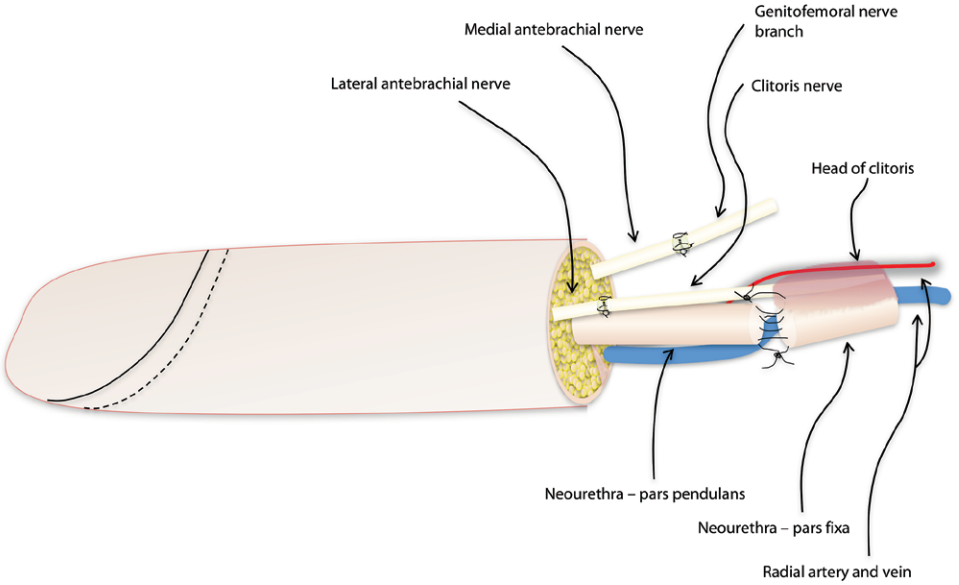

Fig. 1. Specifically regarding the genital sensitivity, the labia minora are closed together to create the pars fixa of the penis, the clitoris is denuded of its mucosa and displaced at the basis of the penis, the clitoral hood is incorporated to form the superior and anterior part of the scrotum, and the labia majora are lifted and rotated to create the scrotum. In addition, the medial and lateral antebrachial nerves of the forearm are harvested together with the RFF; one of the antebrachial nerves is anastomosed to one of the dorsal clitoral nerves, and the other antebrachial nerve is anastomosed to any branch of the ilioinguinal or genitofemoral nerve.

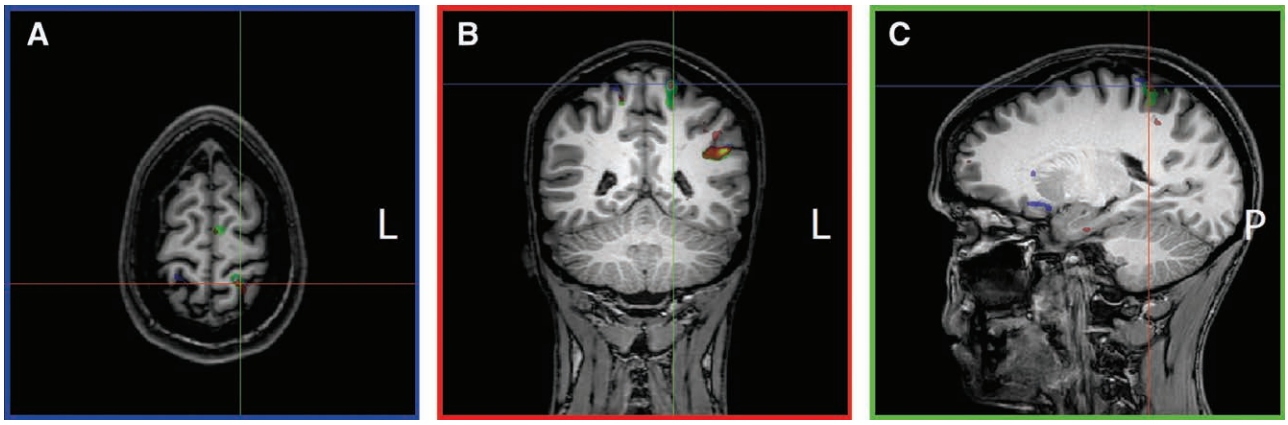

Fig. 2. Activation found in the postcentral gyrus (S1), lateral to the midline, in correspondence with the groin region. Activations were bilateral, with a left-sided dominance. A, Blue = activation from stimuli 1 (poking the left side of the neophallus. B, Red = activation from stimuli 2 (poking the right side of the neophallus. C, Green = activation from stimuli 3 (poking the right groin. Only activations with *t* score ≥ 4 are shown.

We demonstrated bilateral activation of S1 (Fig. 2) with left-hemispheric dominance, lateral to the midline, that is, the groin region, consistent with previous fMRI findings.[7] The overlapping suggests common somatotopic arrangement for the groin and clitoris. Left-hemispheric dominance has been described previously and has been postulated to stem from a brain lateralization bias.[6,7] We found no activation of the mesial part of S1, described by the Penfield and Rasmussen homunculus as well as a recent fMRI study.[3,4]

We also demonstrated bilateral activation of S2 (**Supplemental Digital Content 1**, ***http://links.lww.com/PRSGO/A457***) with left-sided dominance, similar to previous findings,[4,6,7] suggested for a role in the conscious perception of a stimuli as being sexual.[6]

Finally, we demonstrated activation posterior to ramus ascendens on the sylvian fissure, near Broca's area (**Supplemental Digital Content 2**, ***http://links.lww.com/PRSGO/A458***). We found no previous records from this area regarding clitoral stimulation.

Furthermore, we found nonsignificant activations on the insular region. Although its purpose in tactile stimulation is not known, it is shown to activate when stimuli is perceived as sexual, whereas nonsexual stimulation reports no increased activity.[7,8]

The somatotopic arrangement of the genital presented by Penfield and Rasmussen is challenged by several brain imaging studies,[6,7,16] whereas some studies support it.[4] It may be due to 2 distinct S1 regions for genital sensations, 1 mesial and the other lateral to the midline.[8]

Indeed, this is a single case report. If performing the same type of surgery to other patients, more precisely the same type of anastomosis and the same fMRI protocol, we would expect similar cortical activations. Because anastomosis of the forearm nerves to the clitoral and inguinal nerve are constant, and considering the proposed distinction by Cazala et al.,[8] we expect that variations among individuals would not be due to different surgical techniques or peripheral anatomy but rather due to difference in the type of stimuli.

CONCLUSIONS

This is the first case showing genital cortex representation on fMRI after RFF phalloplasty with nerve anastomosis on a trans-man patient, similar to previous reports on imaging related to genital sensitivity. It contradicts the classic Penfield and Rasmussen homunculus, that is, the activations were bilateral with a left-sided dominance in the lateral parts of the medial postcentral gyrus (overlapping the groin region), and no activations were observed in the mesial parts of the postcentral gyrus.

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