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Psychophysiological and subjective sexual arousal to visual sexual stimuli in new women

LORI A. BROTTO[1], DARLYNNE GEHRING[2], CAROLIN KLEIN[3], BORIS B. GORZALKA[3], SYDNEY THOMSON[1], & GAIL KNUDSON[2]

[1]*Department of Obstetrics/Gynaecology, University of British Columbia, Vancouver, Canada,* [2]*Department of Psychiatry, University of British Columbia, Vancouver, Canada, and* [3]*Department of Psychology, University of British Columbia, Vancouver, Canada*

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Abstract
Conflicting data exist regarding the sexual arousal patterns of post-operative male-to-female (MTF) women with Gender Identity Disorder. The purpose of this study was to examine objective and subjective aspects of the sexual arousal response using a vaginal photoplethysmograph. Fifteen MTF women viewed neutral and erotic audiovisual film segments while their blood flow patterns were monitored. Subjective measures of affect and sexual arousal were taken before and immediately after the films. There was a significant increase in self-reported subjective arousal, perceived genital arousal, perceived autonomic arousal, and positive affect; however, movement artefacts interfered with our assessment of the genital arousal response. MTF women reported both low levels of pain and low levels of awareness of the vaginal probe during testing. These data are discussed in the context of differences in pelvic musculature between natal and new women and have implications for future studies that aim to measure sexual arousal objectively in MTF women.

Keywords: *Gender identity disorder, male-to-female transsexual, sex reassignment surgery, vaginal photoplethysmography, sexual arousal*

Gender Identity Disorder (GID) is diagnosed when an individual experiences (1) a strong, persistent cross-gender identification (not merely a desire for any perceived cultural advantages of being the other sex), and (2) a significant discomfort with his or her sex or a sense of inappropriateness in the gender role of that sex (termed gender dysphoria) [1]. GID should be distinguished from Transvestic Fetishism – a form of cross-dressing that the DSM-IV-TR describes as often being associated with intense sexual fantasies or sexual urges. In a small number of individuals with transvestic fetishism, there is also the persistent desire to live and dress permanently as the opposite sex, in which case the diagnosis becomes Transvestic Fetishism with Gender Dysphoria.

Views on GID have changed considerably over the last three decades, from attempting to ''treat'' individuals with the disorder through various behavioural therapies [2,3], to focusing on quality of life via surgical techniques that preserve sexual function [4,5]. The Harry Benjamin International Gender Dysphoria Association was established in 1978 to provide Standards of Care for health professionals treating individuals with GID. According to the Standards of Care published in 1998 [6], Sex Reassignment Surgery (SRS) is considered to be ''effective. . .when prescribed or recommended by qualified practitioners, is medically indicated, and [is] medically necessary''. Research on the long-term results of SRS in individuals with GID includes studies examining physical function [7], psychological function [8], and satisfaction with surgery [9]. For example, a large retrospective study on 232 male-to-female (MTF) women at least one year following SRS indicated that 96% were happy with the surgical results and 97% experienced improved quality of life as a result [5]. Moreover, no individuals reported consistent regret, and only a small minority experienced occasional regret over the surgery. Satisfaction with mammoplasty has also been evaluated with 75% of a sample of 107 MTF women reporting a favorable outcome [10].

Relative to these domains, much less research has explored the long-term impact of SRS on sexual functioning in the post-operative woman, and this literature will be summarized briefly here. Lindemalm and colleagues [11] interviewed 13 MTF individuals between 6 and 25 years after SRS in

Correspondence: Lori A. Brotto, PhD, Department of Obstetrics/Gynaecology, Room 119, 805 West 12th Avenue, Vancouver, BC, Canada, V5Z 1M9. E-mail: Lori.Brotto@vch.ca

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hopes of documenting effects on physical sexual function. Medical records and physical examinations supplemented the interview material and indicated that the surgical outcome overall was ''disappointing,'' with only half of the sample having a functional vagina. The interview responses suggested an even less favorable outcome, with less than a quarter of the sample reporting that they felt they had a functional vagina. Rehman et al. [12] found that 50% of their sample of 28 post-operative women was able to engage in intra-vaginal intercourse following surgery. Those who did not engage in intercourse attributed this to vaginal stenosis (narrow and shallow vagina) and/or pain with penetration. In another study, 19 of 22 patients were able to experience intercourse at least once after SRS [13]. Among this subgroup, however, nearly half reported believing that their neovagina was inadequate to tolerate penetration by some or all partners.

Sexual satisfaction has also been the focus of a few studies. Hunt and Hampton [14] collected self-reports from 17 MTF women as well as from their partners and family members. Sexual adjustment reportedly improved in 13 and deteriorated in one individual. Others [12] have found slightly lower rates of sexual satisfaction. For example, only 50% of a sample of 28, and 20% of a sample of 10 individuals [15] reported sexual satisfaction following SRS. Using a more dimensional measure of satisfaction, Schroder and Carroll [16] found the average satisfaction rating in a sample of 17 MTF women to be 5.4 where 10 represented ''very high satisfaction''.

Orgasmic function following SRS has also been the focus in a few studies. Rates of orgasmic experience have reportedly ranged anywhere from 29%–70% across studies [11,12,16,17,18]. For some patients, the quality and intensity of orgasms are reported to be better than before SRS, whereas for others, orgasmic difficulties after SRS lead to new onset sexual desire complaints. In studies that have focused on the quality of orgasmic experience, various outcomes emerged with one study reporting 32% of women having no difficulties, 32% experiencing some difficulties, 18% experiencing a diminished intensity of orgasms, and 18% reporting complete inability to reach orgasm following SRS [13].

Taken together, studies exploring sexual function in this population have yielded variable outcomes depending on the methodology, sample, year of publication, and research center where the study was conducted. The vast majority of this research on sexuality after SRS has relied on self-report instruments or interviews. It has been argued that these measures are particularly vulnerable to distortion in the GID population [19], and this may partially account for the disparate outcomes with respect to sexual function. Efforts to employ more objective measures, such as medical reports or obtaining information from sexual partners and family members have also been problematic and do not necessarily overcome the potential bias in self-report. Green [19] issued a call for ''hard data and physiological measures of sexual arousal'' in MTF women after SRS to address such methodological shortcomings.

Physiological measurement of sexual response in natal women has taken place for nearly four decades and includes a variety of techniques including the vaginal photoplethysmograph [20], labial thermistor [21], heated electrode [22], and genital magnetic resonance imaging [23]. These methods provide indirect indices of genital sexual arousal based on physiological properties of the genital tissue. Penile plethysmography has been used in pre-surgical MTF individuals, and has found lower penile volume responses to erotica compared to homosexual and heterosexual natal men without GID [24,25]. In post-surgical MTF individuals, however, we could identify only one published English-language study that employed a physiological measure of sexual response. Using a vaginal photoplethysmograph, Schroder and Carroll [16] found that neovaginal blood flow in a sample of 17 MTF women was comparable to that from natal women during a resting baseline state. Approximately half of these women were able to engage in full vaginal intercourse. Although this study represents an improvement in the assessment of sexual response in MTF women by incorporating a physiological measure, the methodology used limits any conclusions about the genital sexual arousal responses of the group. In other words, because women in that study were not exposed to erotic stimuli, and because measurement characteristics of the vaginal photoplethysmograph require that blood flow responses are compared between neutral and erotic stimuli in order for inferences about genital vasocongestion to be made [26], any conclusions about genital arousal patterns are tenuous, at best.

Therefore, the primary purpose of this investigation was to examine patterns of genital blood flow, using a vaginal photoplethysmograph, in a sample of post-surgical MTF women during a condition of heightened sexual arousal. To the extent that the reconstructed genital anatomy permits analysis of blood flow with a vaginal photoplethysmograph, this method may provide important information about genital arousal following SRS.

Methods

Participants

Fifteen individuals with GID were recruited from the existing patient population at the Center for Sexuality, Gender Identity, and Reproductive Health at a large metropolitan hospital. Their health care provider, who was providing follow-up care, informed potential participants about the research and indicated that their participation in this research

would not impact their current or future care at the clinic. Interested individuals were asked to contact the psychophysiology laboratory affiliated with this clinic where one of the co-investigators conducted a telephone screen to assess suitability. Inclusion criteria included: (1) at least 12 months post-operative for SRS; (2) age between 21–65; and (3) ability to insert a vaginal probe. Exclusion criteria were: (1) current, active psychopathology including psychosis or suicidality; and (2) current use of psychotropic medication with known sexual side effects. All new women had also undergone a recent genital examination by a gynaecologist in the clinic where follow-up care was provided and information on vaginal length was documented. Individuals who agreed to participate and who met study criteria scheduled a date for their session.

Procedure

The session was conducted by one female researcher and began by orienting the participant to the laboratory equipment, obtaining written consent, and answering any questions about the study protocol. Participants then completed a short battery of questionnaires in a private, internally locked testing room adjacent to the investigator's room. Questionnaires included the Brief Index of Sexual Functioning for Women (BISF-W) [27], which assesses various aspects of female sexual function and satisfaction; the Detailed Assessment of Sexual Arousal [28], which assess aspects of sexual arousal including mental sexual arousal, awareness of physical non-genital and genital sexual arousal, and pleasure from direct genital stimulation; and a Demographics Form, which assesses aspects of health and demographic variables. The Detailed Assessment of Sexual Arousal was measured on a Likert scale from 1 (*low intensity*) to 7 (*high intensity*). Women were also asked about their level of satisfaction with orgasmic function ranging from ''I am very satisfied with my orgasmic functioning'' (5) to ''I am greatly distressed about my orgasmic functioning'' (1). Following completion of the questionnaires women participated in a psychophysiological assessment of sexual arousal where they were asked to insert the vaginal probe with the aid of diagrammed instructions. The instrument was sterilized in a solution of Cydex-activated glutaraldehyde between uses. A TV monitor was placed on a high table so that participants could comfortably recline on a couch with full view of the screen. Participants were provided with a light blanket and instructed to lie quietly for a 5-minute adaptation period before the onset of the video. Each film sequence included a 1-minute display of the word ''relax'', followed by a 3-minute neutral stimulus depicting a documentary of a geographical location. Immediately following, a 3-minute erotic stimulus of the ''female-friendly'' variety was presented, and consisted of a nude heterosexual couple engaging in foreplay, mutual manual-genital and oral-genital stimulation, and intercourse. The films depicted exclusively heterosexual activity. During the telephone screen participants indicated that they would expect to find heterosexual erotic films subjectively arousing; however, on questionnaires the participants reported various responses regarding their preferred sexual partner. Immediately prior to and following the film, participants completed a self-report questionnaire assessing autonomic arousal, perception of genital sexual arousal, subjective sexual arousal, anxiety, positive affect, and negative affect [29]. These items were rated on a 7-point Likert scale from (1) not at all to (7) intensely. At study completion, women were debriefed in terms of responding to any questions that may have arisen during the course of the investigation. At this time participants were also asked to rate their level of awareness of the probe during testing as well as the level of pain evoked from the probe (1 = low, 10 = high). All procedures were approved by the Institutional Review Boards of the University of British Columbia and Vancouver Hospital.

Psychophysiological recording

Vaginal pulse amplitude (VPA) was chosen instead of vaginal blood volume as it is consistently found to be the more sensitive and specific measure of genital arousal [30]. VPA was monitored throughout exposure to each film segment and recorded on an HP Vectra Celeron personal computer using the software program, AcqKnowledge III, Version 3.5 (BIOPAC Systems, Inc., Santa Barbara, CA) and a Model MP100WSW data acquisition unit (BIOPAC Systems, Inc.) for analog/digital conversion. A sampling rate of 200 samples/second was used for VPA throughout the 180 seconds of neutral and 180 seconds of erotic film exposure. The signal was band-pass filtered (0.5–30 Hz). One of two vaginal probes (Behavioral Technology Inc., Salt Lake City, UT) was used, and the incoming signal was calibrated prior to each session using the zero adjustment knob on the MP100WSW unit. Data were analyzed in 30-second segments, then averaged over the neutral and erotic segments separately, resulting in two data points per subject. Artefact detection and deletion took place following visual inspection of the data.

Data analyses

Demographic and questionnaire data are presented in terms of means and standard error of the mean (SEM; for ordinal scales), and proportions (for categorical variables). The effects of visual sexual stimuli on psychophysiological and subjective sexual arousal were assessed with paired-samples *t*-tests. A Bonferroni correction was applied to the analysis of

subjective reactions to the film given that the six domains of this scale might be theoretically related. A p level of 0.05 / 6 = 0.008 was thus set for these comparisons. For analysis of all other variables, a p level of 0.05 was deemed significant.

Results

Demographic information

All 15 MTF individuals completed the study procedures in their entirety. Participants were an average of 43.2 years old (range 33–55) and received SRS approximately 24 months earlier (range 12–60 months). All participants received penile skin inversion surgery and were receiving follow-up care at the same clinic. At the time of participation in this study, the average vaginal length was 8.9 cm (range 5.5–11.6 cm). Vaginal length was unrelated to time since surgery ($p > 0.05$). Four participants were involved in a sexual relationship at the time of physiological testing. Eleven women identified as having a largely or entirely heterosexual orientation (i.e., attracted to men), one woman as equally homosexual and heterosexual, and three women as largely or entirely homosexual (i.e., attracted to women). Fourteen women were Caucasian and one was First Nations Canadian. Ten participants were currently employed, four women were either retired or unemployed, and one did not provide employment information.

Questionnaire data

BISF-W subscale totals (means and SEM) are listed in Table I. On all subscales, scores were found to be in the lower half of the normative range for this questionnaire despite the finding that scores on the "Problems affecting sexual function" subscale were very low, indicating no sexual problems. Responses on the Detailed Assessment of Sexual Arousal with a maximum score of 7, revealed the average level of mental sexual arousal to various types of sexual stimuli to be 5.00 (SEM = 0.28). Awareness of non-genital physical arousal was 4.7 (SEM = 0.37), awareness of genital arousal was 4.57 (SEM = 0.41), and self-reported pleasure from direct genital stimulation was 4.67 (SEM = 0.48). Six women (40%) reported an ability to attain orgasm by at least one means (e.g., clitoral stimulation, intercourse, vibrator use, fantasy). Ten women (67%) reported being satisfied with their orgasmic function, three women (20%) reported being dissatisfied or distressed, and two women (13%) did not complete this item.

Table I. Responses to items on the Brief Index of Sexual Functioning for Women (BISF-W) in post-surgical MTF women. The number of women the data are based upon are listed. Data represent means (± standard error of the mean).

BISF-W subscale	n	Mean (± SEM)	Maximum possible score
Thoughts/ desire	15	5.93 (1.34)	12
Arousal	15	3.00 (0.63)	8
Frequency of sexual activity	15	2.10 (0.48)	6
Receptivity/ initiation	6	8.67 (1.02)	15
Pleasure/orgasm	11	2.66 (0.54)	8
Relationship satisfaction	15	5.20 (1.02)	12
Problems affecting sexual function	15	2.29 (0.44)	16

For all scales except the "Problems affecting sexual function", higher scores denote better sexual function. For the final subscale, higher scores indicate more problems affecting sexual function.

Effects of erotic stimuli on physiological sexual arousal

As suggested by Table II, the effect of the erotic film on physiological sexual arousal was not significant, t (14) = 0.147, $p > .05$ (mean VPA increase during neutral condition = 4.94 mV and mean VPA increase during erotic condition = 4.83 mV). Closer examination of individual VPA profiles indicates that there were numerous movement artefacts throughout the VPA signals, which rendered data reduction and analysis difficult, even with software artefact removal and smoothing. We chose a random sample of four VPA outputs to illustrate the magnitude of movement artefacts (see Figure 1).

Effects of erotic stimuli on self-report measures of arousal and affect

As shown in Table II, the erotic film significantly increased self-reported autonomic arousal, $t(14) = -5.00$, $p < 0.001$; perceptions of genital arousal, $t(14) = -4.84$, $p < 0.001$; subjective sexual arousal, $t(14) = -4.71$, $p < 0.001$, and positive affect, $t(14) = -4.32$, $p < 0.001$. Neither anxiety, $t(14) = 1.38$,

Table II. Effects of visual sexual stimuli (neutral and erotic) on Vaginal Pulse Amplitude (VPA) and self-report measures of arousal and affect. Data represent means (± standard error of the mean).

Measure	Neutral	Erotic
VPA (millivolts)	4.94 (2.14)	4.83 (1.41)
Autonomic arousal*	9.60 (1.10)	16.93 (1.03)
Perception of physical arousal*	8.80 (1.18)	17.73 (1.69)
Subjective sexual arousal*	7.40 (0.52)	10.8 (0.53)
Positive affect*	12.53 (1.32)	20.67 (1.66)
Negative affect	13.00 (0.70)	14.27 (1.16)
Anxiety	2.73 (0.54)	2.07 (1.66)

*$p < 0.001$, significant difference between neutral and erotic conditions.

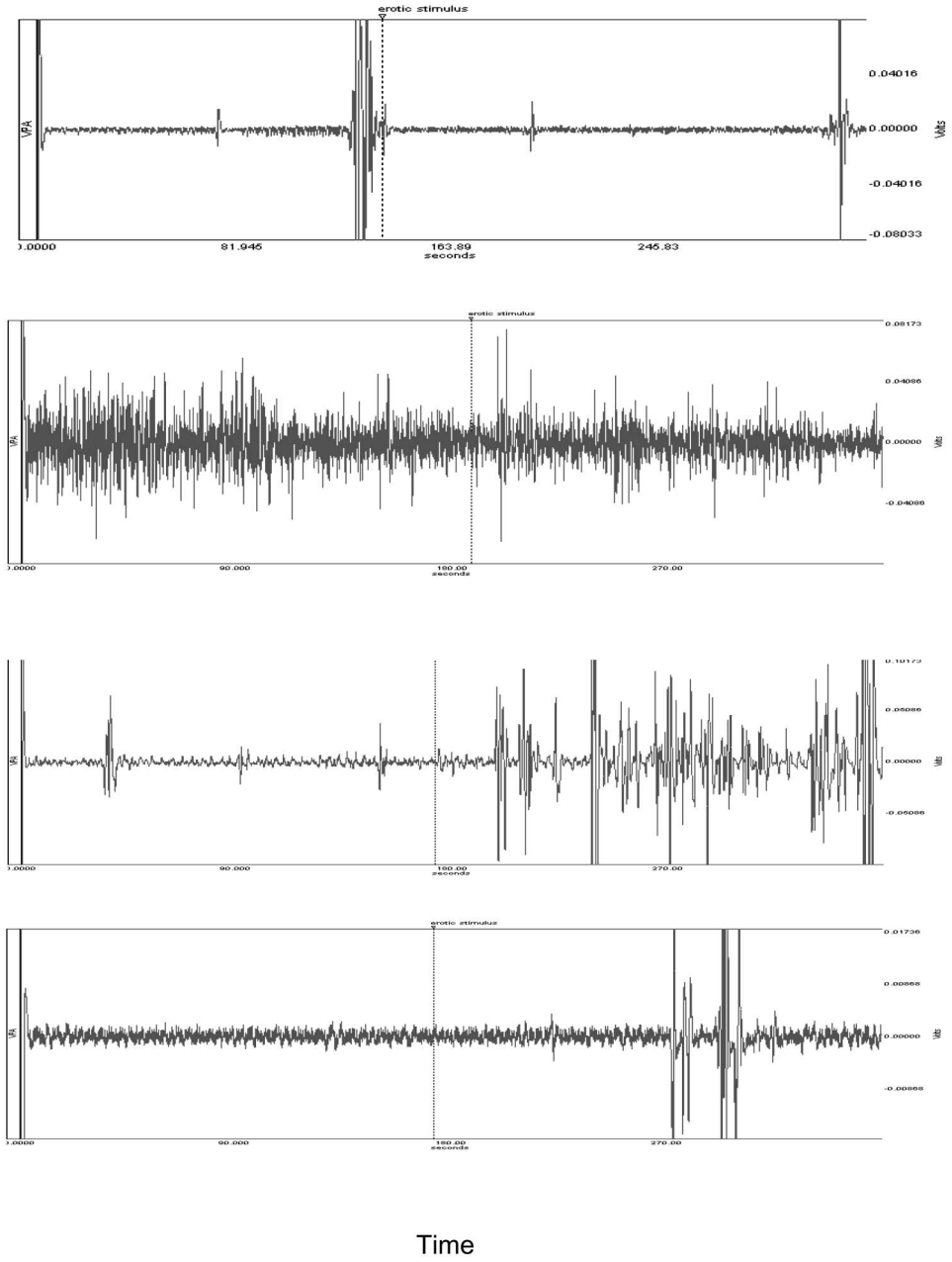

Figure 1. Effects of visual sexual stimuli (neutral and erotic) on Vaginal Pulse Amplitude (VPA) for a random sample of four data outputs. Output to the left of the dotted line indicate responses to the neutral stimulus and output to the right of the dotted line represent responses to the erotic film.

$p > 0.05$, nor negative affect, $t(14) = -1.33, p > 0.05$, were significantly affected by the erotic film.

Responses to vaginal probe insertion

The mean level of awareness of the probe was 3.9 (SEM = 0.68) where 1 = completely unaware and 10 = completely aware of the probe. The average level of pain from inserting the probe was 1.0 (SEM = 0.00) where 1 = no pain and 10 = very painful. Vaginal length was not significantly related to awareness of the probe during testing ($r = 0.08$), nor to pain with insertion of the vaginal probe ($r = 0.00$), $p > 0.05$.

Discussion

Overall the findings suggest satisfactory levels of self-reported sexual arousal in the real-life setting for MTF individuals who are at least 12 months post-SRS. Compared to responses from a similarly-aged group of natal women experiencing sexual arousal difficulties [31], levels of self-reported mental arousal, awareness of genital arousal, and pleasure from direct genital stimulation were higher in the current group of MTF participants. However, scores on the BISF-W Desire, and Pleasure subscales were in the lower half of the normative range for this questionnaire. This may partially be explained by the low

number of new women currently in a relationship or currently engaging in partnered sexual activity. Despite the lower Desire and Pleasure scores, this group did not report sexual problems overall. Therefore, it appears that this group of MTF individuals experience satisfactory levels of subjective and perceived physiological sexual arousal in their natural environments.

With respect to orgasmic function, 40% reported ability to reach orgasm by at least one means, and 67% reported overall satisfaction with orgasm. This suggests that satisfaction with orgasmic function is not necessarily dependent on the physiological ability to attain orgasm, at least in this particular group. Given the marked variability of rates of orgasmic ability in prior research, and the current finding that satisfaction is not correlated with ability, one might conclude that a focus on orgasmic capacity may not be the optimal endpoint measure of sexual function in this group. Rather, assessment of satisfaction may be a more accurate measure. Moreover, which factors predict orgasmic satisfaction, given that actual orgasmic capacity per se is not a predictor, would be an interesting question to explore.

In response to visual sexual stimuli presentation, self-reported sexual arousal, perception of genital arousal, and perception of autonomic arousal increased. This suggests that this particular group of MTF participants was able to become subjectively aroused in a highly artificial testing situation. Moreover, their positive affect towards the erotic film increased, whereas anxiety and negative affect were unaffected. Thus, despite the exclusive heterosexual content of the film, all participants experienced subjective pleasure while viewing the film. These findings suggest that future research should continue to explore assessment of sexual arousal in a laboratory setting using other forms of genital arousal assessment.

With regards to the main outcome variable in the study, we were unable to measure VPA responses during the erotic condition due to significant movement artefacts. We present a random sample of four VPA outputs in Figure 1; however, the VPA responses of all 15 participants contained movement artefacts during the erotic segment that rendered data analysis impossible. In approximately half of the data outputs we could calculate VPA mean values during the neutral stimulus condition. Thus, these findings are not inconsistent with those of Schroder and Carroll [16] who detected a VPA signal during a resting baseline condition, but who did not subsequently present their participants with erotic stimuli. Given the dependence on within-subject comparisons inherent to using the vaginal photoplethysmograph, one cannot make inferences with respect to genital arousal during the erotic condition on the basis of exposure to a baseline condition or to a neutral film alone. We were able to locate one article, published in Dutch, which used vaginal photoplethysmography in a group of MTF women. In their small sample of five individuals, Balsma et al. [32] detected a VPA signal during the erotic film exposure in only two women, but movement artefacts prevented VPA analysis in the remaining individuals. The problem of movement artefacts therefore seems characteristic of the study sample as opposed to the methodological techniques employed at our site alone.

A number of explanations might account for the numerous movement artefacts during the erotic stimulus condition. It is possible that discomfort from the inserted probe resulting in movement might be responsible. However, when asked about their level of awareness of the probe and the amount of pain evoked from its insertion, responses were relatively low (3.9 and 1.0, respectively, on a scale from 1 to 10). Moreover, awareness of the probe was not related to vaginal length. Another explanation for the numerous artefacts relates to the tissue used to construct the neovagina. Balsma and colleagues [32] speculated that the movement artefacts may be attributable to muscle contractions because of remaining male muscle tissue which is stronger in the male pelvic muscles. In natal women the pelvic floor muscles surround the vaginal opening while in MTF women the neovagina is created behind the male pelvic floor muscles. Only the levator ani muscles (which are much deeper in the perineum) have a similar position in both men and women. These researchers also suggest that movement artefacts may be due to the influence of the prostate, which is preserved in MTF women. In the current study all new women had undergone penile inversion surgery where scrotal tissue is used to line the vaginal vault. Another explanation is that MTF women, as do natal men, use voluntary pelvic floor contractions as a means of enhancing vasocongestion.

In conclusion, the findings from this study suggest that the vaginal photoplethysmograph cannot be considered a viable technique to study the blood flow patterns in the neovagina during conditions of sexual arousal. However, the finding that this group was able to become subjectively sexually aroused suggests that the laboratory assessment of sexual arousal may be acceptable if alternative forms of objective genital arousal measurement are considered. Recently neural activity in response to non-erotic stimuli was measured in a group of MTF individuals using the P300 wave, and was found to significantly differ from a natal control group [33]. It is possible that such techniques may be helpful in the psychophysiological assessment to sexual stimuli in the future. It might also be fruitful to re-examine the use of earlier genital psychophysiological techniques (e.g., the heated electrode) [22] which, despite their obtrusiveness, are less susceptible to movement artefacts. With growing sophistication in the assessment of women's sexual arousal, we expect

that the measurement of genital arousal in previously under-researched groups of women will be a thing of the past.

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Current knowledge on this subject

- Although subjective aspects of the sexual response in postoperative male-to-female (MTF) women with Gender Identity Disorder has been studied extensively, almost no data exist on physiological patterns of sexual arousal in this group of new women.
- The study has implications for the use of vaginal photoplethysmography, a technique used widely in the measurement of sexual arousal in natal women, for MTF women.

What this study adds

- This study suggests that the vaginal photoplethysmograph cannot be considered a viable technique to study the blood flow patterns in the neovagina during conditions of sexual arousal in MTF women due to movement artefacts.
- Given that this group of women became subjectively sexually aroused to erotic stimuli in the laboratory setting, researchers might explore other methods of physiological sexual arousal assessment less susceptible to movement artifacts for furthering our understanding of the sexual response in new women.