Physiological Changes in Female Genital Sensation During Sexual Stimulation

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ABSTRACT

Introduction. A normal sexual response in the female depends on the integrity of afferent sensory input from the genital region. So far genital sensation has been investigated only during a non-excitatory state, and the sensory physiological changes, which occur during the sexual cycle in this region, are still obscured.

Aim. To investigate the sensory status of the female genital region during sexual arousal and orgasm.

Main Outcome Measures. Genital sensory thresholds measured by Quantitative Sensory Testing (vibratory and thermal) were compared in a non-excitatory vs. excitatory state in normal sexually functioning females.

Methods. Eleven healthy female volunteers were recruited and attended three separate visits. During each session only one anatomical site, either clitoris or vagina was tested for either vibratory or thermal stimuli. A psychophysical method of limits was employed for threshold determination of warm or vibratory stimuli. In each session, all women were tested at baseline, immediately after arousal, after orgasm and three more measurements – 5, 10, and 20 minutes during the recovery state.

Results. A significant decrease in clitoral vibratory sensation threshold was observed between the baseline and the arousal phases (P = 0.003). Comparison of vibratory sensation between baseline and following orgasm at the clitoral and vaginal region showed a significant difference (P < 0.001) for both regions. These changes were not significant for thermal threshold sensation at the clitoral region (P = 0.6).

Conclusions. This is the first time that genital sensation has been measured during the excitatory phase of the female sexual cycle. This normative data may serve as a baseline for further investigations of the sensory input of the genital organs during intercourse in pathological states. Gruenwald I, Lowenstein L, Gartman I, and Vardi Y. Physiological changes in female genital sensation during sexual stimulation. J Sex Med 2007;4:390–394.

Key Words. Diagnostic Testing; Female Genital Sensation; Sexual Stimulation
be applied as a valuable diagnostic tool in the management of sexual dysfunction, especially when a neurogenic deficit is suspected.

So far, genital sensation has been evaluated only during a non-excitatory state, which does not represent the true sensory status at intercourse. It is debatable whether evaluation of genital sensation during sexual excitation would add valuable information that may help to better assess females with suspected genitalia neuropathies.

The aim of our current study was to determine if there is any difference in sensitivity at the genital area to thermal and vibratory sensation in the non-excitatory state, during and after sexual stimulation in females with normal sexual activity.

Methods

Healthy sexually active females with normal sexual function, as estimated by the Female Sexual Function Index (FSFI) validated Female Sexual Dysfunction (FSD) questionnaire [6] and free of intercourse-related pain were included. All participants signed an informed consent form and the local ethics committee approved the study protocol.

All females attended three separate visits, during which only one anatomical site and sensory modality (either clitoris or vagina, heat or vibratory) was tested. The clitoral region was tested for thermal and vibratory sensation, and the vaginal region only for vibration, as in the first four women no changes in vaginal thermal sensation were found.

Quantitative sensory testing was performed with a Thermal/Vibratory Sensory Analyzer System, using specially designed thermal and vibratory probes. The test involves placing the probes in contact with the clitoris or with the anterior wall of the vagina and gradually increasing the stimulus till the subject indicates sensing the stimulus by pressing a button. A psychophysical method of limits was employed for threshold determination of warm or vibratory stimuli in the genitalia [2]. In each session, all women were tested seven times in a sequential manner (see Table 1). The baseline level was evaluated twice before sexual stimulation (10-minute interval between measurements). Sexual arousal was first achieved by visual and auditory stimuli (by viewing erotic clips) without manual or vibratory self-stimulation. The erotic clips were chosen by each participant according to self-preference from a selection of short promos. The preferred clip (10 minutes duration) was intimately viewed in a specially designed, isolated room. When reaching a lubricated state, the participant was required to call the investigator (by buzzing) and sensory test was performed immediately. As none reached the orgasmic state by visual/auditory stimuli alone, self-stimulation with the usage of a vibrator for achieving orgasm was allowed. Upon reaching orgasm, the fourth sensation test was performed. Three more tests were performed after 5, 10, and 20 minutes after orgasm.

Statistical Analysis

Data were analyzed using SPSS software version 12. Non-parametric Friedman and Dunn's post-hoc tests were used to compare the differences between results of the tests at different phases.

Results

Eleven healthy females with normal sexual function (according to FSFI questionnaire) participated in the study (mean score 25.2 ± 2.6 [range 21–28]). The mean age was 23.77 ± 3.3 years old (range 20–32 years). Comparison between the two baseline evaluations performed sequentially for each patient (10-minute interval) showed no significant difference in threshold levels for vaginal thermal and vibratory sensation or for clitoral vibratory sensation (Dunn’s post-hoc test, $P > 0.05$). The baseline values were in accordance with the normative values, which were published previously [1].

Comparison between the measurements at all phases of each study was performed for each sensory modality (clitoral thermal, clitoral vibratory, and vaginal vibratory sensation—Figure 1). We found significant changes in clitoral vibratory sensation thresholds between the baseline and arousal phases ($1.66 ± 0.3$ vs. $2.31 ± 0.9$, $P < 0.05$). These changes were nonsignificant at the vagina.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>(non-excitatory)</td>
</tr>
<tr>
<td>2</td>
<td>Baseline* (non-excitatory)</td>
</tr>
<tr>
<td>3</td>
<td>Immediately post arousal without self-stimulation</td>
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<tr>
<td>4</td>
<td>Immediately post orgasm with self-stimulation</td>
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<tr>
<td>5</td>
<td>5 minutes post orgasm</td>
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<tr>
<td>6</td>
<td>10 minutes post orgasm</td>
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<tr>
<td>7</td>
<td>20 minutes post orgasm</td>
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</tbody>
</table>

*10 minutes apart between first and second baseline.

QST = Quantitative sensory testing.

Table 1 QST sequence along the study protocol
We also found a significant difference at the clitoral and vaginal region comparing the vibratory threshold sensation between the baseline and immediately post orgasm \((1.66 \pm 0.3 \text{ vs. } 2.69 \pm 1.3, \text{ respectively}) (P < 0.001)\). A Friedman test (which evaluates sequential gradient changes) showed for both clitoral and vaginal regions significant changes along most of the different post-orgasmic phases \((2.38 \pm 0.7, 2.13 \pm 1.7, 2.27 \pm 2.2 \text{ for the vagina, immediately post orgasm, 5, 10, 20 minutes, respectively, } P < 0.001)\).

On the other hand, no significant changes for thermal threshold sensation when comparing baseline levels to the levels measured after sexual arousal and post orgasm were found (Table 2).

For all sensory thresholds, comparing the levels at baseline and 20 minutes after orgasm, we found no significant changes. This means that the sensitivity to external stimuli returned to its baseline level after 20 minutes.

When comparing the current results during all the cycle phases to the normal ranges in the correlating age group, all thresholds recorded were in the normal range apart from three measurements at the post-orgasm cycle phase in the clitoris where they were slightly above the upper normal limits.

Finally, we found a high correlation (yet non-significant) between the clitoral and vaginal regions for the magnitudes of the changes in vibratory thresholds along the sexual cycle (Pearson test—\(P = 0.07\)).

**Discussion**

In order to increase our knowledge of female sexual dysfunction, we must first obtain quantitative data on the normal physiologic sensory changes during the different phases of the female sexual cycle. To our knowledge, from the relatively few studies performed on the physiology of sexual function [7], this is the first that quantitatively examined these sensory changes during sexual excitement in normally sexually active healthy females. Our main finding was that during the arousal and orgasmic state, there is a significant decrease in genital vibratory sensation.

The correlations between sexual stimuli and sensation were previously investigated in rats: in both sexes, an increase in pain threshold was found during copulation [8,9], with the most prominent difference noted during the last third of copulation [8]. In women, Whipple and Komisaruk [10,11] documented a natural analgesic effect upon stimulation of the anterior vaginal wall and specifically the area of the Grafenberg spot, which is activated during both sexual stimulation and labor. More-

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Comparison between measured points along the sexual cycle and baseline</th>
</tr>
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<tbody>
<tr>
<td>Baseline</td>
<td>Arousal</td>
</tr>
<tr>
<td>Clitoris vibratory</td>
<td>(P = 0.003)</td>
</tr>
<tr>
<td>Vagina vibratory</td>
<td>NS</td>
</tr>
<tr>
<td>Clitoris thermal</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS = not significant.
over, they detected a significant increase in the peripheral pain threshold during vaginal self-stimulation. They also found that this increased threshold did not alter the sensitivity to tactile stimuli. It has been hypothesized that pleasurable stimuli have an analgesic effect, which may attenuate or alter the perception of pain and not the tactile one. Bancroft [12] has also suggested that Oxytocin and \( \beta \)-endorphin have a dual role in the arousal phase, both excitatory and inhibitory, and one could postulate that the endorphin peptides involved in this process could contribute to the analgesic effect during sexual activity. These data in combination with ours could raise the hypothesis that during intercourse, there is an increase in sensory threshold not only in the periphery but also in the genital area. This fact may be an important factor in the normal sexual response that is responsible for minimizing pain during intercourse while at the same time enhancing pleasurable sensations. In an effort to explain the meaning of these physiologic changes, one might postulate that anthropologically they may be part of a mechanism that allows the female partner to elude the painful stimuli that potentially increase during the progress of intercourse. Pain would hinder successful mating and would potentially impede the chances of fertilization.

An interesting observation was the fact that similar changes during sexual stimuli were found in the male counterpart. Rowland et al. reported a decreased penile vibratory sensitivity in the erect state [13,14], emphasizing that comparable physiological sensory events probably occur also in the male during intercourse.

The decrease in vibratory sensation may also be partially explained by the physiological changes that occur in the genital tissue during arousal and excitement. We might postulate that the vascular engorgement in this area may increase the distance between the mucosal outer surface and the receptors for vibratory stimuli (Pacinian corpuscle) situated in the submucosa [14]. Another explanation to the decrease in the sensitivity during sexual arousal may be due to the higher content of fluids in the vaginal and clitoral tissue that may dampen the velocity of transmission of the vibratory waves through the tissue. Therefore, a higher stimulus may be needed in order to reach receptor threshold.

In contrast, we did not find any significant changes in thermal sensation during the whole sexual cycle. This phenomenon may be explained by the anatomical location of the thermal-free nerve endings, situated closer in the submucosal superficial layer, and most probably not influenced by the aforementioned physiological vascular events [15,16].

One of the possible limitations of the current study is that during sexual excitation, females may be distracted from the potential strong afferent vibrotactile stimuli coming from the genitalia. However, in that case, we would expect to have the same changes in all three sensory modalities. As this did not occur for the thermal threshold, which was steady during the whole cycle, our results obtained from the vibratory stimuli most probably represent true physiological changes.

Another possible limitation of our study may be the modality used for reaching orgasm, which included manual and vibratory stimulation and was achieved by physically powerful tactile sensory input that may cause changes in vibratory sensitivity in the tested region. Nevertheless, we also found similar changes in the arousal phase which was achieved only by visual/auditory stimuli and without local tactile, mechanical or vibratory stimuli, supporting our conclusion that these changes actually represent genuine physiological processes.

There always remains the possibility that the magnitude of the change in vibratory threshold immediately after orgasm may not have been as great if continuous vibration was not used to elicit the orgasm.

Our findings also have some clinical relevance in the diagnosis of FSD because of neural deficit. For women with neural damage who already have lower genital sensation, sexual problems may become clinically more significant when considering that during sexual arousal and intercourse there is an additional decrease in genital sensation. The mechanisms affecting tactile sensitivity are not well defined; women with arousal problems may simply have fewer tactile receptors than sexually functional women [17].

**Conclusions**

Until now sensations of the genitalia in the female were measured only in the nonstimulated state because of clinical feasibility. The current study demonstrates the feasibility of this testing in the course of stimulation and excitation, and shows that during arousal and orgasm at least the vibratory sensation is decreased. Data are mandatory regarding the clinical significance of these findings in pathological states, such as post-pelvic
surgery, peripheral neuropathy, and spinal cord pathologies.

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Conflict of Interest: None declared.

References