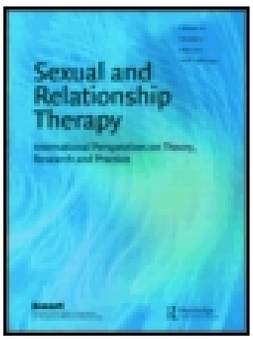

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Genital vibration for sexual function and enhancement: a review of evidence

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ABSTRACT

Vibration, as provided by a genital vibrator, is commonly regarded as a tool to enhance sexual pleasure and in modern day society falls under the category of a *sex toy*. However, the vibrator was not originally intended to be a toy, and its benefits reach far beyond that of a plaything. This article is a narrative review of the current evidence regarding the use of vibratory stimulation for the treatment of sexual dysfunction and/or sexual and relationship enhancement. The literature indicates that vibratory stimulation has evidence-based support for the treatment of erectile dysfunction, ejaculatory dysfunction and anorgasmia. Vibratory stimulation is positively correlated with increased sexual desire and overall sexual function. It has also shown benefit for sexual arousal difficulties and pelvic floor dysfunction. Though definitive evidence is lacking, genital vibration is a potential treatment for sexual dysfunction related to a wide variety of sexual health concerns in men and women.

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Female sexual arousal disorder; orgasmic disorder; sexual physiology; medical therapy; retrograde ejaculation

Introduction

The majority of health care providers do not ask about their patients' sexual health (Ferrara et al., 2003). One of the primary reasons the question is not being asked is because providers do not think there are simple and effective treatments available (Kellogg-Spadt & Krychman, 2010). Genital vibration is an often overlooked, potentially effective treatment for sexual function concerns in both women and men.

Vibrators are typically not regarded as medical devices by mainstream society. Most are sold as novelty devices/toys, and developers rarely seek clearance or approval by the US Food and Drug Administration (FDA). Yet, vibrators can be classified by the FDA as obstetrical and gynecological therapeutic devices for the treatment of sexual dysfunction or as an adjunct to Kegel exercises (Stabile, 2013). This classification exists because vibrators have been shown to provide sexual health benefits for patients (Graham, 2014;

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Laan, Rellini, Barnes, & International Society for Sexual Medicine, 2013; Sobrero, Stearns, & Blair, 1965; Sonksen & Ohl, 2002; Zolnoun, Lamvu, & Steege, 2008) and, according to some accounts, were invented specifically for the treatment of health concerns (Maines, 1999).

The present article is a review of the sexual health benefits of genital vibration and its use for the treatment of sexual functioning concerns and sexual function enhancement.

Methods

This is a narrative review of the evidence regarding the use of genital vibration for sexual function and enhancement. Given the dearth of literature on genital vibration, a systematic review is not feasible. A comprehensive English-language search of several databases from 1946 to 23 August 2016 was conducted and included MEDLINE In-Process & Other Non-Indexed Citations and Ovid MEDLINE. Keywords included *sexual dysfunction* and *vibrator*. Papers were selected for inclusion based on authors' clinical expertise. Statistical analysis of findings was not conducted.

Results

The use of vibration as a treatment for sexual dysfunction is dependent on the domain of sexual function affected (e.g. desire, arousal, orgasm). Thus, findings are divided below based on sexual function domain. However, to understand the sexual health benefits of the vibrator, one must first understand the physiologic impact of vibration and its relationship to genito-pelvic anatomy and function. A brief description of human sexual physiology as it pertains to the use of vibration follows.

Genito-pelvic anatomy, physiology, and genital vibration

Vibrator use for male genitalia primarily focuses on the penis as the target for vibratory stimulation. However, vibratory stimulation of other sexual organs including the testicles or scrotum, perineum, and anus has been described as well (Reece et al., 2010). Clinical experience suggests that individuals with male genitalia often prefer scrotal stimulation; however, this finding is not represented in the scientific literature.

The penis contains a variety of superficial and deep nerve receptors that sense changes in pressure, temperature, stretch, and pain. A specific type of sensory mechanoreceptor known as a Pacinian corpuscle plays a prominent role in transduction of vibratory stimulation into afferent neural signals (Tajkarimi & Burnett, 2011). These signals are transmitted along individual nerve fibers, ultimately converging to form the dorsal nerve of the penis (DNP), which runs along the penile shaft. The DNP is a branch of the pudendal nerve (PN). Other branches from the ventral aspect of the penis, scrotum, and perineum also contribute to penile sensation (Everaert et al., 2010; Tajkarimi & Burnett, 2011). Similar to the penis, the scrotum is innervated by distal branches of the PN, which carries sensory information proximally to the spinal cord (Tajkarimi & Burnett, 2011). Vibratory penile nerve stimulation is transmitted to the sacral spinal cord via the PN, where a complex network of inputs from the spinal cord, brainstem, and cerebral cortex takes place (Steers, 2000). Afferent signals from the PN are also transmitted to supraspinal centers

involved in higher level processing including the medial preoptic area and paraventricular nuclei within the hypothalamus, thalamus, and even the cerebral cortex (Tajkarimi & Burnett, 2011). Interestingly, several rat studies have shown that oxytocin-mediated neuronal signaling between pudendal afferents, the hypothalamus, and the sacral spinal cord contributes to penile erection (Argiolas, Melis, & Gessa, 1985). Afferents originating from the DNP excite oxytocin cells in the hypothalamic paraventricular nucleus of the rat (Tajkarimi & Burnett, 2011; Yanagimoto, Honda, Goto, & Negoro, 1996).

Efferent neuronal signals originating from the spinal cord result in predictable changes in sexual physiology (e.g. erection, ejaculation, orgasm) (Everaert et al., 2010; Steers, 2000). It is hypothesized that, by stimulating spinal reflexes, vibratory stimulation can be used to promote normal sexual function (Nelson, Ahmed, Valenzuela, Parker, & Mulhall, 2007). For instance, the bulbocavernosus reflux results from stimulation of the DNP or other distal pudendal branches. Afferent signals traveling to the sacral spinal cord via the PN are integrated within Onuf's nucleus, and subsequent efferent output from both autonomic and somatic neurons results in rhythmic contraction of the bulbospongiosus and ischiocavernosus muscles. This reflex contributes not only to penile rigidity and tumescence but also to ejaculatory function (Granata et al., 2013; Steers, 2000). Clinically, this reflex is utilized to ascertain the integrity of the sacral spinal cord and is elicited in males by squeezing the glans penis and observing contraction of the anal musculature. While higher level processes including signals from the cerebral cortex play an important role in normal sexual function, reflexes such as the bulbocavernosus reflex help explain why digital (hand), oral, vaginal, and vibratory stimulation have a major role in eliciting erections as well.

Many of the neuronal structures and pathways described above also apply to the clitoris, vulva, and vagina. Below are some important sex-based differences as they may pertain to the use of genital vibration. First, females have a greater capacity to experience more than one orgasm in a short period of time, i.e. sequential orgasm or multiple orgasm. This multiorgasmic capacity is likely to arise from a combination of physical and psychosocial features. One of these features may be the differential contributions of the autonomic nervous system in vaginal and penile arousal (Lorenz, Harte, Hamilton, & Meston, 2012; Meston, 2000; Turley & Rowland, 2013). While moderate levels of sympathetic activity (i.e. incomplete withdrawal of sympathetic tone) suppresses penile arousal (Lange, Wincze, Zwick, Feldman, & Hughes, 1981), moderate levels of sympathetic activity appear to facilitate and even increase vaginal arousal (Bradford & Meston, 2006; Brotto & Gorzalka, 2002; Elliott & O'Donohue, 1997; Hoon, Wincze, & Hoon, 1977; Lorenz et al., 2012; Meston & Gorzalka, 1995; Meston & Heiman, 1998; Meston, Gorzalka, & Wright, 1997; Palace & Gorzalka, 1990). These differential autonomic activity patterns permit considerable vasocongestion and sensitivity to be maintained in the vagina, but not the penis, following orgasm (Amberson & Hoon, 1985).

In contrast to the early stages of arousal, orgasm is associated with a strong spike in sympathetic outflow in both men and women (Carmichael, Warburton, Dixen, & Davidson, 1994); this increase in sympathetic activity continues approximately 2–10 minutes following orgasm (Carmichael et al., 1994; Xue-Rui, Ying, Da-Zhong, & Xiao-Jun, 2008). Thus, it is possible that the burst of sympathetic activity associated with orgasm provides negative feedback that inhibits sustained vasodilation (and thus, erection) in the penis but not the vagina. Moreover, as sensation is both more intense and perceived as more

pleasurable at higher levels of genital blood pressure (Paterson, Amsel, & Binik, 2013), post-orgasmic sensitivity may be expected to be maintained in the vagina, but not the penis. High levels of sympathetic activity suppress clitoral arousal as in the penis (Puppo, 2013; Salonia et al., 2010). However, there is some evidence from animal models that paracrine factors (such as the actions of leptin on vasoactive intestinal peptide) may maintain clitoral erection in the presence of moderate sympathetic input (Lee et al., 2011). Thus, it is possible that the structures of the clitoris and vagina permit the maintenance (or even increase) of arousal following the sympathetic burst associated with orgasm.

Sensitive skin exposed to mild vibration exhibits increased sympathetic nerve activity, potentially via activation of the Pacinian corpuscles; following removal of vibration, blood flow associated with arousal increases (Okada, Naito, Ariizumi, & Inaba, 1991). This suggests that in the early stages of arousal, vibration that is delivered in bursts (interspersing moderate sympathetic activity with parasympathetic recovery) may increase vaginal (and potentially clitoral) blood flow more consistently than continuous vibration. An advance-withdraw pattern during early arousal also appears to maximize the stimulation associated with movement of the clitoris against the prepuce (clitoral hood) and ligaments connecting the clitoris to the vagina (Di Marino & Lepidi, 2014). In the later stages of arousal, however, once genital blood flow reaches plateau, continuous vibration may be more likely to stimulate the high burst of sympathetic activity associated with orgasm (Carmichael et al., 1994).

Another key difference in male and female genital physiology is the remarkable plasticity in female genital innervation and sensation across the lifespan (see Brauer and Smith (2015) for review). The periods of greatest neuronal plasticity correspond to windows of change in progesterone and estrogen, particularly postpartum and post-menopause. In animal models, there is dramatic downregulation of vaginal and vulvar innervation during pregnancy, corresponding with the need to increase pain thresholds and decrease sensation during childbirth (Datta, Lambert, Gregus, Gissen, & Covino, 1983). Following delivery, there is a period of rapid regrowth and adaptation (Liao & Smith, 2011). Very likely, these changes also occur in human females, although there are other factors that may influence genital sensitivity such as increased attention to genital sensations or changes in somatosensory perception. To that end, several studies have documented changes in subjective sexual arousal and pleasure postpartum. For example, in a longitudinal study of 150 women before and after pregnancy, approximately 50% of women reported their genital sensation returned to prepregnancy levels by 6 weeks postpartum, and 20% reported genital sensation to be even higher than prepregnancy levels (Connolly, Thorp, & Pahel, 2005). Of note, there is to date no empirical evidence regarding change in clitoral sensitivity associated with pregnancy. In contrast to the high plasticity associated with pregnancy, during menopause, decreased estrogens and progesterone may decrease the plasticity of female genital innervation (Ting, Blacklock, & Smith, 2004).

Finally, the pelvic floor is an integral component of sexual physiology as it pertains to vibration. Genital vibration facilitates vasodilation and blood flow in the pelvic floor. The oscillatory motion of vibration induces stretching and shortening of the contractile and noncontractile complex, triggering the tonic vibratory reflex via the primary endings of the muscle spindle (Cardinale & Bosco, 2003; Matheson et al., 1976). These length changes stimulate not only the muscle spindles but also increase metabolic rate. The increase in metabolic rate causes local vasodilatation and increased blood flow (Fuller,

Thomson, Howe, & Buckley, 2013), thus resulting in improved tissue perfusion which may assist in decreasing muscle tone and increasing relaxation (Swayne, Rothwell, & Rosenkranz, 2006).

Vibration can be used to either facilitate or inhibit muscle activation (Fuller et al., 2013; Swayne et al., 2006). When used for facilitation, it may improve kinesthetic awareness for better volitional activation or to trigger the reflex loop to help initiate a contraction. Using vibration to achieve muscle contraction allows for improved motor mapping and planning and muscle coordination for both strength and relaxation. From an inhibitory stance, vibration may help bring awareness to areas that are isometrically held, facilitating muscle relaxation and allowing for improved vasodilatation and blood flow (Fuller et al., 2013; Swayne et al., 2006).

Sexual desire and genital vibration

While data on vibrator use for treatment of low sexual desire are lacking, vibrator use has been positively associated with sexual desire in both women and men. Women across several decades of adulthood (aged 18–60 years) who used vibrators in the last month had notably higher scores on the desire domain of the self-reported Female Sexual Function Index (FSFI) compared with less recent or never users (Herbenick et al., 2009). Similarly, a study examining sexual function in male vibrator users also demonstrated higher sexual desire scores on the self-reported International Index of Erectile Function (IIEF) in those who used a vibrator in the last month than in those who used a vibrator more than a year previously. In addition, male vibrator users (within the last month and within the last year) had appreciably higher sexual desire scores than never users (Reece et al., 2009). Of course, the direction of association between vibrator use and desire is not clear. It may be that individuals with greater desire are more likely to use vibrators. However, it is also possible that the increased genital blood flow and sensations provoked by vibrator use are interpreted positively by individuals, thus enhancing desire.

Sexual arousal and genital vibration

Genital vibratory stimulation may facilitate sexual arousal and orgasm in women with compromised genital sensory thresholds. Genital sensory testing has revealed higher sensation thresholds in women with urinary incontinence and sexual dysfunction (Lowenstein, Gruenwald, Itskovitz-Eldor, Gartman, & Vardi, 2011). Abnormalities in genital sensory testing have been found in about 20% of women with sexual dysfunction (defined by abnormal self-reported FSFI scores) and in women with multiple sclerosis (Esposito et al., 2007; Gruenwald, Lowenstein, Gartman, & Vardi, 2007). While vaginal sensitivity in an unaroused state decreases with aging, clitoral sensitivity to vibration appears to degrade more slowly (Vardi, Gruenwald, Sprecher, Gertman, & Yartnitsky, 2000). There is little data on the effect of aging on genital sensitivity thresholds during arousal; however, among young healthy women, clitoral and vaginal sensitivity to vibration is considerably increased during arousal (Gruenwald et al., 2007). Thus, absent other evidence, it is reasonable to expect that older women may benefit from vibration during sexual arousal, and that clitoral vibration may continue to provide benefits even if vaginal sensitivity has declined.

For men, erectile dysfunction (ED) is a novel target for vibratory stimulation (Rowland, den Ouden, & Slob, 1994; Sikka, Tajkarim, Burnett, & Hellstrom, 2016). Penile vibratory stimulation is thought to improve erectile function through stimulation of fibers in the cavernosal and PNs, resulting in release of nitric oxide which induces smooth muscle relaxation in the penile corporal cavernosa (Sonksen & Ohl, 2002). In 2011, the FDA approved a vibratory stimulator known as the Viberect (Reflexonic; Chambersberg, Pennsylvania) for use in men with ED, as well as those with spinal cord injury, in order to induce ejaculation (Stein, Lin, & Wang, 2014). Subsequently, Segal, Tajkarimi, and Burnett (2013) demonstrated that four out of five patients achieved erection rigidity capable of sexual intercourse without buckling while using this device. Vibratory stimulation has also been evaluated as an adjunct to recovery of erectile function after prostatectomy in men with prostate cancer (Fode & Sonksen, 2015). Fode and Sonkesen (2015) and Fode, Borre, Ohl, Lichtbach, and Sonksen (2014) randomized patients to daily penile vibratory stimulation after radical prostatectomy for a period of 6 weeks. While not statistically significant, the authors found a higher percentage of patients who had reached an IIEF-5 score of at least 18 in the vibratory stimulation group compared to controls (53% vs. 32%; $P = 0.07$). Further randomized trials will shed more light on the role of penile vibratory stimulation and recovery of ED.

Ejaculation and genital vibration

Penile vibratory stimulation is a commonly used means to produce ejaculation in men with and without spinal cord injury and in men with multiple sclerosis (Previnaire, Lecourt, Soler, & Denys, 2014; Sobrero et al., 1965; Sonksen & Ohl, 2002). Importantly, this requires an intact ejaculatory reflex arc (Barazani, Stahl, Nagler, & Stember, 2012). As such, patients with spinal cord injuries below cord level T10 have a lower success rate with penile vibratory stimulation (Sonksen & Ohl, 2002). Vibratory amplitude also appears to play a role and has been shown to predict antegrade ejaculation success in patients with spinal cord injuries (Sonksen, Biering-Sorensen, & Kristensen, 1994).

Vibratory stimulation is a viable treatment option for premature ejaculation as well as delayed ejaculation in men without a history of spinal cord injury (Fode et al., 2014; Jern, 2014; Nelson et al., 2007; Segal et al., 2013). However, further study is warranted to identify the optimal role for this therapy in the treatment of ejaculatory dysfunction, particularly in the neurologically intact male.

Orgasm and genital vibration

For men and women, genital vibratory stimulation has been found to be an effective treatment for anorgasmia (Laan et al., 2013; Leff & Israel, 1983; Marcus, 2011; Nelson et al., 2007; Segal et al., 2013). Genital vibratory stimulation is a common component of the directed masturbation (DM) treatment protocol, an empirically supported treatment for primary anorgasmia, supported by nine randomized controlled trials described by Graham (2014).

Additionally, for women, genital vibration may increase orgasmic capacity. Interorgasm latency can be shortened with masturbation training (Bohlen, Held, Sanderson, & Boyer, 1982), and women who use a vibrator to train themselves to have multiple orgasms

during masturbation are more likely to report multiple orgasms with a partner (Hurlbert & Whittaker, 1991). One study involving 17 women between the ages of 25 and 55 years evaluated sexual expectations and experiences with the introduction of vibrator use; about half of the women found it considerably easier to reach orgasm, and a similar number found vibrator use to be liberating and empowering (Marcus, 2011).

Furthermore, survey studies suggest that women are more likely to experience orgasm (at all, and multiple) when a variety of sensations and practices are included (Herbenick et al., 2010; Richters, de Visser, Rissel, & Smith, 2006); thus, a vibrator, particularly one with multiple intensities or stimulation patterns, may be a useful tool for producing the variety of sensations needed to produce multiple orgasms.

Genito-pelvic pain penetration disorder and genital vibration

Some women report feeling more comfortable and familiar with a vibrator compared with a dilator; thus, it has been recommended that vibrators replace dilators for the treatment of genito-pelvic pain penetration disorder (Bakker et al., 2015; Zolnoun et al., 2008). However, given its antinocioceptive properties, a vibrator has benefits beyond its use as a dilator. Vibratory stimulation has been recommended for vulvar massage in order to facilitate genital desensitization for the treatment of provoked vestibulodynia (Dhar & Nunns, 2009). In addition, vibratory stimulation is the basis of an experimental therapy called vulvar vibration therapy (VVT). VVT is targeted vibration to treat the muscular pain component of vulvodynia. It has been assessed in one uncontrolled study of 49 women with vulvodynia. Women were instructed to use VVT daily, 5–10 minutes, on the tender areas of the vulva and pelvic floor. They were also directed to use the vibrator for gentle stretching of the vaginal introitus and for eventual vaginal insertion. The median duration of VVT was 5 months, 3 times per week, once per day. Results indicated that after VVT, 73% of women reported a decrease in dyspareunia, and 74% reported an increase in sexual enjoyment (Zolnoun et al., 2008).

Sexual and relationship satisfaction and genital vibration

Vibrator use, in and of itself, is not associated with sexual satisfaction, but sexual satisfaction is influenced by whether or not one's partner is aware of his/her vibrator use. This suggests that openness to sexual exploration or good sexual communication may be a better predictor of sexual satisfaction than vibrator use (Herbenick et al., 2010). In one nationally representative survey in the United States, most men reported belief that a woman's vibrator use takes the pressure off of them to give their partner an orgasm (Herbenick et al., 2010). Furthermore, in the same study, most men and women endorsed that vibrator use enhanced their sexual relationships (Herbenick et al., 2010). Vibrator use may enhance a sexual relationship by increasing the likelihood of orgasm for women, thereby reducing pressure to achieve orgasm with vaginal–penile intercourse, and by facilitating orgasm in those with limited energy/fatigue (Marcus, 2011). If mutual orgasm during penile–vaginal intercourse is a patient goal, clitoral vibration may increase its likelihood (Lloyd, 2009). Finally, vibratory stimulation may play a role in the renegotiation of sexual intimacy in patients with cancer where penile–vaginal penetration is not feasible or is contraindicated (Gilbert, Ussher, & Perz, 2010).

Overall sexual health and genital vibration

Genital vibrator use has been positively associated with total FSFI scores for women between the ages of 23 and 60 years, where higher scores indicate better sexual function. Furthermore, domain scores for desire, arousal, lubrication, orgasm, and pain were notably higher in those who used a vibrator within the last month compared to less recent or never users across all age groups (aged 18–60 years) (Herbenick et al., 2009). Genital vibrator use has also been associated with increased openness in women's thoughts and attitudes about sexual activities generally and about themselves as sexual beings (Marcus, 2011).

Vibrator use in men was associated with higher scores in four of five domains of the IIEF (sexual desire, erectile function, orgasmic function, and intercourse satisfaction) (Reece et al., 2009).

Conclusion

Vibratory stimulation is a readily accessible and affordable treatment modality for both men and women. Evidence supports its use for ejaculatory dysfunction and anorgasmia, and there exists one FDA-approved vibration device specifically for the treatment of ED. Vibration is positively correlated with increased sexual desire and overall sexual function. It is a potential treatment for sexual arousal difficulties and pelvic floor dysfunction. Furthermore, although more research is needed, the openness to sexual exploration and/or good sexual communication evidenced by vibrator use among couples may enhance sexual and relationship satisfaction. Genital vibration is a potential treatment for sexual dysfunction related to a wide variety of sexual health concerns in both women and men and a valuable tool for health care providers in the treatment of sexual function concerns.

Disclosure statement

The authors report no disclosures.

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