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Evaluation of external vibratory stimulation as a treatment for chronic scrotal pain in adult men: A single center open label pilot study

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HIGHLIGHTS

- The efficacy of vibratory stimulation for treatment of scrotal pain was evaluated.
- Vibration for 20 min daily improved scrotal pain intensity and frequency.
- Vibratory stimulation appears to be a safe alternative to current treatment options.

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ABSTRACT

Background and aims: Chronic scrotal pain is a common yet poorly understood urologic disease. Current treatment paradigms are sub-optimal and include anti-inflammatory drugs and opioids as well as invasive surgical management such as microdenervation of the spermatic cord. In this study, the efficacy of external vibratory stimulation (EVS) was evaluated as an alternative treatment option for idiopathic scrotal pain.

Materials and methods: Ten consecutive patients presenting to an academic urology clinic between December 2016 and April 2017 with scrotal pain were prospectively enrolled. After a comprehensive history and physical exam, patients were presented with and oriented to a spherical vibratory device that they were instructed to use topically each day for four weeks. Average and maximum pain severity, frequency, and bother scores were tracked at 2-week intervals using a visual analog scale (0–10) via survey. Descriptive statistics facilitated interpretation of individual changes in pain.

Results: Nine men, with a median age of 46 years, completed at least 2 weeks of the study intervention. 78% (7/9) of men achieved some improvement in daily scrotal pain levels. Overall, average pain decreased from 4.9 to 2.7 ($p = 0.009$) while maximum pain severity decreased from 6.3 to 4.0 ($p = 0.013$). The frequency of pain also decreased for 55.6% (5/9) of men. No severe side effects were noted by any of the participants though several patients reported mild paresthesia only during application of the device. The majority of men expressed interest in continuing treatment after conclusion of the study.

Conclusion: External vibratory stimulation has been suggested as a promising non-invasive tool to alleviate chronic pain. As a proof-of-concept, we implemented EVS to treat men with idiopathic orchialgia. The majority of patients noted benefit in both severity and frequency of pain. Given its low risk profile, EVS deserves further evaluation and inclusion in treatment guidelines as a promising experimental therapy for a disease with few conservative treatment options available to providers.

Implications: In this longitudinal study, external vibratory stimulation was found to decrease chronic scrotal pain without any adverse effects. The use of this non-invasive, non-pharmaceutical therapy to treat chronic scrotal pain has the potential to decrease physician and patient dependence on surgical procedures and opioid prescriptions. Future randomized, double blind clinical trials with a placebo arm are required to corroborate these findings and establish the true efficacy of EVS.

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1. Introduction

Scrotal pain (SP), or orchialgia, is a common urologic condition that contributes to significant morbidity among adult men. Symptoms are often debilitating and interfere with employment, relationships, and overall quality of life [1]. Furthermore, recent findings have suggested that the prevalence of scrotal pain is on the rise along with its associated financial burden [2]. Unfortunately, current diagnostic and treatment paradigms are insufficient to adequately address this growing epidemic. Men with scrotal pain will seek on average 4.5 different opinions for their pain as physical examination and ultrasonography rarely uncover an underlying source, often leaving patients without validation of their symptoms [3,4]. Diabetic neuropathy, intracanalicular deposits, testicular trauma, and infection have all been posited as possible etiologies, though referred pain and psychogenic etiologies may also contribute [5].

While a variety of treatment modalities (i.e. medical and surgical) have been utilized to alleviate scrotal pain, their efficacy remains mostly equivocal. Conservative therapies such as nonsteroidal anti-inflammatory drugs (NSAIDs) and opiates offer temporary symptom relief for some patients, though frequently have undesirable side effect profiles and introduce risk of dependency. Surgical interventions including microdenervation of the spermatic cord (MDSC), epididymectomy, and orchiectomy have also been studied [4,5]. Yet, success rates of these invasive procedures are as inconsistent ranging from 32% to 70% [1,6,7]. In addition, surgical risks including testis loss can rarely occur. There are few treatment options currently available for men with scrotal pain that are both efficacious, noninvasive, and nonpharmacologic.

Vibratory treatment has recently been explored as a form of conservative therapy for non-urologic pain syndromes such as fibromyalgia, lower back pain, and diabetic neuropathy [8–10]. Forced mechanical oscillation, a form of non-painful vibration, activates mechanoreceptors and competitively inhibits central and peripheral nociceptors. Initially coined in 1965 as "the Gate Control Theory of Pain" by Melzack and Wall, this mechanism of pain relief has shown promise for various chronic pain conditions though has yet to be tested in the urologic setting. We thus sought to evaluate the utility of external vibratory stimulation (EVS) as a non-invasive intervention to alleviate idiopathic scrotal pain in a consecutive series of adult men presenting for care at a urology clinic in an academic medical center.

2. Methods

2.1. Patients

A longitudinal, prospective study was conducted between December 2016 and April 2017 and included 10 adult men who presented to a single academic medical center with the chief complaint of chronic scrotal pain persisting for at least 3 months. Upon physical examination, patients were excluded if they presented with an identifiable or correctable cause of pain, a condition necessitating surgical treatment (e.g. mass suspicious for malignancy or acute scrotum), or history of vasectomy. The presence of varicocele, hydrocele, or benign pathology alone did not meet grounds for exclusion. Patients were approached and consented at the initial visit and had subsequent follow-up via telephone and electronic correspondence. Institutional Review Board approval and standard ethical principles in human subject research were met and included in the consent form.

2.2. Intervention

Each patient was provided with an 8 cm NOV 506C Vibration Accue-Node Massager by HoMedics (300 N. Pontiac Trail, Commerce Township, MI), a battery-operated massage ball that produces mild vibratory stimuli. Patients were instructed to apply stimulation to the location of external ring for 20 min per day for 4 weeks. Somatic stimulation at this rate, even when self-administered at home, has previously been found to provide increasing pain relief over the course of weeks to months [11]. Mid- and post-study surveys captured the true frequency and duration of device use as well its overall comfort and ease-of-use. Patients were instructed to limit their use of pain medications to over-the-counter NSAIDs during the study period.

2.3. Data acquisition

Demographic data were obtained during the initial patient interview and supplemented by the electronic medical record. All participants completed a survey at baseline, 2 weeks, and 4 weeks which established their average and maximum pain levels over the prior 2 weeks and also the frequency and location at which they experience pain. Frequency was described by the number of pain episodes experienced per day or week. Daily pain scores were assessed at each interval using an analog visual pain scale (range 0–10). Changes in pain quality were assessed using a 5-point qualitative scale from severe worsening (−2) to drastic improvement (+2). Two-sided paired *t*-tests were utilized to describe the significance in improvement. All surveys were created and distributed using Qualtrics (Provo, UT).

3. Results

A total of 10 patients aged 28–69 years (median 46 years) were enrolled in the study with a mean duration of pain of 10.3 months. One patient was lost to follow-up immediately after enrollment while two declined follow-up after completion of the second survey (2 weeks). The majority of men presented with normal physical exams, though 2 patients had ipsilateral, epididymal head cysts which were felt to be noncontributory, and another 2 had contralateral, non-tender varicoceles. Ultrasonography (usually obtained prior to office evaluation) did not identify any correctable etiologies of scrotal pain. All but 1 patient were previously prescribed non-steroidal anti-inflammatory drugs or antibiotics as first line therapy, though no patients had undergone prior physical therapy or utilized topical heat/ice. Baseline characteristics of the study participants and their respective scrotal pain were presented in detail in Table 1.

Reduction in average and maximum daily pain severity was noted in 78% (7/9) patients. Overall, the average daily pain score decreased from a mean of 4.9–2.7 ($p = 0.009$) while the maximum daily pain score decreased from a mean of 6.3–4.0 ($p = 0.013$) over the four-week study period (Fig. 1). 5 patients also reported a decrease in the frequency of their pain. 22% (2/9) patients reported a drastic reduction of pain from more than once a day to less than once a week. Another 2 patients described their pain as being constant and unaltered by use of the device (Table 2).

All 5 men who utilized the device as instructed for 20 min per day, reported some improvement in severity and frequency of their scrotal pain over the course of the study. The 2 men who denied improvement of symptoms reported inconsistent use of the vibratory device and did not meet the recommended 20 min per session. No significant or permanent side effects were experienced.

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Table 1a
Baseline characteristics of study participants.

Median age (years)	46 years (range: 28–62)
Race	
Caucasian	5 (55.6%)
Asian	3 (33.3%)
Hispanic	1 (11.1%)
Mean BMI	24.3 kg/m^2
Comorbidities	
Diabetes	0 (0.0%)
Hypertension	1 (11.1%)
Hyperlipidemia	2 (22.2%)
Coronary artery disease	2 (22.2%)
Erectile dysfunction	1 (11.1%)
opioid tolerance	0 (0.0%)

Table 1b
Baseline characteristics of scrotal pain.

Laterality	
Right testicle	3 (33.3%)
Left testicle	6 (66.7%)
Location within scrotum	
Intra-testicular	5 (55.6%)
Extra-testicular	4 (44.4%)
Duration of pain	
<6 months	3 (33.3%)
≥6 months	6 (66.6%)
Quality of pain	
Burning	2 (22.2%)
Ache	3 (33.3%)
Tightness/General discomfort	4 (44.4%)
Prior pharmaceutical therapy	
Acetaminophen	3 (33.3%)
Ibuprofen	1 (11.1%)
Levofloxacin	2 (22.2%)
Celecoxib	2 (22.2%)
Physical exam	
Normal	6 (66.7%)
Cyst/Mass	2 (22.2%)
Varicocele	2 (22.2%)
Ultrasound diagnosis[a]	
Hydrocele	2 (25.0%)
Varicocele	3 (37.5%)
Epididymal Cyst	5 (62.5%)

[a] One subject did not receive ultrasound evaluation.

3 patients reported occasional transient paresthesia at the contact site that abated shortly after conclusion of the treatment session. More than three-fourths of the patients expressed interest in continuing occasional or daily use of the device after completion of the study.

4. Discussion

The utility of EVS for alleviating idiopathic scrotal pain has not been previously evaluated. We prospectively enrolled 10 patients in a novel, proof-of-concept trial to determine both efficacy and safety of vibratory therapy for the treatment of orchialgia. Both average and maximum daily pain diminished over the course of the study for a majority of men and drastic decreases in overall pain severity and frequency were noted in some patients. While there may be an association between device use and symptom improvement, a larger randomized control trial would be required for validation. No significant side effects were observed and the device was tolerated well by all patients. Importantly, no patients experienced subjective worsening of baseline pain levels.

The discovery and implementation of an effective non-invasive treatment modality for idiopathic scrotal pain remains elusive. While nonsteroidal anti-inflammatory drugs (NSAIDs), low-dose antidepressants, and antibiotics have historically been prescribed as first-line treatment, there has been some debate over their true efficacy [4,12]. More than 42% of scrotal pain patients now receive opioids in the United States, up from 14% in 2007, suggesting that initial conservative therapy is often inadequate. Unfortunately, prolonged use of opioid therapy for chronic pain is known to be both unsafe and inefficacious. Tolerance, dependence, and opioid-induced abnormal pain sensitivity are risks becoming increasingly evident in patients prescribed opioids for chronic pain syndromes [13,14].

Spinal cord stimulation of the dorsal root ganglion has been previously investigated as a promising, minimally invasive procedure for groin pain with pain reductions of up to 76% in a small cohort of patients, though studies specific to scrotal pain in men are limited [15]. Several case reports have suggested that sacral nerve and genitofemoral nerve stimulation may alleviate testicular pain, but questions regarding durability of pain relief and the need for prospective studies remain [16–19]. Recent studies have also touted the utility of microsurgical spermatic cord denervation and epididymectomy for refractory scrotal pain [1,6,7,20]. Although success rates of these operations are reasonable, they are invasive and associated with rare postoperative complications such as hematoma, infection, and testicular ischemia [7,20]. Moreover, despite recommendations of urologic guidelines against invasive treatment for idiopathic scrotal pain, nearly 2% of these patients in the United States still undergo surgery with curative intent [2,7,21].

Indeed, current management options available to providers are both limited and insufficient. And unlike for other chronic pain syndromes, prior literature on non-invasive therapies, such as external vibration, is scarce. In 1991, a group of Canadian neurologists found that oscillatory vibration produced a significant analgesic effect in patients presenting to a neuro-rheumatology ward compared to controls [22]. Similarly, Rittweger and colleagues evaluated the utility of whole body vibration (WBV) exercise in 60 patients with chronic lower back pain in a randomized controlled trial and found evidence to support its use as a curative treatment modality [10]. WBV has also proven efficacious in neuropathic pain with patients achieving a 3–4 point reduction in the visual analog pain scale over four weeks [9]. Thus, based on success in other fields and its excellent safety profile, men with scrotal pain would also seem likely to benefit from external vibratory stimulation.

Pain originating from the scrotum is mostly mediated by afferent nerve signals arising from the testis, epididymis and vas deferens. The ilioinguinal and genitofemoral nerves innervate content within the anterior portion of the scrotum while the perineal branches of the pudendal nerve provide sensation to the posterior region. The afferent fibers of these respective nerves course through the spermatic cord and synapse at the dorsal root ganglia before entering the spinal cord between T10 and L1 or S2 and S4. At this point, the fibers decussate before rising to the thalamus via the spinothalamic tracts within the dorsal horn [23–25].

According to Melzack and Wall, vibratory stimuli reduce the excitability of dorsal horn neurons via modulation of the substantia gelatinosa, a collection of cells in the gray matter that influence amplitude and frequency of signal transmission through the spinothalamics. This produces a type of “pain interference” as large A delta fibers, transmitting vibratory perception, diminish the afferent signals of the smaller C fibers, conveying the slow, poorly localized sensation commonly registered as chronic pain [11,26–28]. Indeed, several patients in our study noted mild paresthesia during and immediately after use of the device which temporarily superseded the dull discomfort which they initially presented for. As referred pain from adjacent organs can often

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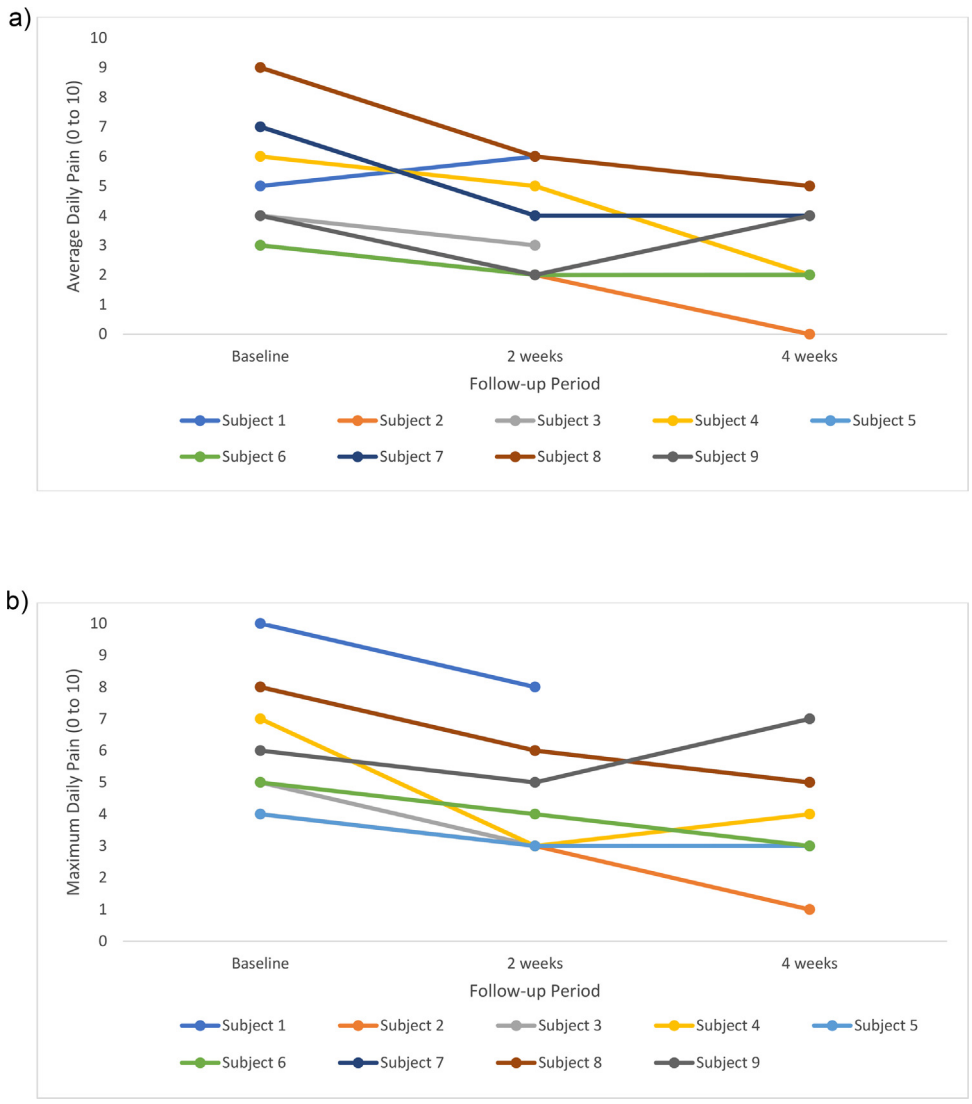

Fig. 1. (a) Average daily pain at baseline, 2 weeks, and 4 weeks follow-up. (b) Maximum daily pain at baseline, 2 weeks, and 4 weeks follow-up.

Table 2
Change in pain frequency by study participant.

Subject	Frequency of pain occurrence			Subjective change in frequency after:	
	Baseline	2 weeks	4 weeks	2 weeks	4 weeks
1	Constant	Constant	n/a	Same	n/a
2	>1× a day	1× a day	<1× a week	Less frequent	Less frequent
3	Constant	Constant	n/a	Same	n/a
4	>1× a day	<1× a week	<1× a week	Less frequent	Less frequent
5	>1× a day	>1× a day	>1× a day	Same	Less frequent
6	1× a day	>1× a day	>1× a day	Less frequent	Less frequent
7	<1× a day	<1× a day	<1× a day	Less frequent	Less frequent
8	>1× a day	>1× a day	1× a day	Same	Same
9	1× a day	<1× a day	1× a day	Same	Same

present in the scrotum due to overlapping peripheral nerve pathways, the central mechanism of vibratory interference also explains why this therapy is efficacious regardless of SP etiology [24].

From our experience in 9 patients with scrotal pain, external vibration therapy appears to be an effective and safe alternative to existing medical and surgical options. More than half of all participants reported some improvement in pain severity and frequency. As scrotal pain is responsible for millions of dollars in annual medical costs and high rates of ineffective and addictive medication prescriptions, these results exhibiting pain relief induced by an inexpensive, over the counter (OTC) therapy is encouraging. While the European Association of Urology (EAU) does recommend a multidisciplinary approach including physiotherapy, as published in the 2010 guidelines on chronic pelvic pain, they fail to mention specific examples of such therapy or cite evidence supporting this recommendation [21]. While further investigation is still required, this study suggests that external vibration therapy may warrant mentioning in published guidelines as a promising experimental therapy in patients with scrotal pain without clear etiology.

Though no patients in our study had a history of infection, tumor, testicular torsion, or trauma, several patients did present with incidental radiologic findings including epididymal cysts. However, upon initial examination, it was determined that all physical exam and ultrasound findings were unrelated to the chief complaint. Scrotal cystic lesions are a common finding in men undergoing ultrasonography with one study discovering incidental cysts in 241 out of 1000 men. While infectious or traumatic cystic lesions can lead to pain, this was ruled out in all five study participants diagnosed with incidental epididymal cysts [5,29]. Post-vasectomy chronic pain syndrome is another common cause of scrotal pain,

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however, no men in our study had previously undergone surgical sterilization.

It is important to note that the primary purpose of this proof-of-concept trial is to evaluate the feasibility and safety of an external vibratory therapy for treating idiopathic scrotal pain. While it is indeed favorable that the majority of participants received benefit from this device, the absence of a suitable control group prevents the exclusion of any placebo effect. However, most estimates of the placebo effect predict only a 30% improvement [30]. In addition, although the patients were advised to only use over the counter pain medications as they have been doing in the past, specific dosing was not monitored which may have conflated the measured efficacy of the device. Finally, patients were requested to apply the vibration at home per their convenience and to record their usage trends at 2 week intervals, possibly introducing recency and recall biases.

Nevertheless, this study represents the first successful evaluation of external vibratory stimulation as a benign treatment modality for idiopathic scrotal pain. As there is currently a dearth of effective and low-risk treatment options, the positive response to vibration by this cohort suggests a need to further investigate EVS as a potential first-line intervention to combine with current conservative management. Future randomized, double blind, placebo controlled trials utilizing varying levels of vibratory frequency (including no vibration) are expected to facilitate a more robust evaluation of the efficacy of this intervention as well as increase the generalizability of these findings.

Ethical issues

The Stanford University Institutional Review Board (IRB) approved this clinical trial. All patients were consented prior to the start of the study and all expenses and liability related to the participation of the study were covered by the institution.

Conflicts of interest

The authors report no conflicts of interest concerning the materials or methods utilized in this study. This study did not receive any grant funding from the public, commercial, or not-for-profit sectors. There are no other financial interests to disclose.

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