The effects of common medications on volumetric phallometry

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Abstract Phallometry is a physiological measure of sexual response widely used for the assessment of paedophilia among sexual offenders. Although many medications decrease penile response sufficiently to interfere with sexual intercourse, it is unknown to what extent such medications might interfere with phallometric testing. In the current study, we utilized a naturalistic convenience sample of 1078 men who attended a clinic for assessment of sexual preferences, mostly related to sexual offence convictions. In the present analyses, we quantified the differences in penile response during phallometric assessment associated with taking a range of common medications. Participants on medication typically showed less penile output than participants not taking medications; however, differences were largely accounted for by age rather than by medication status. Though most medications were associated with decreases in penile responsivity during volumetric phallometric testing, such changes were small in absolute terms and appeared to be associated with ageing rather than with the medications themselves.

Keywords Age; drugs; phallometric assessment; sexual response; medication

Phallometry (also called penile plethysmography) continues to be the most objective and best validated measure of erotic preferences and is widely employed in the clinical evaluation of paedophilia among men who have committed one or more sexual offences (Hanson & Bussière, 1998; Harris & Rice, 1996; Wormith, 1986). The validity of phallometric assessment, however, is directly affected by the magnitude of penile response to the stimuli used—too low a response, and the test is uninterpretable; significant differences (however defined) between arousal to deviant and to non-deviant stimuli are unlikely to have been achieved (Howes, 1995, 2003). Most forensic laboratories that conduct phallometric assessment employ cut-off scores for response magnitude, typically requiring that the subject reached at least 10% or 20% of full erection for test results to be interpreted (Howes, 1995). Because low response is one of the primary factors that invalidates phallometric test results, response magnitude and variables that can affect it remain a critical issue in the clinical and forensic assessment of sexual preferences.

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Multiple factors can impact the magnitude of penile responses in the clinical laboratory; one variable that has been widely discussed, but not yet investigated in a clinical-forensic setting, is the impact of medications on response magnitude. Although some medications improve erectile functioning (e.g. phosphodiesterase type 5 or PDE 5 inhibitors such as sildenafil), the following section will review those medications that have been shown to have a negative effect on erectile functioning. Men taking antihypertensive medications often report erectile dysfunction; a result that has been found in both the retrospective studies (Hogan, Wallin, & Baer, 1980; Reichgott, 1979; Slag et al., 1983) and prospective trials (Croog, Levine, Sudilovsky, Baume, & Clive, 1988; Kostis et al., 1990; Rosen, Kostis, Jekelis, & Taska, 1994; Suzuki, Tominaga, Kumagai, & Sarita, 1988), although at least one study found no adverse effects of these medications on sexual function (Broekman, Haensel, van de Ven, & Slob, 1992). Antihyperlipidemics (medications used to treat hypercholesterolemia or high cholesterol), have also been shown to reduce erectile functioning (Francis, Kusek, Nyberg, & Eggers, 2007), and there is some indication that acetylcholine-induced relaxation associated with the medical treatment of diabetes mellitus may also contribute to erectile dysfunction (Meston & Frohlich, 2000).

Psychopharmacological medications have also been shown to negatively affect erectile functioning. One study found impaired sexual arousal and desire in 14% of patients taking lithium (Aizenberg, Sigler, Zemishlany, & Weizman, 1996), and antipsychotic medications have also been shown to affect sexual functioning (Dossenbach et al., 2005; Knegertin et al., 2008; Meston & Frohlich, 2000). Antidepressants have shown the most consistent association with sexual problems, including erectile functioning. Estimates have varied widely, suggesting that somewhere between 2% and 75% of people taking antidepressants experience negative sexual side effects (Francis et al., 2007; Kennedy & Rizvi, 2009; Meston & Frohlich, 2000; Serretti & Chiesa, 2009). With few exceptions, such as a case study on a female patient (Samuel, 2006), research has consistently supported the relationship between antidepressant use and erectile/arousal problems. Studies have begun to differentiate between quality of function and antidepressants, with selective serotonin reuptake inhibitors (SSRIs) (e.g. paroxetine, fluoxetine and sertraline) having more of an impact on erectile function than broader or non-SSRIs (such as bupropion and venlafaxine; Kennedy & Rizvi, 2009; Meston & Frohlich, 2000; Serretti & Chiesa, 2009).

One other factor well-documented to have an effect on erectile functioning is age. This association has been shown in both cross-sectional research comparing men of different age groups against one another (Karacen, Williams, Thornby, & Salis, 1975; Rowland, Greenleaf, Dorfman, & Davidson, 1993; Rowland, Incrocci, & Slob, 2005; Schiavi & Schreiner-Engle, 1988; Schiavi, Schreiner-Engle, Mandeli, Schanzer, & Cohen, 1990) and in longitudinal research that has followed the same cohort of men as they have aged (Araujo, Mohr, & McKinlay, 2004). Blanchard and Barbaree (2005) showed that the amplitude of penile response declines sharply from adolescence until age 30 and continues to decline (more slowly) with advancing age. Some studies have neglected to parse out other age-related factors known to affect erectile functioning, such as increased rates of weight gain, hypertension, hypercholesterolemia and medication use (e.g. Araujo et al., 2004), but Rowland and colleagues, who did account for these factors in their analyses, suggested that these age-related changes were not restricted to the genitals and appeared to reflect more general changes in neural and vascular integrity associated with ageing (Rowland et al., 2005).

Taken together, the potential effects of ageing and medication use may present particular challenges with regard to forensic phallometric testing, as the average patient attending our clinic for assessment is 39.8 years old ($SD = 13.4$ years), many of whom are on medication.
that may affect their erectile propensity. Thus, we aimed to investigate potential differences in penile response related to age and to medication, using volumetric phallometry. For emphasis, this study was not a controlled drug trial, but rather a naturalistic exploration of the effects of age and commonly used medications on penile response during a phallometric test for deviant erotic preferences in a clinical forensic setting.

Method

Participants

The participants were male patients referred to the Kurt Freund Laboratory of the Centre for Addiction and Mental Health (CAMH; Toronto, Ontario, Canada) because of illegal or clinically significant sexual behaviour or interests. Typically, these were men who were charged or convicted of a sexual offence against one or more persons or of a child pornography offence. The sample ranged in age from 14 to 85 and was distributed extremely normally, except for the expectable patterns reflecting that children are not referred to our clinic and that there is a “bump” representing adolescent and young adult offenders. As part of the sexological assessment, patients are routinely asked to name any medications they were taking. For the purpose of the present data analyses, medications were classified into seven categories: antihypertensives, antihyperlipidemics, diabetic medications, mood stabilisers, antipsychotics, antidepressants and “other”. This final category included over-the-counter medications (such as aspirin), asthma puffers, antibiotics and other prescribed medications too infrequent to merit a meaningful class unto themselves.

Because there are known ethnic variations in drug metabolism (Allen, Rack, & Vaddadi, 1977; González Burchard et al., 2003; Phan et al., 2009), analyses were restricted to Caucasian patients. The final archival sample consisted of the 1078 men for whom all the relevant data were available. These men underwent assessment between 30 January 2000 and 28 April 2006. All men consented to their clinical data being used for research purposes, and the collection and use of the archives were supervised and approved by the CAMH Research Ethics Board.

Volumetric phallometry assessment

All participants in this study underwent the standard testing procedures of the Kurt Freund Laboratory. The laboratory is equipped for volumetric plethysmography, that is, the apparatus measures penile blood volume change rather than penile circumference change. The volumetric method measures penile tumescence more accurately at low levels of response (Kuban, Barbaree, & Blanchard, 1999). The major components include a glass cylinder that fits over the penis and an inflatable cuff that surrounds the base of the penis, isolating the air inside the cylinder from the outside atmosphere. A rubber tube attached to the cylinder leads to a pressure transducer, which converts air pressure changes into voltage output changes. Increases in penile volume compress the air inside the cylinder and thus produce an output signal from the transducer. The apparatus is calibrated so that known quantities of volume displacement in the cylinder (e.g. 1 cc) correspond to known changes in transducer voltage output. The apparatus is very sensitive and can reliably detect changes in penile blood volume below the threshold of subjective awareness.

For the test session, the patient places the volumetric sensor over his penis according to the instructions from the test administrator. The patient then sits in a reclining chair, which faces three projection screens. After set-up, the patient’s lower body is covered with a sheet to minimise his embarrassment or discomfort. During the test, the patient’s face is monitored by
a low-light camera in order to detect stimulus avoidance strategies, such as closing his eyes or averting them from test stimuli.

Test stimuli are presented in discrete trials. Each trial presents stimuli from one and only one class (e.g. adult females, pubescent females, prepubescent females, adult males, pubescent males, prepubescent males or erotically neutral images), although several exemplars of that class are included in the same trial (see Blanchard et al., 2009 for a detailed description). The trials are arranged into blocks, with each block including one stimulus type in a fixed, pseudorandom order. Although the duration of each trial is fixed, the interval between the trials varies, because penile blood volume must return to its baseline (flaccid) state before the next trial begins. The time required to complete the test is usually about one hour.

Recording of penile blood volume begins five seconds before trial onset and ends five seconds after trial offset. Penile blood volume is sampled four times per second. The examinee’s response is quantified in two ways: as the extremum of the curve of blood volume change (i.e. the greatest departure from initial value occurring during the trial) and as the area under the total curve of that trial. As we were only interested in overall physiological arousal, as opposed to differential arousal between the various classes of stimuli (used to ascertain the patients’ preferred sexual object), our main dependent variable for the present study was the Output Index (Blanchard et al., 2009). The Output Index (OI) is calculated by taking the mean of the three highest positive responses. It is important to note that OI is not a global mean, but rather the mean of the three highest responses; thus, the global mean would necessarily be lower than the OI. In routine clinical assessment at the Kurt Freud Laboratory, men whose OIs are less than 1 cc are excluded from analyses, as random fluctuations in non-aroused men fall into this range of blood volume. Because the present study specifically aimed to examine OI as it related to medication use, we retained in the sample 40 participants with OIs of less than 1 cc whose test results would, otherwise, have been excluded from clinical interpretation.

Data analyses

To examine the impact of the different medication classes on arousal, we conducted stepwise linear regression analyses, one for each medication category. For all regressions, the OI served as the dependent variable. For the first step of each equation, we forced in a dichotomous indicator variable that represented whether that client was taking a medication in that class. In the second step, patient age was then forced into the equation, as normal ageing strongly decreases erectile response (Blanchard & Barbaree, 2005).

Results

Of the 1078 men in the sample, 512 men reported taking some type of medication at the time of phallometric assessment (Table I), 223 of whom reported taking medications in more than one category. Regressing OI first onto antihypertensive medication use revealed a significant relationship, \( F(1, 1076) = 8.44, \ p = .004 \). Forcing age into the equation accounted for a significant amount of the remaining variance, \( F\text{-change}(1, 1075) = 200.60, \ p < .001 \). With both antihypertensive medication status and age in the equation, however, response output ceased to be significantly related to medication status, \( B = 0.98, t(1075) = 1.16, \ p = .245 \), but continued to be significantly related to the participant’s age, \( B = -0.23, t(1075) = -14.16, \ p < .001 \). The unstandardised regression coefficient, \( B \), indicates that each additional year of
The results with the antihyperlipidemic medications followed the same pattern observed with antihypertensive medications: regressing OI onto medication status revealed a significant relationship, \( F(1,1076) = 5.08, p = .024 \). Forcing age into the equation accounted for a significant amount of the remaining variance, \( F\text{-change}(1,1075) = 204.14, p < .001 \). With both antihyperlipidimic medications and age in the regression, response output ceased to be significantly related to medication status, \( B = 1.03, t(1075) = 1.00, p = .320 \), but continued to be significantly related to participant age, \( B = 0.23, t(1075) = –14.29, p < .001 \).

The analogous regression revealed no significant relationship between OI and antidiabetic medication use, \( F(1,1076) = 3.19, p = .074 \). Forcing age into the equation, however, accounted for a significant amount of variance, \( F\text{-change}(1,1075) = 205.21, p < .001 \). With both diabetic medication status and age in the regression, the penile response output remained unrelated to medication status, \( B = –0.08, t(1075) = –0.07, p = .945 \), and was significantly related only to age, \( B = –0.22, t(1075) = –14.33, p < .001 \).

The regression onto mood stabiliser medication status revealed a non-significant association, \( F(1,1076) = 0.46, p = .498 \). Forcing age into the regression equation accounted for a significant amount of the remaining variance, \( F\text{-change}(1,1075) = 206.68, p < .001 \). After accounting for age, phallometric output remained unrelated to medication status, \( B = 0.44, t(1075) = 0.44, p = .661 \), and was related only to age, \( B = –0.22, t(1075) = –14.45, p < .001 \).

For antipsychotic medications, regression showed a non-significant association, \( F(1,1076) = 2.63, p = .105 \). Forcing age into the regression accounted for a significant amount of variance, \( F\text{-change}(1,1075) = 206.00, p < .001 \). With both antipsychotic medication status and age in the regression, phallometric output remained unrelated to antipsychotic medication status, \( B = 0.26, t(1075) = 0.33, p = .741 \), but remained strongly associated with age, \( B = –0.22, t(1075) = –14.35, p < .001 \).

The regression onto antidepressant use revealed that medication status was significantly associated with the OI, \( F(1,1076) = 4.30, p = 0.038 \). Forcing age into the equation accounted for a significant amount of the remaining variance, \( F\text{-change}(1,1075) = 208.54, p < .001 \). With both antidepressant status and age in the regression, the OI was significantly related to both the antidepressant status, \( B = 1.16, t(1075) = 1.978, p = 0.048 \), and to years of age, \( B = –0.22, t(1075) = –14.44, p < .001 \). The unstandardised regression coefficient of medication was positive in value; that is, unlike men taking other medications, men taking antidepressants responded with 1.16 cc more output on average (adjusting for age). Each additional year of age continued to be associated with decreasing phallometric output.

### Table I. Sample sizes, mean age and mean OI of men taking versus not taking medications

| Medication Type      | With Medication | Without Medication |
|----------------------|-----------------|--------------------|
|                      | \( n \)          | Age (SD)           | OI (SD)          | \( n \)          | Age (SD)           | OI (SD)          |
| Antihypertensives    | 75              | 54.2 (11.9)        | 4.41 (3.72)      | 1003            | 38.7 (12.8)        | 6.95 (7.50)      |
| Antihyperlipidemics  | 47              | 54.6 (12.1)        | 4.42 (4.33)      | 1031            | 39.1 (13.0)        | 6.88 (7.42)      |
| Antidiabetic medications | 41          | 48.5 (13.1)        | 4.77 (4.85)      | 1037            | 39.5 (13.3)        | 6.86 (7.40)      |
| Mood stabilisers    | 46              | 38.5 (12.0)        | 7.49 (7.47)      | 1032            | 39.9 (13.4)        | 6.74 (7.33)      |
| Antipsychotics      | 79              | 35.1 (13.5)        | 8.06 (7.89)      | 999             | 40.2 (13.3)        | 6.68 (7.23)      |
| Antidepressants     | 215             | 39.3 (12.9)        | 7.70 (7.49)      | 863             | 39.9 (13.5)        | 6.55 (7.28)      |
| Other               | 330             | 44.1 (14.4)        | 6.03 (6.71)      | 748             | 37.8 (12.4)        | 7.11 (7.57)      |
Lastly, regressing OI onto “other” revealed a significant association, $F(1,1076) = 5.01$, $p = .025$. Forcing age into the equation accounted for a significant amount of the remaining variance, $F\text{-}\text{change}(1,1075) = 203.60$, $p < .001$. With both medication status and age in the regression, phallometric output ceased to be significantly related to medication status, $B = 0.31$, $t(1075) = 0.69$, $p = .495$, but continued to be significantly related to age, $B = -0.22$, $t(1075) = -14.27$, $p < .001$.

Discussion

Prior literature documenting the effects of medication on erectile function indicates that several medication classes are associated with lowered sexual response in males. Because response magnitude is a critical issue during clinical forensic assessments of sexual preference (results with too low response are deemed uninterpretable), the current study was undertaken to assess for response variation in men taking a range of commonly prescribed medications. The results of this preliminary study provide evidence that antihypertensives and antihyperlipidemic medications can be associated with lower response magnitude and that antidepressant medications may be associated with higher response magnitude during phallometric testing. With the exception of antidepressants, the effects of all of the medication classes examined on OI were much better accounted for by age than by medication status per se.

Much of the literature supports the relationship between age and erectile problems as has been shown in multiple populations across multiple contexts (e.g., Araujo et al., 2004; Blanchard & Barbaree, 2005; Karacen et al., 1975; Rowland et al., 1993, 2005; Schiavi & Schreiner-Engle, 1988; Schiavi et al., 1990). We cannot directly assess the impact of age versus the impact of advancing disease on response magnitude, though it is reasonable to posit that these two variables are related. Thus, it is possible that at least some of our results occurred due to the effects of the disease itself on erectile functioning rather than age. However, at least one study has been able to distinguish the effects of these two variables, with results still showing a significant effect for age (Rowland et al., 2005), so it appears unlikely that disease status could account for the results entirely, particularly in light of the null results obtained when exploring the results of diabetes mellitus medications (a condition known to affect erectile function).

One somewhat surprising result was that men taking antidepressants showed a 1 cc greater response in phallometric assessment than those who were not. One potential explanation is that antidepressant usage shields patients from reduced penile response associated with the stress inherent in phallometric testing. As discussed previously, several variables have been hypothesised to impact response magnitude, most of which result in increased stress for the patient to varying degrees. It seems feasible that patients taking antidepressants may not be as vulnerable to stressors associated with phallometric testing and thus not affected by stress-induced erectile dysfunction. Because full erection is associated with a blood volume increase of approximately 25 cc, whereas phallometric test subjects manifest 4–8 cc, it is also possible that antidepressant medications have dual effects, one related to the onset of erectile response and one to achieving maximum or near-maximum response (sufficient for engaging in penetrative intercourse).

The results of this investigation demonstrate that, with the exception of antidepressants, medications in general do not appear to have a significant effect on response magnitude in volumetric phallometric assessment. Age does, however, appear to contribute to lower response magnitude. Thus, the use of a pharmaceutical agent to increase phallometric responding may be indicated in some cases, provided that it is not strictly contraindicated by a client’s medical status or current medication regimen. Two studies have shown between
28% and 50% increase in response magnitude during phallometric testing after taking sildenafil (Kolla, Blanchard, Klassen, Kuban, & Blak, 2010; Kolla, Klassen, Kuban, Blak, & Blanchard, 2010), suggesting that non- or low-responding men could be converted into responders with sildenafil administration. Further studies should be conducted to confirm the efficacy of this method in a forensic population, but the results seem promising and could counteract the negative effects of ageing on penile responding, thus contributing to more valid and reliable assessments of sexual preferences in forensic settings.

One of the strengths of the present study is that we examined a large sample of men exposed to multiple different classes of medications and for whom we had access to their phallometric results and demographic information. Furthermore, all the phallometric testing was performed in a single laboratory with normative data derived from the same population from which these men were drawn.

Although this study raises important considerations, there are limitations to the present findings. Due to the low numbers of men on specific medications in this sample, individual medications were collapsed into general classes, thus masking any variability among the different medications within each class (as has been seen with antidepressants). Further, the dosages that these men were taking were unknown, which also may have masked variability in response magnitude. It is also important to note that most of the medications assessed in this study are prescribed to treat conditions that are themselves independently related to erectile dysfunction (e.g. hypertension, hypercholesterolemia, diabetes mellitus and depression). Most studies have not parsed out the differential effects of the disease versus the medication on erectile function, and our database did not allow us to perform this level of analysis either. The question remains: are we seeing the effects of the condition, or of the medications, or of both combined? Additionally, despite significant relationships being found, it is important to emphasise that overall penile responding was still quite low, at approximately one-third full erection. A 1 cc difference at this response level may make an important difference in the interpretation of results, but these men were at the lower end of responding already. It is not readily possible to conduct a controlled experiment, wherein otherwise healthy men receive long-term medication (and risk the already-known long-term side effects), thus causal relationships cannot be asserted definitively. Lastly, it remains unclear as to how much untreated depression in the men not taking antidepressants may have contributed to lower responding.

Future research could address these limitations by controlling the type of medication and dosage, increasing the ability to demonstrate causal relationships between medications and phallometric response. Depression could be assessed in those not already taking antidepressant medication to rule out the potential effect of untreated depression in this subsample. Further, this study should be replicated using circumferential phallometry, as even though volumetric phallometry has been shown to be more reliable at lower levels of response (Kuban et al., 1999), the vast majority of clinical forensic laboratories utilise circumferential phallometry.

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