Safety and Efficacy of Ultra-Low-Dose Intracavernosal Adrenaline for Intraoperative Penile Erection in Transurethral Surgeries under Spinal Anesthesia

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Abstract

Context: Penile tumescence during endoscopic urological surgeries is a rare but problematic complication that can lead to postponement of the surgery. This study was done to assess the efficacy of ultra-low-dose intracavernosal adrenaline in the management of intraoperative penile erection. Subjects and Methods: Between January 2015 and December 2019, all the patients who developed significant penile tumescence during endourology procedures following regional anesthesia were included. Twenty patients required intervention. They were given half milliliter of solution containing 2.5 µg of adrenaline with insulin syringe. Baseline systolic and diastolic blood pressure, heart rate, and oxygen saturation were noted and were recorded at 1, 2, 3, 4, and 5 min after giving adrenaline. Time to achieve complete detumescence and any other related complications were also noted. Results: Penile detumescence was achieved in 2.6 ± 0.47 min in all the patients. There was an increase in heart rate from baseline value which increased to maximum by 3 min and returned back to baseline by 5 min. Systolic and diastolic blood pressure remained unchanged. Conclusion: All the patients achieved penile detumescence without any significant adverse effects after receiving intracavernosal injection of ultra-low-dose adrenaline.

Keywords: Adrenaline, penile tumescence, spinal anesthesia

Introduction

Intraoperative penile erection during transurethral surgeries is a challenge for the surgeon, with an overall reported prevalence of 0.1%–2.4%.[1] This makes the penile instrumentation cumbersome resulting in difficulty to perform the procedure safely, thus exposing the patient to a greater risk of complications such as urethral trauma, bleeding, and stricture formation.[1,2] Rarely, it may lead to postponement of the procedure. Most erections occur during, or just after, a local penile stimulus such as skin preparation or introduction of the endoscope. Penile erection or priapism under spinal or epidural anesthesia is reflexogenic, especially if the sympathetic blockade extends above the midthoracic level or it could be both reflexogenic and psychogenic. The reflex stimuli may arise from the stimulation of the pudendal nerve (S₂, S₃, and S₄) by instrumentation before sensory blockade is complete, thus resulting in erection.[3]

Published literature describes various treatment modalities for the management of intraoperative penile erection. Traditional methods include dorsal nerve block, corporeal aspirations, and increasing the depth of general anesthesia along with induced hypotension. Vasoactive drugs such as phenylephrine, epinephrine, noradrenaline, and metaraminol have been used intracavernosally.[4–7] Others have reported the use of intravenous ketamine, glycopyrrolate, dexmedetomidine, and terbutaline,[2,8–10] and some have reported inhalation of salbutamol[11] for managing intraoperative erection.

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In the literature, intracavernosal adrenaline has been used in the dose of 10–25 µg with good results, but the use of this dose can result in unwanted cardiovascular side effects. We studied the role of ultra-low-dose intracavernosal adrenaline injection (2.5 µg) in cases of transurethral surgeries in patients who developed intraoperative penile erection after spinal anesthesia. The efficacy and safety profile of the use of low-dose adrenaline was recorded.

**SUBJECTS and METHODS**

The study period ranged from January 2015 to December 2019. In this period, 3600 patients were given spinal anesthesia for different endourological procedures. Of these, 2160 (60%) were male patients. All the patients had received spinal anesthesia at L₃–L₄ interspace with a 25G Quincke needle and had achieved sensory blockade of T₃ dermatome.

Twenty patients (0.92%) developed penile erection significant enough to make the procedure difficult. These patients were given intracavernosal injection of 0.5 ml solution containing 2.5 µg of adrenaline using insulin syringe. A gentle pressure was applied at the site of injection for 2 min to prevent any hematoma formation.

**Drug preparation**

0.1 ml of adrenaline from the ampule was loaded in an insulin syringe, and it was further diluted with 20 ml of normal saline. The resultant solution had 5 µg.ml⁻¹ concentration, of which 0.5 ml was given intracavernosly.

Parameters recorded were age (in years), American Society of Anesthesiologists physical status, and type of surgery. Furthermore, baseline heart rate, systolic blood pressure, and diastolic blood pressure were recorded before giving adrenaline, and then again, any changes in these parameters were recorded at 1, 2, 3, 4, and 5 min after giving intracavernosal adrenaline. Any adverse events such as arrhythmias, bleeding, and hematoma were also recorded.

Time to achieve complete detumescence was defined as time duration from intracavernosal injection to complete detumescence as assessed by the surgeon.

**RESULTS**

Of the 2160 male patients who were given spinal anesthesia for varied endourology procedures over the past 5 years, only 0.92% developed intraoperative penile erection significant enough for intervention. The average age of the patients in our study group was 50.3 ± 15.29 years, with a body mass index of 22.4 ± 10. Of these patients who developed penile tumescence, 11 (55%) were the ones undergoing transurethral resection of the prostate (TURP), 7 (35%) ureterorenoscopy, and 2 (10%) retrograde intrarenal surgery. Of these, 12 patients were in physical status Class I and 8 patients had physical status Class II.

The mean heart rate was 76 ± 12.77 at 0 min (baseline), remained the same at 1 min, and thereafter increased to maximum at 2 min (87.45 ± 12.68). Thereafter, it kept on decreasing and reached baseline at 5 min. The change in the baseline parameters of mean systolic and diastolic blood pressures is depicted in Table 1.

Time to achieve detumescence was 2.6 ± 0.47 min, and no adverse event was recorded following the low-dose intracavernosal injection.

**DISCUSSION**

Penile tumescence at the time of surgery has been described irrespective of the type of anesthetic technique used. Incidence has been reported to be more in epidural as compared to spinal or general anesthesia.[10] The reported incidence under spinal anesthesia is 0.11%–2.2%.[2]

The mechanism of penile erection involves the arterioles, venules, and arteriovenous anastomotic channels of the corpora cavernosa. The arterioles are partially closed while the venules and arteriovenous channels remain open during the flaccid state, providing an unimpeded drainage of the arterial inflow. Psychic or local sensor stimulation precipitates sacral (S₂, S₃, and S₄) parasympathetic outflow, leading to relaxation of corporal arterioles and partial closure of the venules and arteriovenous shunts, with a subsequent engorgement of the corpora cavernosa. Normally, the erection subsides after sympathetically mediated arteriolar constriction, with the reduction of inflow and enhanced venous drainage. This is mediated by adrenergic stimulation that causes a constriction of penile venous sinusoids, opening emissary veins, and thereby increasing blood drainage.[11]

The exact mechanism of this penile erection during surgery is not known. However, during regional or general anesthesia, sympathetic output of lower thoracic or higher lumbar spinal segments may be lost, and the local stimulation of penis at the time of surgery could activate parasympathetic pathway leading to an unopposed reflex response through an autonomic imbalance. Other researchers suggest that there may be other mechanisms involving noradrenergic, noncholinergic, and local transmitters which may explain the rare occurrence of this condition.[12]

This penile tumescence during endourological procedures is a problematic thing and may lead to delay or even postponement

**Table 1: The serial changes in heart rate and blood pressure after intracavernosal injection of adrenaline**

| Time interval (min) | Heart rate | SBP | DBP |
|---------------------|------------|-----|-----|
| 0                   | 76.65±12.77| 129.5±12.84| 76.75±8.56|
| 1                   | 75.52±26.87| 130.4±12.75| 77.75±6.86|
| 2                   | 87.45±12.68| 130.7±12.43| 78.15±8.12|
| 3                   | 79.55±12.44| 129.3±12.48| 77.55±7.97|
| 4                   | 78.20±12.80| 129.7±12.39| 77.10±8.34|
| 5                   | 76.40±13.08| 130.85±13.01| 76.70±8.18|

DBP=Diastolic blood pressure, SBP=Systolic blood pressure, SD=Standard deviation
of the surgical procedure. Hence, many pharmacological agents have been used in the literature for the management of intraoperative penile erection, but no single method is fully effective or without side effects.

Alpha-adrenergic agonist drugs such as norepinephrine, phenylephrine, and noradrenaline have been used for priapism in different studies. Either intracavernosal injection or aspiration and irrigation of cavernosal bodies with these drugs have both been used in the management of priapism or in resolving intraoperative rigidity. On local injection, these agents function to cause α-adrenergic-mediated vasoconstriction through contractile stimulation of cavernous smooth muscle, resulting in detumescence. Furthermore, these agents are believed to produce detumescence by decreasing blood supply to or increasing blood drainage from the corpora cavernosa through activation of adrenergic receptors.

Adrenaline is a sympathomimetic catecholamine that exerts its pharmacologic effects on both alpha- and beta-adrenergic receptors. α-1 receptor stimulation leads to increased vascular smooth muscle contraction, pupillary dilator muscle contraction, and intestinal sphincter muscle contraction, whereas β-1 receptor stimulation causes increased heart rate and myocardial contractility.

In our study, we choose to use adrenaline because it is the main drug used for cardiopulmonary resuscitation and is readily available in every hospital setting. We thought of giving the lowest possible dose with good efficacy. Adrenaline in the dose ranging from 10 to 25 μg has been used previously to relieve intraoperative priapism. Bansal et al. in their study have used 5 μg of intracavernosal adrenaline in two patients and found it to be very effective in relieving intraoperative tumescence. We further reduced the dose in order to have the least hemodynamic side effects of the drug.

We observed that the mean heart rate of patients in our study increased from baseline (76 ± 12.77 beats/min) to reach maximum at 2 min (87.45 ± 12.68 beats/min). Thereafter, it kept on decreasing and reached baseline at 5 min (76.40 ± 13.08 beats/min). The maximum increase in mean heart rate was 11 beats/min from the baseline, and then, it returned back to the baseline value in all the patients within 5 min. This can be explained by the fact that adrenaline has a rapid onset but a short duration of action. When given intravenously, it has a half-life of <5 min. Metabolism is primarily in the liver, along with various other locations such as the kidneys, skeletal muscle, and mesenteric organs. It is degraded into an inactive metabolite named vanillylmandelic acid and excreted into the urine. Monitoring was also done for 5 min only keeping in mind the half-life of the drug.

There was no change in mean systolic and diastolic blood pressure after the administration of the drug in our study, and none of the patients had any complication related to the study group.

Complete penile detumescence was achieved in all the study patients (mean time: 2.6 ± 0.47 min). None of the patients required any postponement or delay in the surgery. Adigun et al. have reported two patients in whom TURP surgery was postponed because of the development of penile erection under spinal anesthesia and the priapism resolved after the effect of spinal anesthesia had worn off. Early intervention has been emphasized in these cases as the duration of the erection is the critical factor for the successful detumescence of the penis and minimizing the risks of complications such as fibrosis and thrombosis.

Zappala et al. used adrenaline for intraoperative erections in the dose ranging from (1–100 μg), but inherent cardiovascular risk was reported in their study. Few more authors have used intracavernosal adrenaline in the dose ranging from 10 to 20 μg but have cautioned against the cardiovascular complications. Similarly, Bansal et al. have used 5 μg of intracavernosal adrenaline with good success and no effect on hemodynamic, but their study was done only in three patients. On searching the literature regarding the dose of adrenaline to be given intracavernously, we found that none of the authors have studied the role of such low dose of adrenaline on detumescence and hemodynamics.

Intravenous ketamine is most commonly used drug to achieve detumescence in intraoperative penile erection, but it causes hallucinations and has to be used with caution in elderly hypertensive patients. Major disadvantage with ketamine is that it takes on an average 90 min to 2 h to achieve flaccidity. Moreover, there have been reports of failure of this drug to achieve detumescence. Hence, the use of these drugs has been reported but not without unwanted side effects and failures.

Another commonly used intracavernosal drug is phenylephrine which causes immediate detumescence with minimal side effects, but it is not freely available as adrenaline in the operation theatre.

Because of the rare occurrence of this condition, we could not get a large sample of the study patients, but all the patients who received the study drug achieved detumescence within 2–3 min with a minimal increase in heart rate that returned back to baseline after 5 min.

**Conclusion**

Penile tumescence following regional anesthesia is a rare but troublesome problem. The use of ultra-low-dose intracavernosal injection of adrenaline provides a safe and efficacious outcome.

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**Conflicts of interest**

There are no conflicts of interest.
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