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Original Article

Gas (Oxygen) insufflation: A new technique for the visualization of the operative field during hypospadias surgery

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ABSTRACT

Objective: Maintaining a bloodless operative field is a crucial step in achieving success and reducing complications in hypospadias surgery. So, far, the most harmless and least damaging technique in terms of penile tissue oxygenation during hemostasis has not still been defined. We aimed to present our new technique of gas (oxygen) insufflation for better visualization of the operative field, and to compare this with the control group, where a wet sponge was used for hemostasis.

Material and methods: A total of 28 patients with primary distal hypospadias who were treated with modified tubularized incised plate urethroplasty (TIPU) repair between March 2017 and October 2018 were evaluated prospectively. The patients were divided randomly into two groups. While only a wet sponge was used to clean hemorrhagic area in the control group (group I) (n=12), gas (oxygen) insufflation was used to visualize the operative field during the operation in the patient group (group II) (n=16). The patients' ages, operation time, follow-up durations, and postoperative complications were documented and statistically compared.

Results: The mean ages and follow-up durations of both groups were found to be similar. The operation time was statistically shorter in group II than in group I (p=0.01). Eight patients (66.7%) in group I showed a complication, while 2 patients (12.5%) in group II showed a complication (p=0.005).

Conclusion: The gas (oxygen) insufflation technique provides good visualization during the dissection step of hypospadias surgery and results in better postoperative outcomes. Therefore, we think that this technique can be preferred as an alternative method for the visualization of the operative field in hypospadias surgery.

Keywords: Epinephrine; gas; hypospadias; insufflation; oxygen; tourniquet.

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Introduction

Hypospadias is the most common congenital penile malformation, which occurs at a rate of 1 out of 250 male births in the United States.[1] Although several factors such as hormonal, genetic, and environmental causes are responsible for its etiology, surgery is the only option available to achieve a functionally and cosmetically normal penis.[1,2]

Bleeding is one of the most commonly seen challenges during hypospadias repair. Controlling the bleeding is necessary for better exposure of the surgical site, better cosmetic impact, and reduced postoperative complications, such as wound infections, skin necrosis, hematomas, and urethro-cutaneous fistulas.[3,4]

Several methods for preparing a bloodless field during surgery have been devised, such as tourniquet application, use of electrocautery, and injection of vasoconstrictive agents into the penile skin.[5,6] However, some studies have demonstrated that these methods are not safe for the viability of the tissue and may lead to an increased rate of complications.[7,8] We aim to present our new technique of gas (oxygen) insufflation, for better visualization of the operative field by blowing away of the blood, and

to compare that with a control group, in which only a wet sponge was used to clean the bleeding area during the hypospadias surgery.

Material and methods

The ethical approval for the study was received from the Institutional Review Board of Van Training and Research Hospital (IRB number: 218/14) and written informed consent was obtained from all patients who participated in the study. We prospectively evaluated the patients who were admitted to the urology clinic for hypospadias repair surgery between March 2017 and October 2018. A total of 28 patients who underwent modified tubularized incised plate urethroplasty (TIPU) repair as described by Kamal [9] were enrolled in this study. All the operations were performed by the same surgeon.

The patients were divided randomly using computer-generated numbers into two groups: the control group (group I) and the gas insufflation group (group II). While only wet sponge was used to clean hemorrhagic area in the group I (n=12), the technique of gas (oxygen) insufflation (Figure 1) was performed in group II (n=16), where gas was ejected intermittently at a low flow rate of 5 L/minute to improve the visualization of the operative field during the operation using the frazier aspirator/suction tool (Figure 2). The same surgical technique and procedures were performed in both groups without the aforementioned difference. Only primary distal hypospadias cases repaired with TIPU with a minimum follow-up period of six months were included in the study. The exclusion criteria were: systemic diseases, some treatments impairing wound healing, penile chordee, non-distal hypospadias, and non-primary repairs.

All patients were intraoperatively administered a dose of parenteral cephalosporin (cefuroxime axetil) followed by oral cephalosporin (cefuroxime axetil) and ibuprofen (anti-inflammatory agent) until the removal of the indwelling urethral catheter. The surgical wound was closed with a simple bandage at the end of the operation. The dressings of the patients were opened the next morning (between 16–20 hours after surgery) and were not placed again. Only oxytetracycline ophthalmic ointment was abundantly applied to the surgical wound areas twice a day until the removal of the catheter. The patients were discharged on the third postoperative day. The catheter was removed on the seventh postoperative day. All patients were examined by the surgeon once a week in the first month after catheter removal and every month thereafter. The Clavien classification was used to assess the complications.[10]

Statistical analysis

The Chi-squared test, with Fisher exact test when appropriate, and the independent-t test were used for comparing the categorical data and numerical variables between the groups for statistical analysis, respectively. P-values of less than 0.05 were considered significant.

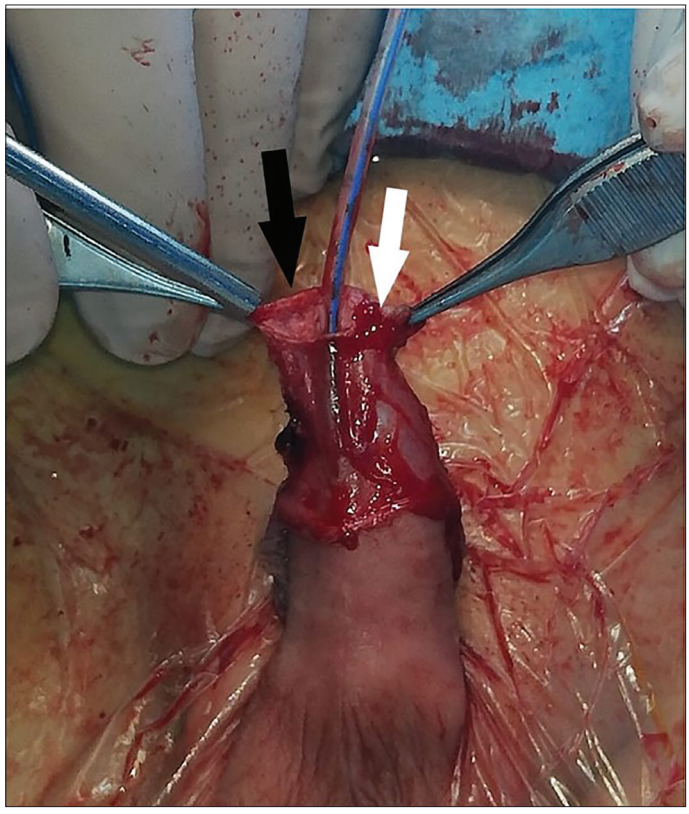

Figure 1. Blood removed from the right glans wing using gas insufflation (black arrow); the bleeding left glans wing without any attempt at hemostasis (white arrow)

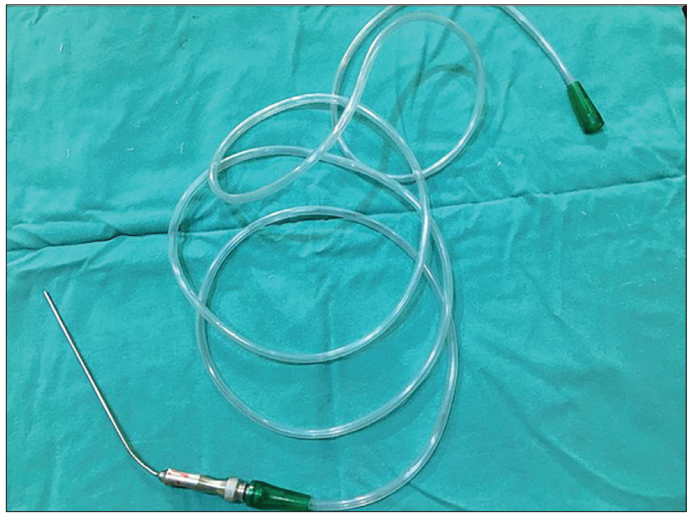

Figure 2. The frazier aspirator/suction device supplied a continuous stream of oxygen from the anesthetic machine to the operative field (18 cm, 367-7846, Germany)

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Results

During the study period, hypospadias reconstruction surgery was performed in a total of 28 patients whose baseline variables and characteristics are listed in Table 1. While the mean ages and follow-up durations of the groups were similar, the operation time was statistically shorter in group II than in group I (p=0.01).

Edema was the most commonly seen complication as a rate of 10.7% (16.7% in group I and 6.3% in group II). All the complications that are listed in Table 2 were similar between the groups when compared one by one. However, the statistical significance between them was revealed when the complications were evaluated as a whole, irrespective of the subgroups. In other words, 8 patients (66.7%) showed some type of complication in group I, while 2 patients (12.5%) showed a complication in group II (p=0.005). Diverticulum, neourethral strictures, or skin necrosis were not observed throughout the follow-up duration in both groups.

Discussion

Since it was introduced in 1994 by Snodgrass, TIPU has been performed to repair hypospadias by many hypospadiologists due to its low complication rates and better cosmetic outcomes.[2,11] The ultimate goal of any hypospadias repair is to achieve a functionally and cosmetically normal penis. Even in the hands of most experienced surgeons, hypospadias repair is associated with a number of complications that vary from edema to the complete breakdown of neourethra, which requires total reconstruction.

Table 1. Baseline variables of the patients

Characteristic	Group I	Group II	p
Age (months)	49.83±27.97	53.31±30.01	0.75
Operation time (minutes)	68.92±9.7	59.69±5.89	0.01
Follow-up (months)	13.75±7.28	13.63±6.30	0.96

Results were presented as mean±SD

Table 2. Postoperative complications of the cohort according to the Clavien Dindo classification

Complication	Clavien type	Group I, n (%)	Group II, n (%)	p
Bleeding		1 (8.3)	0 (0)	0.42
Edema	I	2 (16.7)	1 (6.3)	0.56
Hematoma		1 (8.3)	0 (0)	0.42
Wound infection	II	1 (8.3)	1 (6.3)	0.83
Meatal stenosis	IIIa	1 (8.3)	0 (0)	0.42
Glans Dehiscence	IIIb	1 (8.3)	0 (0)	0.42
Urethro-cutaneous fistula		1 (8.3)	0 (0)	0.42

Bleeding control is a crucial step for a successful and reduced-complications surgery. Different methods have been used for hemostasis during hypospadias repair, such as injection of vasoconstrictive agents to the penis and placement of a tourniquet at the base of the penis. Standardization and a general consensus are absent among surgeons about the dose of the vasoconstrictive agents and the duration of tourniquet application. Besides this, the applications of these techniques are controversial.[7,12-15] According to Redman, if ischemic periods are less than 50 minutes, these techniques are tolerable by the patient.[12] However, a recent study has shown that tourniquet usage is not safe for a time of more than 10 minutes.[7] Also, some surgeons have been continuously applying penile tourniquets from the beginning to the end of the operation, while others have suggested intermittent application every 10 minutes.[12,13]

Cakmak et al.[7] evaluated malondialdehyde (MDA) levels and histological changes such as edema, congestion, and extravasation in penile skin flaps after placement of a penile tourniquet and administration of an epinephrine injection. The results of this experimental study were rather worrying. As the duration of penile tourniquet application increased, the MDA levels also simultaneously statistically increased. Also, the administration of an epinephrine injection resulted in increased MDA levels and a detrimental effect on the histological structure of the penile tissue. In a similar investigation on rabbits, Kajbafzadeh et al.[8] revealed that the application of both penile tourniquets and epinephrine injections for hemostasis might lead to tissue damage following an ischemic-reperfusion injury in the urethral wall.

In our study, neither dilute epinephrine nor placement of a penile tourniquet was used for the visualization of the operative field in any patient during the operation, rather, low flow gas (oxygen) insufflation with the frazier aspirator/suction tool was used for this purpose. We have previously experienced that the operative field can be visualized perfectly with this technique, especially during the dissection of the glans wings. Gas (CO_2, O_2, and room air) insufflation is a widely used method to remove blood from the surgical field and improve the visualization during off-pump coronary surgery.[16,17] When we searched the literature for evidence of the use of the above-mentioned technique during coronary artery anastomosis surgery, we found more than 200 papers. Since its first use in 1991, it has become popular and even routine in many clinics.[17,18] We adapted this technique for hypospadias repair surgery to the avoid harmful effects of former techniques and performed it for the first time. We also compared the outcomes of this technique with control group, in which only a wet sponge was used to clean the bleeding area.

In the present study, the complete rates of complications were calculated as percentage values in group I, which were higher than the values observed in group II. While hematoma, bleeding, meatal stenosis, glans dehiscence, and uretho-cutaneous fistula were not observed, 1 patient had mild edema that was remedied easily with already-administered ibuprofen. Another patient had a wound infection that healed with the change of the topical antibiotic ointment in group II. Therefore, the second intervention for reconstruction was not required with our technique. In a meta-analysis study, the complication rates of urethral fistulae, meatal stenosis, and urethral stricture were 3.8%, 3.1%, and 0% in hypospadias repair, respectively.[19] Although the complication rates compared between the groups in terms of tourniquet application and epinephrine injection in another study conducted in Iran were found to be similar with the rates in our study, there were some patients who needed reoperations in both groups in the previous study.[20] When we compared the postoperative complications between our groups, the control group had higher complication rates than the gas (oxygen) insufflation group (p=0.005). Also, the operation time was statistically shorter in group II than in group I (p=0.01). Besides this, the operation time in our study was revealed to be shorter than study of Alizadeh et al.[20] in terms of mean±SD.

Some studies demonstrated that gas insufflation resulted in endothelial injury of the coronary artery, but did not damage the venous grafts.[17,21-25] The glans penis consists of small capillaries and vascular sinuses, and hypospadias surgery contains no vessel anastomotic step due to its nature. We found only one study regarding endothelial denudation associated with oxygen insufflation, which was ejected under a high positive pressure of 12 L/minute.[24] On the other hand, in a porcine study about heart transplantation, coronary oxygen persufflation preserved the myocardial and endothelial functions for a prolonged period.[26] A potentially harmful effect of this technique on coronary endothelium was investigated mostly at high flow rates with a jet exposure and CO_2 gas insufflation. Also, endothelial denudation occurs focally in the anastomotic line of the artery. In our study, we used oxygen insufflation intermittently at a low flow rate of 5 L/minute, with a duration as short as possible, from the beginning of the incision on the glans till the closure. Endothelial denudation linked with this technique may result from differences in flow, type, and moisture of the gas, the length of the anastomosis, type of vessel, and the duration of exposure. Taking into account all these factors and the lower postoperative complication rates and better outcomes of our study, we think that oxygen insufflation does not cause any harmful effect on hypospadias surgery. However, further experimental studies are needed to clarify this gap.

This study had some inherent limitations. Firstly, the sample size was small. Further clinical studies with larger patient populations are needed for the verification of our results in the future. Secondly, we could not calculate the amount of blood loss due to the presence of gas-blown blood and a shorter duration of gas exposure due to intermittent usage. Finally, a comparison between all the hemostasis techniques was not carried out, which might have been beneficial to assess the safest one. However, we did not deem it suitable to use the techniques of tourniquet application and epinephrine injection, since the discussed studies had pointed out that they were causing harm to penile oxygenation.

In conclusion, we believe that our new technique contributed to a successful operation for the patients without problems because of prolonged ischemia. This technique is advantageous because of its shorter operation time and lesser postoperative complications. We suggest our new technique to specialist hypospadiologists to enable them to gain better exposure of the operative field during hypospadias surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Van Training and Research Hospital (number: 218/14).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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