ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.5336/urology.2021-82081

Comparison of Three Gases for Insufflation to Improve Operating Field Visualization During Hypospadias Surgery

Hipospadias Cerrahisi Sırasında Ameliyat Alanı Görselleştirmesini İyileştirmek İçin İnsüflasyonda Üç Gazın Karşılaştırılması

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ABSTRACT Objective: Maintaining an operating field clear of blood accumulation to provide better exposure is very important to increase the success of hypospadias surgery and to decrease postoperative complications. Gas insufflation has been shown to be an effective technique to improve the appearance of the operating field. We aimed to compare whether oxygen, carbon dioxide, and room air gases used for insufflation have any advantage over each other. **Material and Methods:** A total of 75 patients who underwent modified tubularized incised plate urethroplasty repair for hypospadias were included in this prospective study. The patients were divided into three groups according to order of admission, and all operations were performed by the same surgeon. Group I (n=26) and Group II (n=25) used oxygen and carbon dioxide, respectively, for insufflation to provide better visualization, while room air was used in Group III (n=24). Each patient's age, operating time, follow-up duration, and postoperative complications were documented and statistically compared. **Results:** The demographic characteristics of the patients were found to be similar between groups. There were no statistically significant differences in complications like edema, bleeding, and urethrocutaneous fistula (p=0.708, p=0.852, p=0.730, respectively) between the groups whether oxygen, carbon dioxide, or room air were used. **Conclusion:** Using gas insufflation for better operative field exposure during hypospadias surgery, regardless of whether it is oxygen, carbon dioxide, or room air, contributes to a successful operation without causing the complications associated with long-term ischemia.

Keywords: Hypospadias; insufflation; oxygen; carbon dioxide; air

ÖZET Amaç: Ameliyat sahasında kan birikimini azaltmak ve ameliyat sırasında daha iyi görselleştirme sağlamak, hipospadias cerrahisinde ameliyatın başarısını artırmak ve ameliyat sonrası komplikasyonları azaltmak için çok önemlidir. Gaz insüflasyonu, operasyon alanının görünümünü iyileştirmek için etkili bir teknik olduğu gösterilmiştir. İnsüflasyon için kullanılan oksijen, karbondioksit ve oda havası gazlarının birbirlerine herhangi bir avantajı olup olmadığını karşılaştırmayı amaçladık. **Gereç ve Yöntemler:** Hipospadias nedeniyle modifiye tubularize insizyonel plate üretroplasti onarımı yapılan toplam 75 hasta prospektif çalışmamıza dâhil edildi. Hastalar başvuru sırasına göre 3 gruba ayrıldı ve tüm ameliyatlar aynı cerrah tarafından yapıldı. Grup 1 (n=26) ve Grup 2 (n=25) sırasıyla oksijen ve karbondioksit insüflasyonu kullanılırken, Grup 3'te ise daha iyi görüntü sağlamak için oda havası (n=24) insüflasyonu uygulandı. Hastaların yaşları, operasyon süresi, takip süreleri ve postoperatif komplikasyonlar belgelendi ve istatistiksel olarak karşılaştırıldı. **Bulgular:** Her 3 gruptaki hastaların demografik özellikleri benzer bulundu. Oksijen, karbondioksit ve oda havası insüflasyonu kullanılan gruplar arasında komplikasyonlar açısından istatistiksel olarak anlamlı fark yoktu (sırasıyla p=0,708, p=0,852, p=0,730). **Sonuç:** Oksijen, karbondioksit veya oda havası fark etmeksizin hipospadias cerrahisinde ameliyat sahasının daha iyi açığa çıkması için gaz insüflasyonu kullanılması, uzun süreli iskemi komplikasyonlarına neden olmadan başarılı bir operasyona katkıda bulunur.

Anahtar Kelimeler: Hipospadias; insüflasyon; oksijen; karbon dioksit; hava

Hypospadias is one of the most common congenital pathologies of the male genital system and is seen in 0.8-8.2/1,000 live male births.[1] There are studies that have reported an increased incidence in recent years.[2] Hypospadias can be classified as anterior, distal (glandular, coronal, and subcoronal), midpenile, and proximal depending on the location of the urethral opening. Distal types of hypospadias constitute approximately 60-70% of all cases.[3]

Despite significant improvements in the surgical repair of hypospadias, the operation is associated with complications, such as urethrocutaneous fistula,

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Peer review under responsibility of Journal of Reconstructive Urology.

Received: 05 Feb 2021 ***Received in revised form:*** 14 Apr 2021 ***Accepted:*** 20 May 2021 ***Available online:*** 28 May 2021

meatal stenosis, and bleeding.[4] Bleeding from the incision site is one of the major challenges in hypospadias repair surgery. Regardless of the surgical technique, a vital aspect of the procedure is to provide the surgeon with a bloodless surgical site for better visualization. Injection of vasoconstrictive agents, bipolar electrocautery, and tourniquet use are common methods for hemostasis.[5] However, there are different opinions among surgeons about the most appropriate hemostasis technique.

The aim of this study was to investigate the effects of three different gases used for insufflations to clear the hemorrhagic area on the success or failure of hypospadias surgery.

MATERIAL AND METHODS

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Ministry of Health, University of Health Sciences, Van Training and Research Hospital ethics committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethical consent for the study was issued from the Institutional Review Board of the Ministry of Health, University of Health Sciences, Van Training and Research Hospital (IRB: 2020/04-20.02.2020). All the patients who participated had written informed consent provided by their parents. Patients who were accepted into the urology clinic for hypospadias repair between March 2017 and January 2021 were considered for this prospective study. A total of 75 patients who underwent modified tubularized incised plate urethroplasty (TIPU) repair popularized by Kamal were included.[6] The patients were divided into three groups according to the order of admission. All operations were performed by the same surgeon. Group I (n=26) and Group II (n=25) used oxygen and carbon dioxide, respectively, for insufflation, while room air was used in Group III to improve visualization. The same surgical method and procedures were applied to all three groups, apart from the difference in gas used as mentioned above. Only patients with primary distal hypospadias who underwent repair with modified TIPU and were followed for at least three months were enrolled in the study. The exclusion criteria were any treatments or systemic diseases that could affect wound healing, proximal hypospadias, and non-primary hypospadias. The inclusion criteria were children older than one year of age who had distal hypospadias that could be repaired with one seance.

The preoperative location of the urethral meatus was subcoronal in 33 patients, coronal in 24 patients, and glandular in 18 patients. No tourniquet, epinephrine, or electrocautery was used to control bleeding. Instead of these methods, gas (oxygen, carbon dioxide, and room air) insufflation with a 14 fr Nelaton catheter was used to visualize the surgical area during the operation (Figure 1).

The penis was degloved, and an artificial erection test was performed to check for chordee. Dorsal plication was carried out in 15 patients with ventral curvature. All patients were operated on with the modified TIPU technique. In all operations, the neomeatus region was included in the urethral plate incision. Urethroplasty was performed in a single layer with continuous sutures using 6-0 vicryl material, and the dartos flap was formed into a thick layer by being well-stripped from the dorsal preputial and shaft skin. Then, a longitudinal incision was made in the midline, dividing it into two equal strips by preserving its vascular structure. Each of the dartos strips was then rotated around the penis bilaterally to cover the ventral aspect of the penis and sutured to the inner glans wing of the opposite side to near the tip of the neourethra using 6-0 vicryl sutures. Glansplasty was performed with vertical mattress 5-0 vicryl sutures.

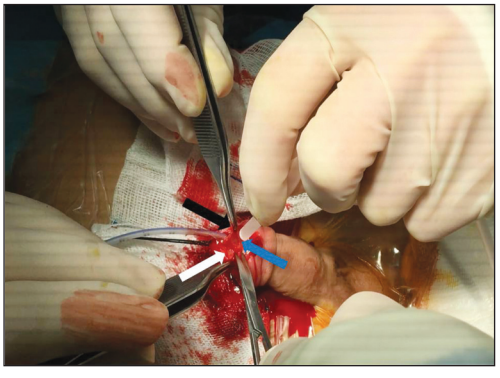

FIGURE 1: Left glans wing previously dissected using gas insufflation (black arrow); dissected right glans wing without any effort at hemostasis (white arrow); urethral plate held by a clamp (blue arrow).

At the end of the operation, the surgical wound was covered with a simple bandage. The bandages of the patients were removed 24 hours postoperatively and not rewound. The surgical wound areas were treated with plenty of oxytetracycline ophthalmic ointment twice daily until the catheter was taken out on the seventh postoperative day. The patients were discharged from hospital on the third day. All patients were evaluated by the surgeon every two weeks in the first month after catheter withdrawal and then every month. The Clavien-Dindo classification was utilized to evaluate complications.[7]

STATISTICAL ANALYSIS

To evaluate numerical variables and categorical data between groups, the Kruskal-Wallis test and chi-squared test were performed, respectively. A p value less than 0.05 was deemed statistically significant.

RESULTS

A total of 75 patients who underwent hypospadias surgery by insufflation with oxygen, carbon dioxide, or room air were divided into groups, and their demographic data were compared. No statistically significant differences were observed between the groups in terms of age, operating time, hypospadias type, chordee repair, and follow-up duration (p=0.967, p=0.925, p=0.855, p=0.813, p=0.903, respectively) (Table 1).

The postoperative complications of the patients in all three groups were assessed according to the Calvien-Dindo classification, and the groups were compared with each other. The most common complication was edema, which occurred in 12% of all patients (11.5% in Group I, 16% in Group II, and 8.3% in Group III, p=0.708). Bleeding occurred in 9.3% of all patients (7.7% in Group I, 12% in Group II, and 8.3% in Group III, p=0.852), and a urethrocutaneous fistula developed in 5.3% of all patients (3.8% in Group I, 4% in Group II, and 8.3% in Group III, p=0.730). Postoperative complications such as hematoma and meatal stenosis occurred less often (p=0.597, p=0.616, respectively). None of the patients had very serious postoperative complications such as wound infection, urethral diverticulum, skin necrosis, or glans dehiscence (Table 2).

TABLE 1: Baseline variables of the patients.

Characteristic	Group I (n=26) (Minimum-maximum)	Group II (n=25) (Minimum-maximum)	Group III (n=24) (Minimum-maximum)	p value*
Age (months)	39.00 (12-84)	41.48 (13-88)	40.46 (11-83)	0.967*
Operation time (minutes)	63.26 (52.75-90.00)	63.44 (52.10-92.00)	63.88 (54.10-88.00)	0.925*
Hypospadias type				
Glandular	8 (30.8%)	5 (20%)	5 (20.8%)	0.855**
Coronal	7 (26.9%)	8 (32%)	9 (37.5%)	
Subcoronal	11(42.3%)	12 (48%)	10 (41.7%)	
Chordee repair (dorsal plication)	6 (23.1%)	4 (16%)	5 (20.9%)	0.813**
Follow-up (months)	20 (3-28)	19.56 (3-27)	19.96 (3-27)	0.903*

Group I: Oxygen insufflation, Group II: Carbon dioxide insufflation, Group III: Room air insufflation. *Kruskal-Wallis test; **Chi-square test.

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

Complication	Clavien Type	Group I (n=26)	Group II (n=25)	Group III (n=24)	p value*
Bleeding	I	2 (7.7%)	3 (12%)	2 (8.3%)	0.852
Edema		3 (11.5%)	4 (16%)	2 (8.3%)	0.708
Hematoma		1 (3.8%)	0 (0%)	1 (4.2%)	0.597
Wound infection	II	0 (0%)	0 (0%)	0 (0%)	-
Meatal stenosis	IIIa	1 (3.8%)	1 (4%)	0 (0%)	0.616
Urethro-cutaneous fistula	IIIb	1 (3.8%)	1 (4%)	2 (8.3%)	0.730

Group I: Oxygen insufflation, Group II: Carbon dioxide insufflation, Group III: Room air insufflation. *Chi-square test.

DISCUSSION

Hypospadias repair surgery is performed to achieve a functionally and cosmetically normal penis. Various surgical techniques are available for hypospadias repair. These surgical techniques are chosen by the surgeon according to the presence of preputial skin, location of the urethral meatus, glans shape, and length and width of the urethral plate, but there are no definitive data indicating that one surgical technique is better than the others.[8] Depending on the surgical technique, hypospadias repair operations can have many complications, ranging from frequent and simple complications, such as edema, to serious complications, such as bleeding and hematoma.[9]

Bleeding, which is one potential complication, prevents the surgical area from being visualized clearly, which is important in terms of surgical success and postoperative complications. Different techniques have been used for exposure purposes during surgery to provide hemostasis, such as injection of vasoconstrictive agents to the penis and controlled ischemia with a tourniquet applied to the penis. Despite these options, there is no optimal hemostasis technique universally accepted by surgeons. Although there are studies showing that 50 minutes of ischemia for bleeding control is not harmful, many studies suggest that ischemia should be limited to 10 minutes.[10-14] There is also a study showing that epinephrine injection damages the tissue histologically; therefore, it cannot be said that there is no damage to the tissue following epinephrine injection.[10] Similarly, in a study conducted on rabbits, it was shown histologically that using methods such as tourniquets and epinephrine injections for hemostasis causes tissue damage by disrupting tissue nutrition.[5] The saline irrigation technique has also been tried to enhance the appearance of the operative field, but it has been observed that there are side effects, such as diffusion into the tissues and circulation, especially during prolonged operations.[15]

Especially in coronary artery surgery in which tissue ischemia is important, gas (oxygen, carbon dioxide, and room air) insufflation has been tried to minimize ischemia while providing a clear surgical field of view, and it has been found to be successful. Oxygen, carbon dioxide, and room air insufflation have been used to improve the image in arterial anastomosis surgeries for years and, similar to the present study, there are many articles indicating that no type of gas is superior to the others, as long as sterile medical gases are used. In 1991, Teoh et al. developed a new technique for improved visualization during coronary artery anastomosis that employed a catheter-directed constant jet of oxygen to remove blood from the operative field. They found that this technique provided excellent visualization with all methods of myocardial protection. In 1992, Poulton et al. used room air and carbon dioxide rather than oxygen to improve visualization for coronary artery anastomoses during the continuous delivery of blood cardioplegia. They found it appeared to be clinically safe as long as the gases were sterile.[15,16] In another study, it was observed that blowing gas (oxygen) to clear the bleeding area reduced complications and operation time.[17] In order to avoid the harmful effects of ischemia, this technique was used in the present study for hypospadias repair surgery.

This study has some technical limitations. Since the technique was similar for all three gases, we did not calculate the amount of blood lost. In addition, since we did not use the tourniquet and epinephrine injection techniques, we could not compare these techniques with gas insufflation.

CONCLUSION

We believe that using gas insufflation for better exposure of the operative field in hypospadias surgery, regardless of whether it is oxygen, carbon dioxide, or room air, contributes to a successful operation without causing the complications of long-term ischemia. We have seen that you could use oxygen, carbon dioxide, or room air, whichever can be most easily supplied, for gas insufflation during hypospadias surgery.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Selamettin Demir;* ***Design:*** *Selamettin Demir;* ***Control/Supervision:*** *Selamettin Demir, İrfan Şafak Barlas, Alper Bitkin;* ***Data Collection and/or Processing:*** *Selamettin Demir, İrfan Şafak Barlas, Alper Bitkin;* ***Analysis and/or Interpretation:*** *Selamettin Demir, İrfan Şafak Barlas, Alper Bitkin;* ***Literature Review:*** *Selamettin Demir, İrfan Şafak Barlas;* ***Writing the Article:*** *Selamettin Demir, İrfan Şafak Barlas, Alper Bitkin;* ***Critical Review:*** *Selamettin Demir, İrfan Şafak Barlas, Alper Bitkin;* ***References and Fundings:*** *Selamettin Demir, İrfan Şafak Barlas;* ***Materials:*** *Selamettin Demir, İrfan Şafak Barlas.*

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