

## Incidence of Complications Following Thermocautery-assisted Circumcisions

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**Purpose:** This study aimed to examine the short- and long-term complications of thermocautery-assisted circumcisions.

**Materials and Methods:** A total of 1780 children who consecutively underwent thermocautery-assisted circumcisions from May 2014 to May 2016 in Yuksekova State Hospital in Turkey were included in this study. These children were classified into perioperative, early postoperative, and long-term complication groups. In addition, the age groups were compared in terms of complications.

**Results:** The patient age and surgical duration means were  $4.16 \pm 3.805$  years old and  $6.14 \pm 1.703$  minutes, respectively. Complications were observed in twelve patients, or 0.6% of the whole observation set. One patient exhibited bleeding and was included in the perioperative complications group. Four patients were included in the early postoperative complications group; three of them had bleeding and one had an infection. Finally, three patients had trapped penises, two patients had meatitis, one patient had a delayed wound healing issue, and one had a glans-skin bridge. These seven patients fell into the long-term complications group. The patients younger than 3 years old had significantly higher complication rates when compared to the older patients, and this comparison was statistically significant ( $P = 0.001$ ).

**Conclusion:** The results showed that thermocautery-assisted circumcision is a safe and efficient surgical technique for use in children.

**Keywords:** circumcision; child; complication; surgical technique; thermocautery

### INTRODUCTION

Male circumcision is a well-known surgical procedure performed worldwide<sup>(1)</sup>. Statistically, one out of every six men is circumcised globally. Circumcisions can be performed using different approaches, including scalpels and scissors, clamps (Ali's clamp, Mogen clamp, or Shang ring), and electrical devices (thermocautery or bipolar cautery)<sup>(1,2)</sup>. A circumcision reduces the risks of several serious illnesses, like urinary system infections, pyelonephritis, penile and prostate cancers, cervical cancer in female partners, human papillomavirus, herpes simplex virus 2, human immunodeficiency virus (HIV), and other sexually transmitted diseases<sup>(3,4)</sup>.

Thermocautery has also been proven to be a cheap and practical circumcision method, and it has become more popular. However, there are not yet adequate academic studies of the short- and long-term complications of the thermocautery-assisted circumcision technique. This paper provides several statistical results and comparisons within a huge set of patients that underwent thermocautery-assisted circumcisions. The short- and long-term complications were examined, and the thermocautery-assisted circumcision technique was discussed in light of the current literature.

### PATIENTS AND METHODS

This research was carried out in accordance with the

Helsinki Declaration rules, and with the approval of the local ethics committee (Clinical Ethics Committee of Afyon Kocatepe University, date 02/03/2017, issue 2017/2-52). In addition, consent forms were obtained from the legal representatives of the patients for the use of the medical images.

A total of 2700 children underwent circumcisions from May 2014 to May 2016 at the Yuksekova State Hospital in Turkey. Of those children, 737 were circumcised by a different surgeon. Another circumcision method was used for 20 of the children. Five patients were older than 18 years old, and 17 had systemic diseases. One hundred and fifteen patients had concurrent inguinal pathologies, 11 underwent recircumcisions due to complications, and 15 had megameatus intact prepuce variants of hypospadias. Therefore, in total, 920 of the 2700 enrolled patients were excluded from the statistical analysis. The remaining 1780 patients were classified into perioperative, early postoperative, and long-term complications groups. The perioperative complications group included bleeding during the circumcision or during the hospital stay. The early postoperative complications group included complications emerging during the first ten days after discharge from the hospital. The long-term complications group included those complications occurring ten or more days after discharge from the hospital. The surgical complications related to the circumcisions were evaluated according to the modified Clavien-Dindo classification system<sup>(5)</sup>.

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**Table 1.** Thermocautery circumcision complication rates.

Complication		Patient age	Clavien-Dindo classification	Treatment
Perioperative	Bleeding (n=1)	1y	3a	Cauterization
Early postoperative (< 10 days)	Bleeding (n=3)	15y, 1y, 2y	3a, 3a, 3a	Cauterization, dorsal vein knotting, frenular artery knotting
Late postoperative (> 10 days)	Infection (n=1)	1	2	Medical
	Secondary phimosis/trapped penis (n=3)	3m, 6m, 8m	3b, 3b, 3b	Redo surgery
	Meatitis (n=2)			
	Delay in wound healing (n=1)			
	Glans-skin bridge (n=1)	40d, 2y 2y 6m	2 1 3a	Medical Medical Surgical

**Abbreviations:** d, day; m, month; y, year; n, number

The following symptoms were not evaluated as complications: foreskin swelling, glans penis incrustation due to a phimosis opening, or a temporary color change after local anesthesia.

### Circumcision technique

The circumcisions were performed under local anesthesia using bupivacaine HCl (Marcaine 0.5%; AstraZeneca, Istanbul, Turkey) and prilocaine HCl (Citaneest 2%; AstraZeneca, Istanbul, Turkey). While the guillotine technique was being applied, the cutting and bleeding control were performed using a thermocautery device (Thermo-Med TM 802-B; Thermo Medical, Adana, Turkey). While cutting, the appropriate heat level was chosen from among the six different device adjustments (degrees) according to the patient's age and foreskin thickness. After the bleeding was controlled with the thermocautery device, the skin-mucosa connection was provided with 5/0 absorbable sutures, and the wound was dressed. Two different surgeons (the authors of this paper) performed the circumcisions as described above. The patient was observed for one hour after the circumcision. After that, the patient and parents were advised to continue with their daily life routines. In those cases in which an excoriation due to phimosis opening, the patient or his parents were advised to apply epithelizing cream to the wound.

After all the circumcised infants and children were controlled on the 10th postoperative day, only the patients with complications were followed for the long-term. The possible complications were explained to the patients and parents, and we asked them to visit the hospital if any symptoms developed, such as penile bleed-

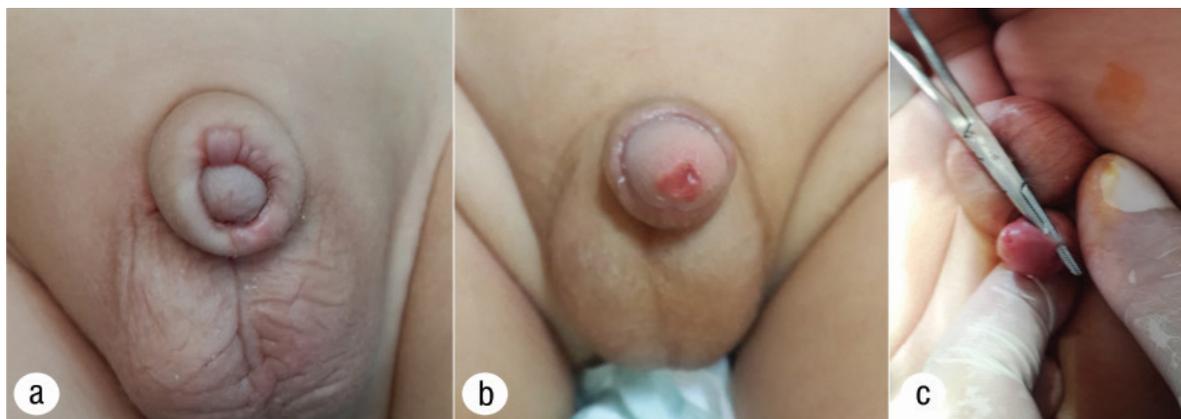
ing, color change, or shape change. In those cases, the patients were assessed, followed up, and treated by the first author of this paper.

### Statistical analysis

The observation set, which consisted of those patients circumcised using the thermocautery-assisted method, was evaluated with the Statistical Package for the Social Sciences software (SPSS Inc., Chicago, IL, USA). The data distribution was examined using the Kolmogorov-Smirnov test. The continuous variables were expressed as the mean  $\pm$  standard deviation (range: minimum–maximum), and the appropriate categorical variables were denoted as the numbers and percentages. The chi-squared and Mann-Whitney U tests were applied to evaluate the categorical data and the quantitative variables, respectively. Two-tailed P values of less than 0.05 were accepted as statistically significant.

### RESULTS

The mean age of the patients was  $4.16 \pm 3.805$  years old (range: 14 days–18 years old). The average surgical duration was  $6.14 \pm 1.703$  minutes (range: 4–15 minutes). Complications were observed in twelve patients, or 0.6% of the whole dataset. The complications were evaluated according to the modified Clavien-Dindo classification method (Table 1). One patient had bleeding from the suture line, which was classified as a perioperative complication. The bleeding was stopped immediately via cauterization. One infection and three bleeding cases were classified as early postoperative



**Figure 1.** Long-term complications of thermocautery-assisted circumcision: a. trapped penis, b. meatitis, c. glans-skin bridge.

**Table 2.** A sample of the circumcision techniques and complication rates in the current literature (2, 13, 15-24, 30).

First author	Technique	Number of patients	Duration of surgery	Complication rate and major complications
Tuncer (present study)	Thermocautery	1780	6.14 ± 1.703 min	0.67% -Bleeding (n=4, 0.22%) -Trapped penis (n=3, 0.16%) -Meatitis (n=2, 0.11%) -Delay in wound healing (n=1, 0.05%) -Infection (n=1, 0.05%) -Glans-skin bridge (n=1, 0.05%)
Aslan (2)	Thermocautery	5781	-	-Bleeding (0.05%) -Scrotal abscess (0.01%) -Tachycardia and syncope after injection (0.01%)
Saracoglu (15)	Thermocautery	55	5.15 min	-Hyperesthesia of the glans penis (n=6, 12%)
	Conventional technique	55	13.55 min	-Hyperesthesia of the glans penis (n=5, 10%) -Secondary phimosis (n=1, 1.8%)
Kazeem (13)	Plastibell device	3760		-Bleeding (0.5%) -Urinary retention (0.32%) -Delay in wound healing (0.15%)
	Frenular manual compression			
	Ophthalmological thermal cautery	3750		-Bleeding (0.05%) -Urinary retention (0.93%) -Delay in wound healing (0.77%)
Méndez-Gallart (16)	Bipolar diathermy scissors	115	10.8 ± 1.2 min	-Edema (19%)
	Conventional scalpel technique	115	19.1 ± 2.6 min	-Edema + bleeding (11.3%)
Jimoh (17)	Plastibell	2276		<b>1.1%</b> -Bleeding (n=12, 0.52%) -Retained Plastibell (n=11, 0.48%) -Wound infection (n=1)
Young (18)	Mogen	1239		<b>2.7%</b> -Bleeding (n=10, 0.80%) -Too little foreskin removed (n=9, 0.72%) -Infection (n=5, 0.40%) -Meatal abrasion (n=3, 0.24%) -Impetigo (n=3, 0.24%) -Damage to the glans (n=1, 0.08%)
Senel (19)	Ali's clamp	7500	4.5 ± 1.5 min	2% -Buried penis (n=78, 1.04%) -Infection (n=45, 0.6%) -Bleeding (n=30, 0.4%)
	Conventional	5700	23 ± 4 min	10.4% -Buried penis (n=68, 1.2%) -Infection (n=238, 4.2%) -Bleeding (n=285, 5%)
Huang (20)	Shang ring	2589	19.16 min	1.27%
Awori (21)	No-flip Shang ring	80	Circumcision 7.4 ± 3.2 min Ring removal 4.4 ± 4.2 min	<b>5%</b> -Wound disruption (n=2, 2.5%) -Pain during removal (n=1, 1.25%) -Wound disruption with mild infection (n=1, 1.25%)
Amir (22)	Gomco	1000	-	1.9% -Bleeding (n=6, 0.6%) -Preputial adhesions (n=4, 0.4%) -Superficial sepsis (n=4, 0.4%) -Inadequate (n=3, 0.3%) -Frenular ulcers (n=2, 0.2%)
Buwembo (23)	-Dorsal slit	2471	22.5 min	0.6% -Bleeding (n=9, 0.36%) -Infections (n=5, 0.20%) -Other (n=1, 0.04%)
	-Sleeve	2681	25.3 min	1.4% -Bleeding (n=20, 0.75%) -Infections (n=12, 0.45%) -Wound dehiscence and infection (n=2, 0.08%) -Other (n=2, 0.07%)
Mavhu (24)	PrePex device	1000	-	-PrePex removal (n=10, 1%) -Pain (n=12, 1.2%)
Shen (30)	Langhe disposable circumcision suture device	89	8.1 ± 2.0 min	-Second operation for bleeding (n=2, 2.2%) -Infection (n=4, 4.7%) -Blood loss (4.21 ± 1.31 ml) -Cases requiring manual staple removal (7/85)
	Daming disposable circumcision suture device	94	7.6 ± 2.2 min	-Infection (n=13, 13.8%) -Blood loss (2.56 ± 1.45 ml)

**Abbreviation:** min, minute

complications. The infection was treated with antibiotics and a dressing. Due to a ligated artery, a one-year-old patient had frenular artery bleeding on the first day after the circumcision. One two-year-old patient had dorsal vein bleeding that was treated via vein ligation.

A fifteen-year-old patient had suture line bleeding due to a hard dressing, but the bleeding was stopped via thermocauterization.

Seven patients fell into the late complications group (**Figure 1**). The penises of three patients were trapped,

and they were surgically circumcised again. A 40-day-old patient developed meatitis three months after the circumcision, while a two-year-old patient had the same issue six months after the circumcision. Both children were medically treated. One patient exhibited delayed wound healing 20 days after the circumcision, and ointment was applied daily to the penis. Finally, one patient had a glans-skin bridge complication six months after the circumcision and was surgically treated.

Except for one patient, complications were only observed in children younger than 3 years old ( $n < 3 = 781, n3 \leq -18 = 999$ ). Therefore, the patients younger than 3 years old had significantly higher complication rates when compared to the older patients ( $P = 0.001$ ). A total of 1310 circumcisions were performed by the first author, and 9 (0.7%) of these patients developed complications. The second author performed 470 circumcisions, and complications developed in 3 of the patients (0.6%). According to the analysis, these two surgeons had statistically similar complication rates ( $P = 0.912$ ).

## DISCUSSION

Male circumcisions are very popular worldwide, and they are considered to be simple surgical procedures. However, a circumcision can lead to serious complications<sup>(1)</sup>. Although there are different studies of the various circumcision methods in the literature, researchers are still debating the most convenient circumcision age and the safest circumcision method. The applied technique should be practical, cheap, and safe, and it should induce very few or no complications. For this purpose, we compared the thermocautery-assisted method with the other circumcision methods in terms of the early and long-term complications. The early complications included bleeding, pain, inadequate skin removal, infection, chordee, iatrogenic hypospadias, glanular necrosis, and glanular amputation. The long-term complications included epidermal inclusion cysts, suture sinus, penile adhesions, phimosis, urethrocuteaneous fistula, trapped penis, meatitis, and meatal stenosis<sup>(3,6,7)</sup>. In addition, hydronephrosis and permanent renal damage can be caused by a meatal stenosis<sup>(8)</sup>.

The thermocautery-assisted technique exploits the heat energy used for cauterizing. When compared with the monopolar cautery technique, which uses an electrical current, the thermocautery-assisted method carries the heat locally. According to the skin features of the patient, the heat levels are adjustable on the most recently developed thermocautery devices. Previous studies have shown that optimum hemostasis is achieved with a temperature ranging between 100°C and 400°C. Although a range between 350°C and 900°C can be obtained within in vivo environments, the highest heat level is reduced by half in a bloody environment<sup>(9)</sup>. Thermocautery devices have been used successfully in local dermatological excisions with the implementation of cardiac devices<sup>(9)</sup>. However, there have been few studies on the use of thermocauterization in circumcisions<sup>(2,10-12)</sup>. It has been shown that the thermocautery technique results in similar wound healing when compared to the scalpel technique<sup>(11)</sup>.

Aslan et al. performed mass circumcisions with thermocautery devices in Sudan, and they reported a complication rate of 0.086% in the early postsurgical period (3 weeks). These complications included bleeding,

scrotal abscess, tachycardia, and syncope after the local anesthesia injection<sup>(2)</sup>. Kazem et al. performed 3-minute manual frenular compressions for bleeding control in 3760 newborn patients undergoing Plastibell circumcisions. They also used an ophthalmological thermocautery technique on a different study set including 3750 patients. While a 0.5% complication rate was observed in the first group, the thermocautery method exhibited a 0.05% complication rate<sup>(13)</sup>. Although urinary retention has been reported when using the Plastibell technique, the ophthalmological thermocautery-assisted circumcisions took longer with regard to urinary retention and wound healing<sup>(13,14)</sup>.

According to our observations, the circumcision line usually heals within 7 days when using the thermocautery technique. We observed that the wound healing was extended to 20 days in only one patient in our data set. Moreover, urinary retention was not observed in any of our thermocautery-assisted circumcisions. Saraçoglu et al. compared the thermocautery technique with conventional circumcisions in their prospective study. Hyperesthesia of the glans penis was observed in 12% of the patients with the thermocautery method and 10% of the patients with the surgical method. In the long-term follow-up, 0.9% of the patients who underwent the surgical circumcisions had secondary phimosis<sup>(15)</sup>. Although the short-term complications were examined in these studies, there have not been adequate observations of the long-term complications. This paper provides a complete evaluation of the thermocautery-assisted circumcision technique with respect to the short- and long-term complications. The patients in our dataset were followed up postoperatively for one to three years.

Since the cauterization is performed during the cutting process in the thermocautery technique, the bleeding risk is less when compared to the other methods. Here, the long-term complications observed when using the thermocautery technique have been reported for the first time in the English literature. All of the complications, except for one patient, were observed in children under three years old, and a statistically significant difference was found among the age groups in terms of the complications. In recent years in Turkey, circumcisions have been increasingly preferred for children at earlier ages, due to the belief that this leads to faster wound healing. However, our study results show that this may not be accurate. Our observations show that children older than three years have less short- and long-term complications when undergoing circumcisions.

There are many different circumcision techniques currently in use, and these have been summarized in the context of the current literature in **Table 2**<sup>(2,13,15-24, 30)</sup>. For example, the Plastibell circumcision technique can be applied safely in infants from newborns to one-year-olds<sup>(25)</sup>. The operation takes between five and ten minutes, and the Plastibell is abandoned in the penis for one or two weeks until it comes off by itself. Complications related to this method have been reported in 3% of the patients<sup>(25)</sup>, and Jimoh et al. reported a complication rate of 1.1% in their Plastibell study of 2276 patients<sup>(17)</sup>. The Mogen clamp is often used among the Jewish population<sup>(26)</sup>, and Young et al. reported a complication rate of 2.7% in their Mogen clamp study of 1239 patients<sup>(18)</sup>. Ali's clamp is a tool widely used in Turkey. It consists of a whistle-shaped tube on the glans and a ring that

compresses the foreskin through it. The average duration of this application is approximately five minutes. Senel et al. reported a complication rate of 2% in their Ali's clamp study of 7500 patients<sup>(19)</sup>. They showed that Ali's clamp is easier to apply, and the operation time was less than in the other current methods, with fewer complications<sup>(19)</sup>. Another technique uses the Shang ring, which was developed in China. It is an apparatus that compresses the foreskin between two rings; however, this method carries the risk of glans amputation<sup>(27)</sup>. The ring is removed after 5–7 days<sup>(21)</sup>. In one meta-analysis including 18 randomized clinical studies, Huang et al. reported a complication rate of 1.27% in 2589 patients circumcised using Shang rings<sup>(20)</sup>. The Gomco method uses a metal clamp with a bell-shaped tip, and Amir et al. reported a complication rate of 1.9% in their study of 1000 patients<sup>(22)</sup>. Ozen et al. reported that 13 newborns who were circumcised using the Gomco technique developed meatal stenoses. Meatoplasties were used to treat these patients<sup>(7)</sup>.

The dorsal slit, guillotine, and sleeve methods are defined as open circumcision surgical techniques. For the dorsal slit method, a vertical incision is made in the forward direction; then, an appropriate amount of mucosa is selected with the foreskin and removed by cutting the tissue around the penis with scissors. Following hemostasis, the remaining skin and mucosa are stitched together. In the sleeve technique, the incision on the foreskin is done circularly with a scalpel, and the mucosal boundaries are excised. The skin is cut in the form of a band and then removed. This process is followed by hemostasis and stitching. Buwembo et al. reported a complication rate of 0.6% in their dorsal slit study of 2471 patients, and a complication rate of 1.4% in their sleeve study of 2681 patients<sup>(23)</sup>. The application of monopolar diathermy runs the potential risk of coagulation due to the electrical current at the penile base<sup>(28)</sup>. Previous studies have revealed serious complications, such as penile ablation, necrosis, and gangrene<sup>(29)</sup>. Shen et al. compared two disposable circumcision suture devices (Langhe and Daming). Complications such as bleeding, manual staple removal, and infections are frequently observed when using these devices<sup>(30)</sup>. The relatively small cohort size, retrospective design, and lack of standardization among the surgical techniques of the operating surgeons are the limitations of this research study of the thermocautery-assisted circumcision method.

## CONCLUSIONS

The results of this study show that thermocautery-assisted method is a safe, practical, reliable, and efficient technique for performing male circumcisions.

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## CONFLICTING INTERESTS

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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