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Chapter

Laser Circumcision: A New Technique

Rosario Leonardi and Giuseppe Saitta

Abstract

In this chapter, we would like to enlighten the importance of circumcision as a feasible and sometimes necessary surgical technique. In particular, laser circumcision seems to be more effective than other minimally invasive techniques in terms of safety, reproducibility of the technique, learning curve, and reduced execution times. Moreover, it is associated with low rates of all circumcision complications: no bleeding, no postoperative edema, and rapid functional recovery. The aesthetic results are very pleasing.

Keywords: laser circumcision, safe, quickly, aesthetic, cost-effectiveness, reproducible, no complications, fast recovery

1. Introduction

Male circumcision consists of the surgical removal of some or all of the foreskin (or prepuce) from the penis. It is one of the most common procedures in the world. Moreover, specific benefits from this procedure were identified for the prevention of urinary tract infections, acquisition of HIV, transmission of some sexually transmitted infections, and penile cancer [1].

Some trials in Africa have demonstrated that adult MC decreases human immunodeficiency virus (HIV) acquisition by 51–60% in men, and also increased protection as it affects time after surgery [2].

Other ones showed that MC reduces the risk of other heterosexually acquired sexually transmitted infections (STIs): the risk of acquiring genital herpes by 28–34%, risk of developing genital ulceration by 47%.

Moreover, MC reduces the risk of oncogenic high-risk human papillomavirus (HR-HPV) by 32–35% [3].

Neonatal MC provides other potential benefits during childhood, such as prevention of infant urinary tract infections, meatitis, balanitis, phimosis, and also protection from viral STIs [4].

It is associated also with a lower prevalence of human papillomavirus (HPV) infection and herpes simplex virus-type 2 (HSV-2) transmission, and decreased rates of bacterial vaginosis (BV) in female partners with good evidence [5–8].

A meta-analysis found 68% lower balanitis rates after MC [9].

A large Australian survey reported penile candidiasis in 7.7% of uncircumcised men versus 4.9% of circumcised men [10].

The prevalence of fungal infection was 44% in uncircumcised boys versus 18% in circumcised boys [11].

Uncircumcised men had a 22-fold higher risk of penile cancer, according to a Californian study [12].

Countries with high MC prevalence have lower prostate cancer-related mortality, corrected for potential confounding factors [13].

Arguments opposing MC are supported mostly by low-quality evidence and opinion, and are contradicted by strong scientific evidence [14].

MC did not affect sexual dysfunction: In the trial from Kenya, 99.5% of circumcised participants reported that they were “very satisfied” for increased penile sensitivity. The vast majority of female partners of male participants in this trial reported that they were very satisfied (92%) or somewhat satisfied (5%) with the outcome of circumcision [15].

Circumcision may result in early (intraoperative) or late (postoperative) complications. Early complications are often minor and treatable: Bleeding, pain, swelling, or inadequate skin removal. Major complications, such as amputation of the glans or of the penis, occur very rarely. Persistent pain, wound infection, edema, urinary retention, meatal ulcer, meatal stenosis, foreskin adhesions, fistulas, and loss of penile sensitivity could be considered as late complications.

The complications rates may appear consistently divergent between the considered studies for various surgical procedures and also by different data collection methods [16].

2. Different techniques of circumcision

The three most common operative methods of circumcision are: the Gomco clamp, the plastibell device, and the Mogen clamp (or some variations) [1].

2.1 Gomco clamp

The Gomco clamp was specifically developed for performing MC.

In this procedure, “the foreskin is cut lengthwise through the stretched tissue to allow space in order to insert the device. The bell of the Gomco clamp is placed over the glans, and the foreskin is pulled over the bell. The base of the Gomco clamp is placed over the bell, and the Gomco clamp’s arm is fitted. When the surgeon is sure of the correct fitting and placement by the amount of foreskin to be excised, the nut on the Gomco clamp is tightened and left in place for some minutes to obtain hemostasis, so the foreskin is removed using a scalpel.”

Therefore the Gomco’s base and bell are removed [17].

Some studies showed evidence of lower complication rates in newborn circumcisions, using this technique: an overall complication rate of 1.9% in Saudi Arabia, bleeding in 0.6%, infection in 0.4%, and redundant prepuce in 0.3% of cases.

Another one from Houston, including 521 newborn MC, showed a 2.9% incidence of phimosis (trapped penis) [18].

2.2 Plastibell device

In this circumcision, a plastic ring is inserted under the foreskin, and support is placed over the ring allowing hemostasis. The ring is left up on the penis for some days until tissue necrosis and spontaneous fall off the ring.

Studies on this device reported an overall complications rate from 2.4 to 5%, urinary retention in 3.6%, infections in 2.1%, and bleeding in 0.8–3% of cases [19–24].

2.3 Mogen clamp

This device consists of two flat blades that have limited space between them and a mechanism that draws the blades together and locks them in place. The slit is limited to 3 mm to allow the foreskin ride, but not the glans to cross the opening by the clamp. The foreskin is taken down and the glans pushed downward, protected from the blades. The prepuce distal to the glans is drawn into the slit between the blades and these are locked together, in order to push the skin and permit hemostasis. So, the skin is excised from above the clamp and the device is removed. Complications are rare [23–29].

3. Newborn circumcision techniques

In the last years, many authors have considered the possibility to perform MC with other new devices or maybe other newborn techniques, to reduce or even remove the time for sutures and hemostasis.

A systematic review containing eight RCTs and including 3314 patients, compared the safety and efficacy of traditional versus device-assisted circumcision, showing lower complication rates in the device group compared with the conventional technique group (RR 0.54, 95% CI 0.39–0.74): this difference was due in particular by higher healing and lower bleeding rates [30].

Contraindications to newborn circumcision include significantly premature infants, blood dyscrasias, family history of bleeding disorders, and those who have congenital abnormalities, such as hypospadias, congenital chordee, or deficient shaft skin, such as penoscrotal fusion or congenital buried penis [31].

The true incidence of complications after newborn circumcision is unknown, due to different definitions of “complications” and for the undetermined time of the problem appearing (i.e., early or late).

Adding to the confusion is the comingling of “early” complications, such as bleeding or infection, with “late” complications, such as adhesions and meatal stenosis.

The risk of significant acute MC complications by two large US studies was shown between 0.19% and 0.22%: bleeding from 0.08% to 0.18%, infection (0.06%), and penile injury (0.04%) [32–34].

The most common surgical complication is excessive bleeding (e.g., bleeding that did not stop with local pressure, perhaps requiring a suture), reported in 0.6% of 1742 male infants [35].

Late complications of newborn circumcision include excessive residual skin (incomplete circumcision), excessive skin removal, adhesions (natural and vascularized skin bridges), meatal stenosis, phimosis, and epithelial inclusion cysts.

Hohlfield et al. did not find serious difference between circumcision devices and surgical techniques [36].

There are many newborn techniques, but the most common provide the use of glues and bipolar energy.

3.1 Glue

Sutureless circumcision with tissue glue (iso amyl 2-cyanoacrylate) was cosmetically superior and timeless in comparison to traditional technique in Tiwari's Indian experience [37].

The glue was comparatively safe, efficient, and had a better functional outcome and good cosmesis in the comparative study by Raut [38].

Histoacryl glue saved operative time and was associated with less postoperative pain (severity and duration) [39].

3.2 Bipolar

The bipolar scissors circumcision approach was an effective and safe procedure alternative to the standard scalpel technique in pediatric circumcision with no significant morbidity [40].

This technique was safe and achieved good cosmetic results [41].

The use of bipolar diathermy was shown to be simple, safe, and acceptable [42, 43].

4. Laser circumcision

The carbon dioxide laser for circumcision was introduced in 1989 by the Department of Pediatric Surgery, KK Women's & Children's Hospital in Singapore [44].

In 2004 Vaos compared the clinical effects of the Nd:YAG laser contact technique with those of a conventional technique on the grounds of certain perioperative parameters, including operative time, length of hospital stay, postoperative complications, and morbidity. Thinking that the tissue effects of the Nd:YAG laser contact technique theoretically may attenuate some of the causes of postoperative complications, he demonstrated an effective laser-assisted procedure as a valid alternative to the conventional technique in circumcision with no significant postoperative morbidity [45].

In 2020 an Italian study wished to evaluate the benefits of the use of carbon dioxide (CO₂) laser versus the conventional procedure for circumcision in adults, in terms of duration of surgery, surgical techniques, complications, pain, and cosmetic appearance. So, they showed that the use of a CO₂ laser was associated with a shorter operative time, less wound irritation, and better cosmetic appearance compared with standard surgical techniques for circumcision [46].

We performed 22 laser circumcisions (10/15 W, 1470 nm, 600 μ) with good results [*].

Table 1 resumes the results shown by some authors in terms of functional outcomes (pain, bleeding, edema, and fast recovery), operation time, and good cosmesis between different circumcision techniques: traditional surgery, glue, bipolar, and lasers.

4.1 Safety

Laser circumcision (LC) appears as a safe and reproducible procedure with few complications, almost no bleeding, and no postoperative edema and inflammation.

Circumcision studies	Functional outcomes (in terms of pain, bleeding, edema, fast recovery)	Operation time (min)	Good cosmesis
Traditional			
[36]	more pain at 24 hours, no difference at 7 days	24	—
[37]	no significative difference	24.4 ± 5.06	—
[38]	—	—	excessive swelling
[39]	more postoperative pain	—	—
[40]	blood loss 2.1 ml (range, 0.9–4.2 mL) 22 patients with postoperative edema	19.1 ± 2.6	—
[45]	length of hospital stay 11.8 ± 5.1 h early postoperative morbidity 9% late postoperative morbidity 7.2%	19.8 ± 1.9	—
[46]	47 patients (27.9%) with pronounced edema	23.1 ± 2.8	103 patients (61.3%)
[47]	mean blood loss 7.2 + – 1.5 g, more pain at 1 and 7 days	21.1 ± 2.7	—
[48]	—	22 (20–26)	—
[49]	higher rate of local irritation	50.4	poor appearance
Glue			
[36]	lower pain at 24 hours, no difference at 7 days	17	—
[37]	no significative difference	—	—
[38]	—	14.2 ± 2.42	cosmetically superior
[39]	less postoperative pain	—	no swelling
[48]	—	7 (6–9)	—
[49]	lower rate of local irritation	30.8	all patients satisfied
Bipolar			
[40]	blood loss 0.2 ml (range, 0–0.8 mL) 10 patients with postoperative edema	10.8 ± 1.2	—
[41]	—	—	satisfactory quantified
[42]	1/30 patients	—	all patients satisfied
Laser			
[45] Nd:YAG	length of hospital stay 9.71 ± 4.5 h early postoperative morbidity 2% late postoperative morbidity 0%	31.6 ± 3.6	—
[46] CO2	62 (19.7%) with pronounced edema	12.8 ± 0.9	298 patients (94.9%)
[*]	no early postoperative morbidity	15.6 ± 5.2	all patients satisfied
[47] CO2	no blood loss, less pain at 1 and 7 days	10.5 ± 0.9	—
[48] CO2	—	7 (6–9)	—
[49] CO2	lower rate of local irritation	30.8	all patients satisfied

no significative difference: p value >0.05.
 —: no information about.

Table 1.
 Comparative data between different circumcision techniques.

The purpose of the study conducted by Xu et al. was to investigate the safety and efficacy of a modified CO₂ laser technique for circumcision in adult males as compared with the conventional dorsal-slit method. A total of 300 patients >18 years of age were recruited for this study. Several perioperative data, including age, indications, operation time, intraoperative blood loss, complications, and postoperative pain, were analyzed. With respect to blood loss, there was almost no blood loss during the operation using the CO₂ laser, whereas the mean blood loss was 7.2 + – 1.5 g in the conventional group ($p < 0.05$). The CO₂ laser technique was associated with less pain at 1 day (2.9 + – 1.9 vs. 4.9 + – 2.5, $p < 0.05$) and 7 days postoperatively (1.2 + – 0.5 vs. 1.9 + – 1.3, $p < 0.05$) [47].

Huang et al. found the use of Holmium YAG laser in circumcision as a novel, less complicated, easy, and less painful alternative procedure for circumcision in young males [50].

Patients have a risk of complications, such as local edema and tenderness, scarring, wound dehiscence, hematoma, and infections, despite the fact that MC is largely considered a minor surgical procedure [51–53].

It was demonstrated that the Holmium:YAG is effective for the treatment of soft tissue pathologies, for example, BPE/BPO, upper tract urothelial carcinomas (UTUC), and urinary strictures. The Holmium:YAG laser has strong absorption of water molecules around 2140 nm, which implies a short destruction length in the tissue [50].

Carbon oxide lasers are currently widely used to perform MC, for the following positive features: CO₂ laser procures good incision and hemostasis because a high-power setting can cauterize small vessels; the incision is more effective with a CO₂ laser compared to the traditional scalpel method; patients feel less postoperative pain and declare more comfort.

These facts are corroborated by several studies. The lower postoperative complication rate in the laser group compared to the conventional group was showed by Xu et al.: less bleeding and shorter operative times [47].

Another important question discussed is the potential sub-clinical injury by electrosurgery on the penile tissue. Conventional monopolar electrocoagulation may cause electrical burns, necrosis, and penile damage [54–58].

An experiment by Tsai et al. demonstrated that the electrical field strength of the whole penis shaft was 9.03 V/cm, so it was found heat generated from the penis is four times that of other body parts, which may contribute to erectile tissue damage. Therefore, new laser technologies, including CO₂, Nd-YAG, or Holmium:YAG laser, are considered superior methods after the conduction of this study [59].

4.2 Fast surgery

LC needs not too much experience to have good results (we could talk about “learning curve”, although there are no major studies on this in the literature).

It is associated with reduced operative times, fast recovery, and quick return to normal life.

A comparison of the patients in the two groups of the Chinese study demonstrated a 10 minutes decrease in the operative time in the laser-treated group (10.5 + – 0.9 vs. 21.1 + – 2.7 min, $p < 0.05$) [47].

There was a significant decrease of 5 minutes in operating time for the group of patients who underwent laser circumcision in the retrospective review by the Singapore group of pediatric surgery [44].

Vaos highlighted increased operative time in the Nd:YAG laser group compared with the group of patients treated by conventional technique (31.6 ± 3.6 min vs. 19.8 ± 1.9 min, $p < 0.001$), reduced rates of early and late postoperative complications (2% vs. 9%, $p < 0.05$ and 0% vs. 7.2%, $p < 0.05$, respectively) and also reduced length of hospital stay in comparison with the traditional technique (9.71 ± 4.5 h vs. 11.8 ± 5.1 h, $p < 0.05$) [45].

Gorgulu et al. developed a combined technique with CO₂ laser and cyanoacrylate in order to prevent hematoma and hemorrhage, so in their results, they had a short operation median time (7 minutes vs. 22 minutes of the conventional guillotine group) [48].

4.3 Aesthetic results

LC represents an aesthetically satisfying technique, maybe better of the traditional one.

Thirty boys were divided into two groups in the study by Mungnirandr et al.: Group 1 ($n = 17$) underwent MC by scalpel and approximation of the wound edges by sutures. Group 2 ($n = 13$) underwent circumcision with CO₂ laser and approximation of the wound edges using tissue glue.

The following parameters were recorded: patient age, indications for surgery, operation time, wound bleeding, swelling or infection, pain, local irritation, and cosmetic result.

Only one case of bleeding was reported in Group 1.

Group 2 showed a shorter operative time ($p = 0.011$), lower rate of local irritation ($p = 0.016$), and better aesthetic picture ($p < 0.001$) than Group 1.

CO₂ laser and tissue glue have advantages over standard surgical techniques in circumcision, with a significantly shorter operative time, lower rate of local irritation, and better cosmetic appearance. There were no significant differences in pain score, wound infection rate, or cost of surgery between the two groups [49].

Lichen sclerosus (LS) is a chronic inflammatory skin disease that primarily affects the anogenital region. The disease can affect patients of all ages, in particular in the fifth or sixth decade, but it is rare in children. Etiology is unknown, maybe in genetically predisposed patients, an important pathogenetic role could be represented by the immune system. LS often plays with a relapsing trend that can lead to scars, cutaneous atrophy, and functional impairment [60].

LS is associated with an increased risk of developing spinous cell carcinoma in the affected genital area. Chronic irritation, trauma, and occlusion under the prepuce represent precipitating factors [61].

Some researchers carried out treatments using a fractional micro-ablative CO₂ laser (SmartXide2, DEKA, M.E.L.A, Florence, Italy), with these parameters: emission mode, high pulse (HP); power, 10–13 W; spacing between dots, 500 and 600 μm ; the number of pulses on the same spot, 1–2. They repeated the treatment at a monthly interval till achieving good clinical and aesthetic results, so five sessions were necessary to obtain an excellent outcome [60].

The figures below show some cosmetic results obtained with our laser technique.



4.4 Costs

LC deserves low costs, especially when compared to other techniques (traditional and non-traditional).

In 2001 How et al. carried out a retrospective study comparing the operative times of two groups of 30 patients both: the first ones underwent conventional circumcision in 1985 and the other ones were treated in 1995 by LC.

The total cost of use of the laser machine was calculated, considering maintenance costs, estimated life span of the machines (10 years), and disposables used during each procedure. This was counted against the cost savings from shorter operating times and operating room facilities. Furthermore, morbidity data from 2781 LC performed between May 1997 and April 2000 were collected.

Calculated cost savings per laser circumcision from the reduced operating theater time was S\$31/–.

There was an overall complication rate of 1.15%, related to the 2781 LC. Bleeding occurred in 29 patients (1.04%), of which 10 cases (0.36%) required to return to the operating theater for hemostasis. Wound infection requiring readmission to the hospital was described in three cases (0.11% of cases).

LC represents a simple technique with reduced operative time and consequently cost-effectiveness. Complication rates of laser circumcision compared to those of conventional circumcision appear favorable [44].

There are also some studies considering the savings attributed to the reduction of HIV infection by circumcision procedures. Kacker et al. assessed that continued decreases in MC rates are associated with increased infection prevalence [62].

5. Circumcision and COVID-19

Since the COVID-19 pandemic has widespread around the world, we should also consider all the medical, legal, and economic aspects related to the new situation.

Healthcare lockdown involving the cancelation or postponement of nonurgent examinations and treatments during the pandemic has reduced the number of emergency department visits by urological patients. Of the most common urological procedure types, the lockdown had a clear negative effect on the incidence of BPO, as well as foreskin excision procedure [63, 64].

The laser technique does not require any anesthesia or only a local one, so the patient can keep well the mask during the procedure, reducing the risk of infecting and being infected, especially in cases where a PCR-test is not performed before the circumcision procedure. (e.g., outpatient procedure).

Rivera-Calonsje et al. reported a case of COVID-19 positive 12 years old patient who presented for urgent wound incision and drainage at the circumcision site. He was transported from the COVID-19 isolation floor to the negative pressure operating room. He was placed in a lateral decubitus position and oxygen was delivered through a facemask. Under sedation, spinal anesthesia was achieved at the first attempt as a safe alternative to general endotracheal anesthesia [65].

6. Conclusions

For all the reasons explained we believe that laser use may become the gold standard of circumcision in the next future or in any case be more considered than traditional surgery and maybe also than newborn techniques.

Conflict of interest

“The authors declare no conflict of interest.”

Abbreviations

AAP:	American Academy of Pediatrics
BPE:	Benign Prostatic Enlargement
BPO:	Benign Prostatic Obstruction
BV:	Bacterial Vaginosis
CDC:	Centers for Disease Control and Prevention
CI:	Confidence Interval
CO ₂ :	Carbon Dioxide
COVID:	Corona Virus Disease
HIV:	Human Immunodeficiency Virus
HoLEP:	Holmium Laser Enucleation Prostate
HP:	High Pulse
HPV:	Human Papillomavirus
HR:	High-Risk
HSV:	Herpes Simplex Virus
IELT:	Intravaginal Ejaculatory Latency Times
LC:	Laser Circumcision
LS:	Lichen Sclerosus
MC:	Male Circumcision
Nd:YAG:	Neodymium-Doped Yttrium Aluminum Garnet
PCR:	Polymerase Chain Reaction
OR:	Odds Ratio
RCT:	Randomized Controlled Trial
STI:	Sexually Transmitted Infection
US:	United States
UTI:	Urinary Tract Infection
UTUC:	Upper Tract Urothelial Carcinoma
V:	Volume
W:	Watt

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