

# Comparison of a CO<sub>2</sub> (Carbon Dioxide) Laser and Tissue Glue with Conventional Surgical Techniques in Circumcision

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## Abstract:

**Introduction:** CO<sub>2</sub> (Carbon Dioxide) laser application in circumcision, for cutting and coagulation, has been reported to have excellent results. Also, tissue glue has been reported to have advantages over sutures for approximation of wound edges. Most previous studies focused on comparisons between CO<sub>2</sub> laser and scalpel, or between tissue glue and sutures. This study prospectively compared the results and complications CO<sub>2</sub> laser and tissue glue, with standard surgical techniques in circumcision.

**Methods:** Thirty boys were prospectively divided into two groups. Group 1 ( $n = 17$ ) underwent circumcision by scalpel with approximation of the wound edges using chromic catgut sutures. Group 2 ( $n = 13$ ) underwent circumcision with CO<sub>2</sub> laser and approximation of the wound edges using tissue glue. Patient age, indications for surgery, operative time, wound swelling, bleeding, wound infection, local irritation, pain score, and cosmetic appearance were recorded.

**Results:** Group 1 had a significantly longer operative time ( $P = 0.011$ ), higher rate of local irritation ( $P = 0.016$ ), and poorer cosmetic appearance ( $P < 0.001$ ) than group 2. Bleeding only occurred in one patient in group 1. There were no significant differences in pain score, wound infection rate, or cost of surgery between the two groups.

**Conclusions:** CO<sub>2</sub> 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. The cost of surgery is similar between the two groups.

**Keywords:** circumcision; CO<sub>2</sub> laser; tissue glue; children

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## Introduction

Circumcision is one of the most common surgical procedures performed in children. The indications for circumcision vary from country to country, and include

religious and medical reasons. Various surgical techniques for circumcision have been described, with different results and complications. Many studies reported that circumcision using a CO<sub>2</sub> (Carbon Dioxide) laser for cutting and coagulation had excellent results. Tissue glue

has also been reported to have advantages over sutures for approximation of the wound edges. Most previous studies focused only on comparisons between CO<sub>2</sub> laser and scalpel, or between tissue glue and sutures. This prospective study compared the results and complications of CO<sub>2</sub> laser and tissue glue with standard surgical techniques using a scalpel and sutures in circumcision.

## Methods

From April 2008 to January 2012, 30 boys undergoing circumcision were prospectively divided into two groups. Group 1 ( $n = 17$ ) underwent circumcision by scalpel with approximation of the wound edges using 4-0 or 5-0 chromic catgut. Group 2 ( $n = 13$ ) underwent circumcision with CO<sub>2</sub> laser (continuous wave, 1 W) and approximation of the wound edges using tissue glue (N-butyl-2-cyanoacrylate; Histoacryl®). The exclusion criteria were: jaundice, bleeding disorder, allergy to Histoacryl®, or undergoing more than one concomitant procedure. All circumcisions were performed using a sleeve technique. Meticulous hemostasis was achieved in group 1 with bipolar diathermy, and in group 2 using the CO<sub>2</sub> laser in a defocused mode. Any vessels seen at the cutting line were coagulated before cutting. A double layer of glue was used to approximate the wound edges in group 2. One pediatric surgeon performed or assisted all the circumcision procedures.

Patient age, indications for surgery, and operative time were recorded. Postoperative wound swelling, bleeding, and infection were assessed at 4 h and 7 days after surgery by independent surgical residents. The pain score was assessed by surgical residents at 4 h and 7 days after surgery, and by each patient's parents at 24 h. The surgical wound was photographed immediately

after surgery and at 1 month after surgery. The cosmetic appearance on the wound photographs was graded by two surgical residents and three pediatric surgical nurses using a numerical scale from 1 to 10. Finally, local irritation at the wound and cosmetic satisfaction were assessed by each patient's parents at 1 month postoperatively. All statistical analyses were performed by a statistician. Numerical data were compared between groups using the unpaired *t* test or Mann-Whitney U test, and categorical data were compared using the Chi-squared test or Fisher's exact test. Statistical significance was set at  $P < 0.05$ .

Informed consents were obtained from the parents and children (more than 8 year old). This study was approved by the ethic committee of Siriraj Hospital.

## Results

Thirty boys were included in the study (age range, 8 months to 14 years; mean age, 6.66 years). Most of the patients (80 %) had a preoperative diagnosis of phimosis with or without balanoposthitis. The other indications for surgery were smegma retention, cyst, redundant prepuce, and verrucous squamous hyperplasia. The operative time was significantly different between the two groups (Table 1). Bleeding occurred in one patient in group 1, and was treated with a pressure dressing. There were no significant differences in postoperative wound swelling (at 4 h and 7 days) or pain score (at 4 h, 24 h, and 7 days) between the two groups. Two patients in each group had a postoperative wound infection on day 7, and were treated with oral antibiotics ( $P > 0.999$ ).

The inter-observer reliability for assessment of cosmetic outcome was 0.129 (95 % confidence interval 0.014–0.304) immediately after surgery and 0.614 (0.460–0.761) at 1 month after surgery. There were

**Table 1.** Comparison between circumcision using scalpel and sutures, and by CO<sub>2</sub> laser and tissue glue

	Suture (n =17)	Glue (n =13)	P-value
Age (mean;year) (+/-SD)	6.4 (+/-4.0)	7 (+/-4.3)	<i>ns</i>
Operation time (mean;min)	50.4	30.8	0.011
Pain severity score (median;min-max)			
CHEOPS <sup>a</sup> score:			
at 4 hr, 24 hr, and 7 day	5.5 (4-9), 6 (4-9), 4 (3-5)	6 (4-9), 5 (5-10), 4 (4-5)	<i>ns</i>
Face:			
at 4 hr, 24 hr, and 7 day	4 (0-8), 3 (0-8), 1 (0-4)	4 (0-4), 2 (0-6), 0 (0-2)	<i>ns</i>
Bleeding (number) (%)	1 (5.88)	0 (0)	<i>ns</i>
Infection (number) (%)	2 (11.76)	2 (15.38)	<i>ns</i>
Good wound edge regularity at 1 month (number) (%) <sup>b</sup>	7 (41.18)	13 (100)	0.001
Cosmetic appearance score at 1 month (mean) <sup>b</sup>	5.9	8.4	<0.001
Good cosmetic satisfaction (number) (%) <sup>c</sup>	11 (64.71)	13 (100)	0.024
Annoying from foreign body at penis (number) (%) <sup>b</sup>	10 (58.82)	2 (15.38)	0.016

<sup>a</sup> Children's Hospital of Eastern Ontario Pain Scale; <sup>b</sup> assessed by five medical personnel; <sup>c</sup> assessed by each patient's parents; *ns* = not significant

no significant differences in wound edge regularity or cosmetic appearance between the two groups immediately after surgery. At 1 month after surgery, there was better wound edge regularity (41.13 % vs. 100 %,  $P = 0.001$ ) and cosmetic appearance (5.9 vs. 8.4,  $P = 0.001$ ) in group 2 than in group 1. The parents were more satisfied with the cosmetic appearance in group 2 than in group 1 ( $P = 0.024$ ). The cost of surgery was 5575.24 baht in group 1 and 5223.42 baht in group 2.

## Discussion

Many previous studies compared outcomes between CO<sub>2</sub> laser and scalpel in circumcision. CO<sub>2</sub> laser was reported to be associated with a shorter operative time, less blood loss, less wound edema, and less postoperative pain<sup>1-3</sup>. The CO<sub>2</sub> laser does not penetrate well through tissues, and the absorbed laser energy vaporizes and carbonizes the upper tissue layer. When the continuous wave impact time is longer than 1 ms, there is a thermal effect on the underlying tissues<sup>4</sup>, resulting in tissue coagulation. A shorter operative time and less blood loss are therefore expected when using a CO<sub>2</sub> laser for circumcision.

Most studies of sutureless circumcision using tissue glue reported superior cosmetic results compared with standard wound closure using interrupted sutures<sup>5-9</sup>. Some studies reported that wound approximation using tissue glue was associated with a shorter operative time, lower rate of wound infection, and less postoperative pain than wound approximation using sutures<sup>6,8,10</sup>. The rate of postoperative bleeding reported after wound approximation using tissue glue is 2.2–6.7 %, which is comparable to the rate reported for postoperative bleeding after wound approximation with sutures<sup>5-9,11</sup>.

This study compared outcomes between circumcision by scalpel with approximation of the wound edges using sutures (group 1) and use of a CO<sub>2</sub> laser with approximation of the wound edges using tissue glue (group 2). The operative time was significantly shorter in group 2 than in group 1. As the CO<sub>2</sub> laser can be used for simultaneous cutting and coagulation, and some previous studies reported a shorter operative time with the use of tissue glue for approximation of the wound edges compared with sutures<sup>6,8</sup>, a shorter operative time should be expected when using a combination of CO<sub>2</sub> laser and tissue glue. The differences in operative time between groups in this study are comparable to those of previously reported studies<sup>1-3,6,8</sup>.

The CO<sub>2</sub> laser uses a thermal effect for coagulation<sup>4</sup>,

which may cause postoperative pain. However, use of tissue glue reduces the local irritation from reactions to suture materials. In this study, there was significantly less local irritation at the wound in group 2 than in group 1. However, there were no significant differences in pain scores between the two groups. Further study of a larger number of patients is required to determine the effect of combined use of a CO<sub>2</sub> laser and tissue glue on postoperative pain.

The rate of postoperative bleeding in group 1 (5.88%) was comparable to previously reported rates<sup>5-9,11,13</sup>. There were no cases of postoperative bleeding in group 2. The CO<sub>2</sub> laser has a coagulation function, and was previously reported to reduce postoperative bleeding after circumcision<sup>1-3,12</sup>. In this study, vessels were coagulated before being cut. This technique is somewhat time consuming, but may prevent major intraoperative bleeding that cannot be controlled using the CO<sub>2</sub> laser.

Previous reports considered that sutureless circumcision techniques should not be used for children aged over 12 years because of the increased risk of wound breakdown following penile erection<sup>8</sup>. In this study, most of the patients were aged less than 12 years, and there were no cases of wound separation. Although the tissues around the wound edges were exposed to the thermal effects of the CO<sub>2</sub> laser, the tensile strength created by the tissue glue was sufficient for approximation of the wound edges, resulting in excellent wound healing.

The cosmetic appearance and wound edge regularity, as assessed by both medical personnel and each patient's parents, were better in group 2 than in group 1. Suture tension on the wound may result in an irregular wound edge and a poor cosmetic outcome. Sutureless approximation of the wound edge using tissue glue should therefore result in a better cosmetic outcome. The results of this study are comparable to those of previously reported studies<sup>5-9,12</sup>. The mean cost of surgery (for operation room charges) was 5575.24 baht in group 1 and 5223.42 baht in group 2. The increased cost of using the CO<sub>2</sub> laser and Histoacryl<sup>®</sup> was compensated for by the shorter operative time.

Use of a CO<sub>2</sub> laser with approximation of the wound edges using tissue glue was associated with a shorter operative time, less wound irritation, and better cosmetic appearance compared with standard surgical techniques for circumcision; and was not associated with postoperative bleeding. However, there was no difference in postoperative pain between CO<sub>2</sub> laser with approximation of the wound edges using tissue glue and use of a scalpel with approximation of the wound edges

using sutures. The cost of surgery was similar between the two groups. The main obstacles to performing circumcision using a CO<sub>2</sub> laser with approximation of the wound edges using tissue glue are the high cost of the CO<sub>2</sub> laser machine and the surgical skills required for use of both the CO<sub>2</sub> laser and tissue glue.

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