



Comparative Effects of Standard and Bipolar Cauterization in Pediatric Orthopedic Surgery

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Abstract

Background: One of the most important issues in the orthopedic surgery, especially pediatric orthopedic surgery, is to prevent or reduce bleeding during the operating time. The goal of local hemostasis is to prevent or blockade the flow of blood from a disrupted vessel that has been incised or transected.

Objectives: The aim of this study was to compare the effects of standard (monopolar) and bipolar electrocauterization during the pediatric orthopedic surgery.

Methods: In this study, 60 patients were enrolled for the pediatric orthopedic surgery and classified into two groups. Group I included 30 patients undergoing hemostasis with standard electrocautery and group II comprised 30 patients undergoing hemostasis with bipolar electrocautery. The intraoperative bleeding was measured with sterile absorbent gauze. Every gauze could absorb 20 mL of blood. Then, bleeding was compared between the groups.

Results: The average amount of blood loss and operating time was 134.6 ± 0.04 mL and 140.9 ± 0.02 minutes in group I and 133.4 ± 0.07 mL and 140.2 ± 5 minutes in group II, respectively. Thus, there was no significant difference between the two groups ($P = 0.65$ and 0.70 , respectively).

Conclusions: There was no significant difference in blood loss and operating time between patients in groups I and II. Therefore, the use of monopolar and bipolar cauterization in the pediatric hip surgery has the same effects on blood loss and operating time.

Keywords: Hemostasis, Pediatric Hip Surgery, Bleeding

1. Background

Pediatric orthopedic surgery includes the correction of congenital anomalies, soft tissue reconstruction, tumor surgery, and fracture repair. An important issue that must be addressed in such procedures is the prevention of bleeding during and after the surgery (1). The purpose of local hemostasis is to stop bleeding from a severed or lacerated vessel (2, 3). Hemostasis includes mechanical, chemical (pharmacological), and heat types (2-4). Generally, a clamp or ligature is used to create permanent hemostasis in a lacerated vessel. When a small blood vessel is lacerated, a small ligature is enough to stop bleeding. However, if a large artery is severed, a wide suture should be used (2, 5). Suture thread is widely used in surgery to create hemostasis in vessels. The strength of thread differs depending on the local enzyme absorbency and injured tissue (6). Another method of hemostasis is the denaturation of proteins with electrocautery. In this method, direct heat is used to coagulate a large area of tissue to seal blood vessels. Although time efficient, cauterizing may necrotize

the area of the tissue when compared to ligation (2, 5, 7).

One of the most common complications during and after the pediatric orthopedic surgery is bleeding, requiring the application of methods that can reduce the risk of complications. There is no study on the effects of hemostasis with electrocauterization during the pediatric orthopedic surgery. Thus, this research was done with the aim of comparing the effects of standard (monopolar) and bipolar electrocauterization during pediatric orthopedic hip surgery.

2. Methods

In this study, 30 patients who were candidates for pediatric orthopedic surgery for developmental dysplasia of the hip at Imam Khomeini, Pediatric Children Center, and Shariati hospital of Tehran University of Medical Sciences from September 2016 to January 2018 were selected by simple convenience sampling. They were enrolled after taking their written informed consent. Inclusion criteria were

an age between 1 and 5 years and the need for pediatric hip surgery. Exclusion criteria were previous hip surgery, congenital heart disease, ischemic vascular disease, coagulopathy disorders, collagen vascular disorders, malignant diseases, and using anti-coagulant medication. Matching of the groups was done by the nonrandomized selection of patients. The patients were divided into two groups. Group I included 30 patients undergoing hemostasis with standard or monopolar electrocautery and group II comprised 30 patients undergoing hemostasis with bipolar electrocautery.

Blood loss was measured quantitatively using sterile gauzes each of which could absorb 20 cc of blood. Therefore, each soaked gauze contained 20 cc of blood and half of each gauze contained 10 cc of blood lost during the surgery (8).

Blood loss and operation time were compared between the groups. Data were collected by observation and checklists. After data gathering, they were analyzed in SPSS 21 software using a t-test, ANOVA, and Fisher's exact test. $P < 0.05$ was considered significant.

3. Results

In this study, 60 patients were selected, of whom 15 (25%) were male and 45 (75%) were female. There was no difference between group I and II in demographic data ($P = 0.68$) (Table 1).

Four types of hip surgery included Open Reduction in Medial Approach, Open Reduction in Anterior Approach, Open Reduction + Salter Innominate Osteotomy + Adductor Tenotomy, and Open Reduction+ Salter Innominate Osteotomy + Femoral Osteotomy + Adductor Tenotomy. The comparison of the mean \pm SD of blood loss and operating time in each of 4 operation groups showed no difference between monopolar and bipolar groups in blood loss and operation time ($P = 0.56, 0.67,$ and 0.59 respectively). In addition, the mean \pm SD of blood loss and operating time were 134.6 ± 0.04 mL and 140.9 ± 0.02 minutes in group I and 133.4 ± 0.07 mL and 140.2 ± 5 minutes in group II, respectively; thus, there was no significant difference between the two groups ($P = 0.65$ and $0.70,$ respectively) (Table 2).

4. Discussion

Decreasing blood loss is an important factor in every surgery, especially pediatric orthopedic surgery. Mechanical techniques and electrocautery are used for this purpose (2). Sometimes, more than one method is used in a surgery.

Electrocautery uses high voltage and high frequency to generate heat by an alternating current. It is applied for

surgical cuttings, as well as blood clotting, through serving electrodes.

Bipolar electrocautery is a kind of electrocautery in which, the active or input electrode and the return electrode are placed in a separate section of the electrocautery instrument; thus, the current only passes through the tip of the two electrodes and only a small part of the body tissue is affected.

Monopolar electrocautery (unipolar electrocautery or sealer) is a kind of electrocautery in which, the current is passed through a group of active electrodes and returns to the generator of the electrocautery instrument via an inactive electrode connected to the patient's body (the grounding pad) so that the patient is part of the electrical circuit (9,10).

In the cases where flammable materials exist near the treatment place, there is the risk of firing or eruption during the performance of electrocautery.

Alcohol, oxygen, and the intestine gases are very flammable. As far as possible, for cleaning the surgical place (prepping), alcohol-containing cleansers shall not be used or if they are used, the site shall be dried completely before starting the surgery and using electrocautery.

In conditions that the patient uses a portable oxygen concentrator, it shall be stopped during the use of electrocautery. In order to prevent from sparking or firing of the skin scars, they shall be far from the route of electrodes in electrocautery or they shall be put under surgery by scalpel before applying electrocautery (11, 12).

Observing the principles for the prevention from transferring infection is applicable in every electrical surgery using electrocautery.

Potential ways for transferring infection while using electrocautery include the infection of the used electrode and its application in a section with no infection, created smoke during the surgery with electrocautery, and microdroplet or very fine blood particles suspended in the air (aerosolized) due to using electrocautery.

In experimental studies on the animals' skin, the transfer of Hepatitis B virus, human papillomavirus (HPV), and Staphylococcus aureus has been indicated from an infected place to an uninfected place using the infected electrocautery electrodes during surgical cutting by electrocautery (13).

During the surgical cutting by electrocautery, aerosolized blood droplets can be jumped up to 30 centimeters from the surgery place and in case of inhalation, they may create infection (14).

In this study, in group I, hemostasis was achieved by standard electrocautery or monopolar sealer while in group II hemostasis was done by bipolar electrocautery.

Table 1. The Comparison of the Mean \pm Standard Deviation of Demographic Data in Two Groups

| Operation Type | Group I: Standard Cauterization (Monopolar) | | | | | Group II: Bipolar Cauterization | | | | |
|------------------|---|---------------------|--------------------|-----------------|----------------------|---------------------------------|---------------------|--------------------|------------------|----------------------|
| | Number of Operations | Hb Before Operation | Hb After Operation | Blood Loss (cc) | Operation Time (Min) | Number of Operations | Hb Before Operation | Hb After Operation | Blood Loss (cc) | Operation Time (Min) |
| OR (MA) | 3 | 13 \pm 0.04 | 13 \pm 0.03 | 20 \pm 0.02 | 60 \pm 5 | 2 | 13 \pm 0.02 | 13 \pm 0.01 | 20 \pm 0.01 | 58 \pm 4 |
| OR (AA) | 5 | 14 \pm 0.03 | 13 \pm 0.02 | 100 \pm 0.04 | 105 \pm 12 | 5 | 14 \pm 0.04 | 13 \pm 0.04 | 100 \pm 0.03 | 103 \pm 10 |
| OR + S + AT | 12 | 14 \pm 0.05 | 13 \pm 0.04 | 140 \pm 0.03 | 151 \pm 4 | 12 | 14 \pm 0.05 | 13 \pm 0.04 | 140 \pm 0.01 | 150 \pm 3 |
| OR + S + FO + AT | 10 | 14 \pm 0.02 | 13 \pm 0.01 | 180 \pm 0.03 | 171 \pm 3 | 11 | 13 \pm 0.02 | 12 \pm 0.01 | 175 \pm 0.02 | 170 \pm 2 |
| | | 13.9 \pm 0.005 | 13.03 \pm 0.06 | 134.6 \pm 0.4 | 140.9 \pm 2 | | 13.6 \pm 0.03 | 12.8 \pm 0.07 | 133.4 \pm 0.07 | 140.2 \pm 5 |

Table 2. The Comparison of the Mean \pm Standard Deviation of Blood Loss and Operating Time in the Two Groups^a

| | Age ^b | Weight ^b | Height ^b | P Value |
|---|------------------|---------------------|---------------------|---------|
| Group I: standard cauterization (monopolar) | 2.31 \pm 0.03 | 15.96 \pm 0.21 | 94.33 \pm 0.16 | 0.065 |
| Group II: bipolar cauterization | 2.33 \pm 0.35 | 16.01 \pm 0.18 | 95.02 \pm 0.2 | 0.069 |
| P value | 0.067 | 0.072 | 0.058 | 0.068 |

Abbreviations: AA, anterior approach; AT, adductor tenotomy; FO, femoral osteotomy; MA, medial approach; OR, open reduction; S, salter innominate osteotomy.

^aComparison of data by ANOVA, t-test, and Fisher' exact test.

^bValues are expressed as mean \pm SD.

In this study, the results showed there was no significant difference in blood loss and operating time between group I undergoing hemostasis with standard electrocautery or monopolar sealer and group II undergoing hemostasis with bipolar electrocautery. In other words, the comparison of the mean \pm SD of blood loss and operating time in each of 4 operation groups showed no difference between monopolar and bipolar groups in blood loss and operation time ($P = 0.56, 0.67,$ and $0.59,$ respectively). The mean \pm SD of blood loss and operating time in group I were 134.6 ± 0.04 mL and 140.9 ± 0.02 minutes while they were 133.4 ± 0.07 mL and 140.2 ± 5 minutes in group II, respectively. Thus, there was no significant difference between the two groups ($P = 0.65$ and $0.70,$ respectively). It seems that hemostasis with bipolar and standard electrocautery did not have significantly different effects on the amount of blood loss in pediatric orthopedic hip surgery.

In a study by Marulanda and colleagues, they indicated that bipolar sealer was an effective alternative for preventing from bleeding and clotting during total knee arthroplasties surgery and it reduced hemorrhage and blood need (transfusion); it had no effect on the clinical outcome of the surgery, as well. Meanwhile, it reduced the surgery period and bleeding rate during the surgery; these results were different from our findings (7).

In another research by Siegel and colleagues, it was shown that using the bipolar sealing device in the surgeries for the tumors of musculoskeletal system or orthopedic oncology procedures reduced the hemorrhage rate,

blood transfusion need, and surgery duration compared to the surgeries made by standard electrocauterics (15). These results differ from the results of our study, which may be because, in our study, no surgery was performed on tumors.

In another study by Min and colleagues, they showed that in total hip arthroplasty, using bipolar electrocautery or bipolar sealer reduced blood transfusion rate and total bleeding during surgery, but the saving costs for blood transfusion was not determined in the study (16). These results differ from the results of our study, which may be due to the difference in the age of the patients and the type of surgery.

In another study by Yang and colleagues, they showed that bipolar electrocautery or bipolar sealer in the patients who underwent the primary total hip arthroplasties surgery was not superior to standard or monopolar electrocautery concerning bleeding rate and surgery period. Thus, its application was not recommended (17). The results of this study are similar to our study findings.

In another research by Lu and colleagues, it was shown that based on a meta-analysis, using bipolar electrocautery or bipolar sealer and standard or monopolar electrocautery was superior for reducing the bleeding rate in the surgery of the spinal column and so it is preferred to be used in surgical procedures of the spinal column (18). These results differ from our study results, which may be due to the difference in the type of hip surgeries for children and adults' spinal column.

In another study by Morris and colleagues, they showed that no significant difference was observed regarding blood transfusion, hemorrhage rate during surgery, and hemoglobin reduction when using bipolar electrocautery or bipolar sealer and standard or monopolar electrocautery in the surgery of Tissue-sparing anterior supine intermuscular total hip arthroplasty (THA). Therefore, the routine use of bipolar electrocautery or bipolar sealer was not recommended in anterior supine intermuscular THA (19). The results of this study are similar to our study results.

In another study by Barsoum and colleagues, they showed that no significant difference between the study groups (treatment and control groups) concerning the need for blood transfusion or the bleeding rate. Thus, they stopped using the bipolar sealer or bipolar electrocautery set at their center for uncomplicated primary total hip arthroplasty (20). The results of this study are similar to our study results.

In another research by Nielsen and colleagues, they showed that using bipolar electrocautery or bipolar sealer in the revision of total knee arthroplasties (TKA) without closing tourniquet did not reduce hemorrhage rate or blood transfusion (21). The results of this study are similar to our study findings.

In another study by Fukui and colleagues, they showed that the duration of surgery and bleeding rate in each section of the surgery were significantly less in the bipolar electrocautery or bipolar sealer group than in the control group (22). The results obtained by this study differ from our study findings, which may be due to the difference in the age of the patients and the type of the surgery.

In another study by Marulanda and colleagues, they showed that bipolar electrocautery or bipolar sealer is a suitable alternative for reduction of bleeding in total hip arthroplasties that reduces the need for blood transfusion, tissue damage, and smoke formation without effect on the surgery outcome compared to the standard or monopolar electrocautery (23). These results differ from our study, which may be due to the difference in the age of the patients and the type of the surgery.

In another study by Gordon and colleagues, they showed that in the posterior spinal fusion (posterior spinal fusion for both idiopathic and neuromuscular scoliosis), the need for blood transfusion was significant in patients whose surgery was performed with bipolar electrocautery or bipolar sealer (24). These results differ from our study results, which may be due to the difference in the age of the patients and the type of the surgery.

In a research done by Mankin and colleagues, they showed that bipolar electrocautery or bipolar sealer effectively improves hemostasis and reduces bleeding and

blood transfusion need during the surgery of adolescent idiopathic scoliosis (25). These results differ from our study findings, which may be due to the difference in the age of the patients and the type of the surgery.

In another study by Wang and colleagues, they showed that using bipolar electrocautery or bipolar sealer for lumbar degenerative scoliosis surgeries leads to significantly reduced bleeding compared to using standard or monopolar electrocautery (26). These results differ from our study results, which may be due to the difference in the age of the patients and the type of the surgery.

In another study by Lan and colleagues, they showed based on the existing data, using bipolar electrocautery or bipolar sealer compared to using standard or monopolar electrocautery in the surgery of spinal column is accompanied by reduced bleeding, reduced surgery period, and reduced blood transfusion, but there was no significant difference between the two groups in terms of hospitalization period and the wound infection rate. Thus, using bipolar electrocautery or bipolar sealer is recommended in spinal column surgery (27). These results differ from our study findings, which may be due to the difference in the age of the patients and the type of the surgery.

It seems that hemostasis by bipolar electrocautery or bipolar sealer and monopolar or standard electrocautery did not have significantly different effects on blood loss in the pediatric orthopedic hip surgery.

The reduction of blood loss and operating time due to using a bipolar sealer is shown in [Table 3](#).

As shown in [Table 3](#), in all spine surgeries, the bipolar sealer was effective in reducing blood loss and operation time but in THA and TKA, it had different effects in different studies.

Finally, in the current study, we did not find any evidence of a difference between bipolar and monopolar sealer or cauterization in blood loss and operation time of pediatric hip surgeries.

4.1. Conclusion

Based on the evidence of the current study in pediatric hip surgery, there is no significant difference between the monopolar and bipolar cauterization in blood loss and operation time. Therefore, the use of monopolar or bipolar cauterization is similar and the preferred method depends on the surgeon opinion.

4.2. Recommendations

Finally, monopolar and bipolar cauterizations in pediatric hip surgery are the same in blood loss and operating time and both types of sealers are acceptable in the pediatric hip surgery.

Table 3. The Reduction of Blood Loss and Operating Time by Using Bipolar Sealer

| Organ of Study | Name of Author | Year of Publication | Kind of Operation | Effect of Bipolar Sealer | |
|----------------|-------------------|---------------------|---------------------------------|--------------------------|------------------------|
| | | | | Reduced Blood Loss | Shorten Operating Time |
| Knee | Marulanda GA (7) | 2009 | TKA | + | + |
| | Nielsen CS (21) | 2017 | TKA Revision | - | - |
| Hip | Min JK (16) | 2016 | THA | + | + |
| | Yang (17) | 2014 | Primary THA | - | - |
| | Morris MJ (19) | 2013 | Anterior THA | - | - |
| | Marulanda GA (23) | 2008 | THA | + | + |
| | Barsoum WK (20) | 2011 | Primary THA | - | - |
| | | | | | |
| Spine | Lu D (18) | 2017 | Spine fusion | + | + |
| | Fukui D (22) | 2017 | Spine (fusion) posterolateral | + | + |
| | Gordon ZL (24) | 2013 | Spine (fusion) scoliosis | + | + |
| | Mankin KP (25) | 2012 | Spine (fusion) scoliosis | + | + |
| | Wang Xn (26) | 2016 | Spine (fusion) scoliosis | + | + |
| | Lan T (27) | 2017 | Different spine surgeries | + | + |
| Various organs | Siegel HJ (15) | 2004 | Orthopaedic oncology procedures | + | + |

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Footnote

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