



Original Article

Body temperature management during pediatric full mouth rehabilitation surgery under general anesthesia



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KEYWORDS

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Abstract *Background/purpose:* It was found that body temperature would be gradually increased during pediatric full mouth rehabilitation surgery. Although the etiology is unknown, here, we introduced an effective method to maintain normothermia during this kind of surgery.

Materials and methods: Following IRB approval, the medical records of pediatric patients who received full mouth rehabilitation surgery from Jan. 2014 through Jun. 2016 were collected. All the patients included were managed by a “tent-like draping” with a forced-air warmer (Life-Air 1000, Progressive Dynamics Inc.). The temperature of the forced-air was changed from 38 °C to cool ambient temperature when the body temperature higher than 36 °C. The body temperatures (preoperative, periodic during operation, and postoperative) and the maximum body temperature changes during operation were recorded. The data was compared with the results of a previous report.

Results: Total 37 patients were enrolled. The maximum temperature change during operation was 2.08 ± 0.6 °C. The incidence of body temperature higher than 37.5 °C during operation was 10.8% (4/37). Compare to the previous report in which the patients received the same operation with ordinary surgical draping, the maximum temperature change and the incidence of body temperature higher than 37.5 °C during operation were significantly lower in patients received “tent-like draping” (2.08 ± 0.64 °C vs 2.50 ± 1.17 °C, $p < 0.001$; and 10.8% (4/37) vs 32.4% (11/34), $p < 0.05$, respectively)

Conclusion: The increase of body temperature during pediatric full mouth rehabilitation surgery can be effectively controlled by ambient forced-air cooling using tent-like draping.

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Introduction

A lengthy general anesthesia is required for full mouth rehabilitation surgery in children. Avoid hypothermia during operation is a general rule of thumb for pediatric patients. However, gradual increase of body temperature during pediatric full mouth rehabilitation surgery was found.¹ The etiology is still unknown. Regarding the relations between body temperature changes and pediatric full mouth rehabilitation surgery, postoperative hyperthermia has been reported in two studies.^{2,3} Several factors have been examined for the causes of the postoperative hyperthermia in these two studies, such as patient's oral hygiene, gingival condition, soft tissue trauma and bacteremia, however, no significant relation was found. In this retrospective charts review study, we introduce a method to maintain normothermia during pediatric full mouth rehabilitation surgery.

Materials and methods

Institutional review board approval was obtained (TSGHIRB 1-105-05-149). The medical records of pediatric patients who received full mouth rehabilitation surgery from Jan. 2014 through Jun. 2016 were collected. The included patients were free of upper respiratory infection and no atropine administration. The cases with operation time less than 4 h were excluded. All of the included patients received a "tent-like draping". The total number of the included medical records is 37.

All patients received a standard anesthetic protocol. The operating room temperature was set around 25–26 °C. Intravenous fluid was administered with 2–3 ml/kg/hr since the night before operation day. Arriving at operation room, electrocardiogram, pulse oximetry and non-invasive blood pressure monitoring were applied. General anesthesia was induced by intravenous thiamylal (3–5 mg/kg), then nasotracheal intubation was facilitated by intravenous cisatracurium 0.15 mg/kg. Anesthesia was maintained by sevoflurane, fentanyl and cisatracurium, controlled mechanical ventilation was applied to maintain end-tidal CO₂ between 35 and 40 mmHg. 0.33% glucose saline was administered by 3–5 ml/kg/h during operation. Foley catheter was inserted for urine output monitor and the urine was maintained more than 1 ml/kg/hr during operation. A temperature probe was placed in axillary region for continuous body temperature monitoring. The "tent-like draping" was applied as follow (Fig. 1). Two screen frames were used, one was toward head side as usual preparation and the other was toward feet side. The feet-side screen frame was positioned at 30 cm in height at the knee's level. Only one piece of surgical drape was covered over the patient's body. The air duct of a forced-air warmer (Life-Air

1000, Progressive Dynamics Inc.) was placed between two knees. The following surgical preparations were as usual. If the body temperature lower than 35 °C, warm forced-air with temperature of 38 °C was given. When the body temperature increased up to 35.5 °C, the warm forced-air was discontinued. A cool forced-air with ambient temperature was started when the body temperature higher than 36 °C. If the temperature further increased to more than 37.5 °C, ice packs were placed over groin region. Rectal diclofenac suppository was administered if body temperature higher than 38.5 °C. Tracheal extubation was performed after eye opening with spontaneous regular breathing when the operation finished. Then the patient was sent to post-anesthesia care unit for postoperative care.

The body temperatures (preoperative, periodic during operation, and postoperative) were recorded. The preoperative and postoperative temperatures were measured by tympanic membrane thermometry. The maximum temperature changes during operation for each patient were also calculated. The operation times were recorded. All the recorded data were compared with the corresponding results of a previous report. A *p*-value less than 0.05 was considered significantly different.

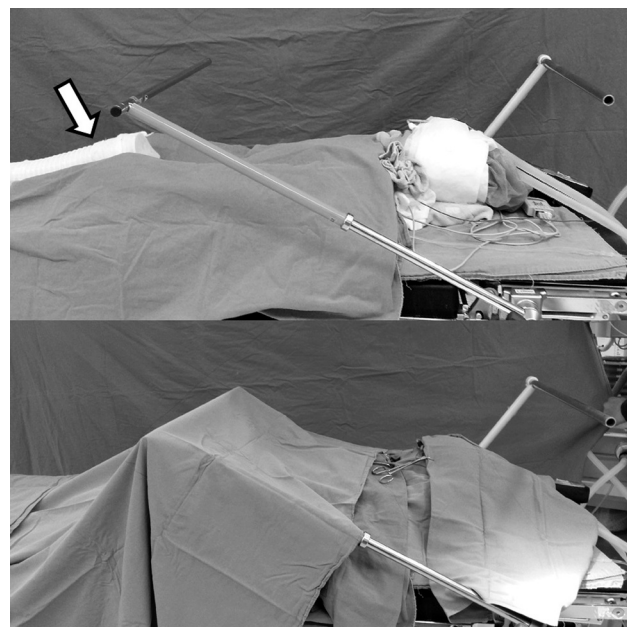


Figure 1 View of the tent-like draping. One screen frame was toward head side and the other was toward feet side. The feet-side screen frame was positioned at 30 cm in height at the knee's level. Only one piece of surgical drape was covered over the patient's body. The air duct of a forced-air warmer (white arrow) was placed between two knees.

Results

Thirty seven patients were enrolled in this study (20 boys and 17 girls). The age (range) was 3.46 ± 1.80 y/o (2–9 y/o). Preoperative tympanic temperature was 36.39 ± 0.25 °C. The operation time was 481.3 ± 125.6 min. The maximum temperature change is 2.08 ± 0.64 °C. There were 4 patients with body temperature higher than 37.5 °C during operation. No patient with body temperature high than 38.5 °C was found. The tympanic temperatures were all within normal limit at postoperative 5 h. The age, gender, preoperative tympanic temperature, and operation duration are comparable with the previous report in which the patients received the same operation with ordinary surgical draping (Table 1). The maximum temperature change and the incidence of body temperature higher than 37.5 °C during operation were significantly lower in patients received "tent-like draping" (2.08 ± 0.64 °C vs 2.50 ± 1.17 °C, $p < 0.001$; and 10.8% (4/37) vs 32.4% (11/34), $p < 0.05$, respectively).

Discussion

In this study active thermal management using forced-air cooling with "tent-like draping" can effectively maintain normothermia during pediatric full mouth rehabilitation surgery.

Perioperative temperature management is crucial for the patients receiving general anesthesia, especially for the pediatric patients. Pediatric patients can easily develop hypothermia during operation because of their high body surface area/body weight ratio and an undeveloped thermoregulatory system.⁴ Consequently, hypothermia prevention is always an important issue for pediatric surgery. An unusual increase of body temperature was found in the pediatric patients receiving full mouth rehabilitation surgery under general anesthesia.¹ However, this intraoperative hyperthermia returned to normal soon after operation. Several factors such as bacteremia, the effect of drugs, dehydration, environmental conditions, and frequent teeth stripping/drilling have been discussed to explain the possible mechanisms, but all not likely.¹ Besides, the anesthetic drugs we used during anesthesia included volatile anesthetic (sevoflurane) and opioid (fentanyl). These drugs have been reported to inhibit expression of fever.^{5,6} The real etiology of this intraoperative

hyperthermia needs further investigation. As we know, hyperthermia is more dangerous than a similar degree of hypothermia. Hyperthermia results in many harmful adverse effects such as increase of metabolic rate, tachycardia, and increase of oxygen consumption. Aggressive management for the hyperthermia is strongly indicated.

Forced-air warmer is recommended to be a good device to manage body temperature during operation.^{7,8} Forced-air transfers more heat than any other active warming systems.^{9,10} Based on this theory, forced-air cooling may also provide effective thermal management as forced-air warming. In this study we used forced-air cooling to manage the hyperthermia during operation. In addition, a tent-like draping was applied in this study. Under tent-like draping, an air space is developed between the drapes and the patient's lower body. This space provides a favorable condition for air convection when forced-air blowing inside. This maneuver may enhance the effectiveness of temperature control. There is another reason why this maneuver works. The region of the forced-air warming or cooling includes bilateral groins where femoral arteries located. The femoral artery belongs to large artery in the body and it located superficially over groin region. The thermal control may become more effective when the warm or cool forced-air blows over the blood flow-rich area such as groin region. In our hospital, this maneuver was routinely used for preparing the pediatric patients receiving full mouth rehabilitation surgery. We found no patient needed extra-effort to manage this intraoperative hyperthermia in the past year.

Several methods are able to lower body temperature during operation, such as lowering the temperature of IV fluid, using cooling/warming blanket and lowering room temperature. Actually, prior to use the maneuver of "tent-like draping", we have tried to use cooling/warming blanket and lowering room temperature, however the effectiveness was limited. Regarding the cooling of IV fluid, in our hospital the equipment for managing IV fluid temperature is only for heating, but not cooling. Thus the effectiveness of IV fluid cooling is not clear on the body temperature control during pediatric full mouth rehabilitation surgery.

In conclusion, we introduced a novel maneuver, a tent-like draping with forced-air cooling, for thermal management during pediatric full mouth rehabilitation surgery. It effectively controlled the increased body temperature during operation. Although the etiology of this transient intraoperative hyperthermia is uncertain, a continuous body temperature monitoring and active thermal

Table 1 Demographic data and body temperature associated measurements.

	Patients with TLD	Patients without TLD	p-Value
Age (Y/O)	3.46 ± 1.80	3.90 ± 1.32	n.s.
Gender (M/F)	20/17	19/15	n.s.
Preoperative BT (°C)	36.39 ± 0.25	36.37 ± 0.33	n.s.
Operation duration (min)	481.3 ± 125.6	514.6 ± 98.7	n.s.
Maximum BT change during operation (°C)	2.08 ± 0.64	2.50 ± 1.17	$p < 0.001$
Incidence of BT higher than 37.5 °C during operation	10.8% (4/37)	32.4% (11/34)	$p < 0.05$

Data presented as mean \pm SD. BT, body temperature; TLD, tent-like draping.

manipulation such as tent-like draping with forced-air cooling are highly recommended for the pediatric patients receiving full mouth rehabilitation surgery.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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