Statistical analysis of complications in laser treatment under general anesthesia performed for pediatric inpatients

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Objective: We report relationship between complications and predictive factors of occurrence with multivariate analysis for cases of laser treatment under general anesthesia.

Study Design: Pediatric patients (330 cases, aged 1 to 15 years old) who underwent laser treatment under inpatient general anesthesia against body surface hemangiomas or melanocytosis were examined for the complications.

Methods: Retrospective study from medical and anesthesia records, statistical assessment was carried out using multivariate analysis by univariate and logistic regression analysis, and p value less than 0.05 was considered to be significant difference.

Results: Complications were confirmed in 25%, mostly due to emergence agitation from anesthesia, and no severe complications were recognized. Multivariate analysis of factors causing complications revealed a significant difference in the limbs, the Q-switched Nd: YAG laser, and the anesthesia time of 60 minutes or longer.

Conclusion: While the length of anesthesia time was reported as a factor of complication occurrence in the past, there has been no report on the extremity and the Q-switched Nd: YAG laser as significant complication factors.

Key words: laser • pediatric patients • 330 cases • general anesthesia • complication

Introduction

There are many families who wish to treat their children’s skin conditions such as nevi and angioma under general anesthesia from the viewpoint of controlling the pain and the motion during the procedures. With cooperation of anesthesiology and pediatric departments, we performed laser treatments under general anesthesia after admitting children to the hospital. In this paper, we report relationship between complications and predictive factors of occurrence with multivariate analysis for cases of laser treatment under general anesthesia.

Objective and Methods

86 children aged 1 to 15 who underwent laser treatment under general anesthesia at Tokyo Women’s Medical University Medical Center East, department of plastic surgery in the 10 years from January 2005 to December 2014 were included in this study (330 cases: 70 boys, 260 girls). Treated diseases consist of Port-wine stain, infantile hemangioma, aberrant mongolian spot, nevus of Ota, and nevus spilus. Laser devices including a pulsed dye laser (Vbeam, Syneron Candela Inc, USA), Q-switched Nd:YAG laser (Medlite®, Cynosure Inc. USA), Q-switched ruby laser, MM & NIIC Co., Ltd, Japan) were selected depending on the types of the diseases.

All patients were admitted and stayed 1-2 days in the hospital. The anesthesia method was determined by anesthesiologists based on the condition of the patients.

Received date: June 5th, 2017
Accepted date: December 19th, 2017
and either mask (gas) ventilation, laryngeal mask ventilation, or endotracheal intubation was utilized. Induction of the anesthesia was carried out with oxygen, nitrous oxide, and sevoflurane, then analgesic suppository such as acetoaminophen was inserted per rectum, thus pain control was obtained.

As a pre-treatment to the laser application, the hair-bearing area was deprived of hair under the approval of the family, and petrolatum was applied to the hairy part around the treatment field to prevent burn injuries. In the case of the face, protective goggles for the laser were worn on both eyes, and when the eyelid was treated, a silicon contact was attached and shaded. The patients were examined by an anesthesiologist the day after the laser procedure, and allowed discharge from the hospital unless there was any abnormality. Laser irradiation time is limited within 30 minutes regardless of size, laser irradiation size is not measured.

We excluded the cases that required general anesthesia but not for laser treatment and laser cases under general anesthesia but over 16 years old. Retrospective study from medical and anesthesia records, statistical assessment was carried out using multivariate analysis by univariate and logistic regression analysis, and p value less than 0.05 was considered to be significant difference. The age was classified as an infant (1 to 5 years old), school childhood (6 to 12 years old), adolescence (13 to 15 years old), and time was divided every 30 minutes. BellCurve® for Excel was used as statistical software. This clinical study was conducted with the approval of Tokyo Women's Medical University ethics committee (approval number 4320).

Results

Complications were observed in 84 cases (25%). After induction of anesthesia, in 1 patient showed a decrease in arterial blood oxygen saturation due to fentanyl injection. It improved with time and laser treatment was continued. 79 cases of excitement such as crying after arousal of anesthesia, 1 case of coughing and 3 cases of vomiting were observed, but all improved within 30 minutes by observation alone and no serious complication was seen.

Mean values were 4 ± 3 years old (mean ± standard deviation, the same below), body weight 17.5 ± 8.25 kg, anesthesia time 43.3 ± 17.4 minutes, laser irradiation time 19.9 ± 13.4 minutes, irradiation frequency 3.8 ± 3.4 times.

Gender, age, disease type, site, equipment, anesthesia time, and ventilation method were considered to have influence on complications, subjected to univariate analysis, based on the prediction factor p < 0.01 (Table 1). These were further processed using the logistic regression analysis as confounding variables. There were significant differences in the three items; i.e., limbs, Q-switched Nd: YAG laser, and anesthesia time for more than 60 minutes (p < 0.05) (Table 2).

Discussion

The most common complication after the laser treatment under general anesthesia are excitement, and nausea and vomiting, 1-5) and they were observed in 82 patients among the 84 patients with complications. These occur just after arousal of anesthesia. It is difficult to identify the cause of such excitement upon arousal (emergence agitation) in children and it is presumed that multiple factors are involved. Factors that might be related to the emergence agitation were currently reported to be children of pre-school age, children with strong pre-operative anxiety, children who are emotional or active in nature, children who experienced post-operative pain, type of anesthetic (sevoflurane, desflurane), and surgical procedures such as ophthalmology or otolaryngology related.

The emergence agitation in pediatric anesthesia is said to be closely related to the use of sevoflurane and desflurane. 2) The use of sevoflurane, desflurane, a volatile anesthetic with low blood / gas partition coefficient as an anesthetic maintenance agent increases the risk of excitement upon arousal. Kuratani et al have shown that sevoflurane anesthesia in the meta-analysis comparing the sevoflurane anesthesia and halothane anesthesia in children was a risk factor of emergence agitation. 3) The reason for the higher rate of emergence agitation in sevoflurane anesthesia was once believed due to early emergence from the anesthesia and its central excitability, but this is currently not supported. It is rather pointed out that surge in sugar and lactic acid concentration in the brain during sevoflurane anesthesia is related to the emergence agitation.

Although it is a limb which confirmed a significant difference this time, it is said in the past that emergence agitation is likely to occur at the time of surgery of the head and face among the factors mentioned above, as described in the ophthalmology and otolaryngology surgery. There is no report that limbs are factors of emergence agitation. There is pain as a reason why emergence agitation is likely to occur during surgery of head and face. Also, a significant difference was noted in a Q-switched Nd: YAG laser but this was not previously reported as a cause of complications. Naito et al conducted a comparison of sevoflurane and halothane at the time of pediatric outpatient anesthesia, sevoflurane has shorter emergence time compared with halothane, and reported that frequent complications such as restlessness or excitement upon arousal. 4) However, it is presumed that disturbance and excitement are not the influence of sevoflurane but rather due to the postoperative pain. The current author Isago used the sevoflurane in the same day surgery, had also pain management, excitement has been reported that the most frequent among the complications.
Table 1: Demographics data and univariate analysis of complications of laser treatment under general anesthesia.

| Gender       | Data (n=330) | Complications (%) | pValue |
|--------------|--------------|-------------------|--------|
| Male / Female| 70 / 260     | 6 (9%) / 78 (30%)  | < 0.001* |

| Age group (years old) | Data | Complications (%) | pValue |
|-----------------------|------|-------------------|--------|
| 1-5                   | 264  | 70 (27%)          | 0.376  |
| 6-12                  | 61   | 14 (23%)          | 0.619  |
| > 12                  | 5    | 0 (0%)            | 0.188  |

| Disease type          | Data | Complications (%) | pValue |
|-----------------------|------|-------------------|--------|
| Port-wine stain       | 136  | 16 (12%)          | < 0.001* |
| Infantile hemangioma  | 8    | 1 (13%)           | 0.395  |
| Aberrant mongolian spot | 122 | 54 (44%)        | < 0.001* |
| Nevus of Ota          | 55   | 9 (16%)           | 0.090  |
| Nevus spilus          | 9    | 4 (44%)           | 0.185  |

| Site                  | Data | Complications (%) | pValue |
|-----------------------|------|-------------------|--------|
| Face                  | 166  | 21 (13%)          | < 0.001* |
| Trunk                 | 82   | 27 (33%)          | 0.073  |
| Limbs                 | 82   | 36 (44%)          | < 0.001* |

| Laser device          | Data | Complications (%) | pValue |
|-----------------------|------|-------------------|--------|
| Pulsed dye            | 139  | 16 (12%)          | < 0.001* |
| Q-YAG                 | 129  | 57 (44%)          | < 0.001* |
| Q-Ruby                | 62   | 11 (18%)          | 0.122  |

| Anesthesia time (Minute) | Data | Complications (%) | pValue |
|--------------------------|------|-------------------|--------|
| < 30                     | 61   | 10 (16%)          | 0.072  |
| 30-5                     | 204  | 46 (23%)          | 0.123  |
| > 60                     | 65   | 28 (43%)          | < 0.001* |

| Ventilation method      | Data | Complications (%) | pValue |
|-------------------------|------|-------------------|--------|
| Mask                    | 303  | 80 (26%)          | 0.185  |
| Laryngeal mask          | 16   | 1 (6%)            | 0.071  |
| Intubation              | 11   | 3 (27%)           | 0.888  |

*P < 0.01

Table 2: Result of multivariate logistic regression analyses.

| Factor                        | OR   | OR (95%CI) | p Value |
|-------------------------------|------|-----------|---------|
| Gender                        | 0.417| 0.163 - 1.069 | 0.069   |
| Port-wine stain               | 0.841| 0.183 - 3.855 | 0.823   |
| Aberrant mongolian spot       | 1.766| 0.657 - 4.747 | 0.259   |
| Face                          | 1.120| 0.406 - 3.093 | 0.827   |
| Limbs                         | 2.433| 1.152 - 5.138 | 0.020*  |
| Pulsed dye laser              | 1.085| 0.239 - 4.927 | 0.916   |
| Q-YAG laser                   | 2.836| 1.280 - 6.282 | 0.010*  |
| Anesthesia time > 60min       | 2.303| 1.188 - 4.463 | 0.014*  |

OR : Odds ratio, CI : confidence interval. *p < 0.05
While our hospital uses also similar perioperative management, asking to the children who can express words about the presence or absence of pain at the time of excitement, often there is no clear answer, and the relationship of the excitement and the presence or absence of pain is unclear.\(^5\)

If the pain is the cause of emergence agitation, it was expected that not the limbs as in the present case but the head and face, and not only the Q-switched Nd: YAG lasers, but also all three types of laser instruments would make significant differences. Pain control that we provided was not limited to analgesic suppositories, but also in combination with an analgesic-containing cream and local cooling in order to reduce the cause of child discomfort. Matsumine, et al compared the anesthesia time and complications rate every 15 minutes, and found the longer the anesthesia time the higher the incidence of complications.\(^5\) Such tendency was also seen in the current study, i.e., the complication was higher when anesthesia time was 60 minutes or longer, suggesting shorter anesthesia time less than 60 minutes with less complications to develop. Declining arterial blood oxygen saturation by fentanyl injection was seen in a 2-year-old girl whose laser treatment under general anesthesia was the third time. After administering fentanyl injection (that is not routinely done) by an anesthesiologist under mask ventilation, arterial blood oxygen saturation dropped to 85%, but because it recovered to 97% with 2 L oxygen administration, laser procedure was continued. In this case, although the anesthesia time was prolonged, complications were not observed after awakening.

From the viewpoint of safety of anesthesia, at our hospital we treat patients under general anesthesia who is 1 year or older, weighing 10 kg or more, and ASA I, II only. Because we try to complete laser treatment within 30 minutes, in the absence of underlying disease in children, most patients receive mask ventilation for the purpose of sedation, but in case of Sturge-Weber syndrome and when the face including upper lip and oral cavity is treated, laryngeal mask ventilation or endotracheal intubation is utilized.

Although not observed in our facility, it is important to keep in mind that there are possible burns caused by fire from the laser light. Epstein and colleagues measured fluctuations in oxygen concentration and laser output to investigate whether to ignite the hair or gauze. According to this study, it is not easy to ignite even if the oxygen concentration and the laser output are high, but if the site remains dry state, so if the treatment areas are moist, the possibility of ignition is reported to decrease remarkably\(^7\). Moreover, examination of the laryngeal mask ventilation and the mask ventilation during general anesthesia of children reveals oxygen leakage in both types of ventilation, but in mask ventilation in particular, oxygen leaks easily, therefore use of laryngeal mask ventilation is recommended to prevent fire hazard\(^9\). We mainly use mask ventilation, but the anesthesiologist uses the size of the mask suited to the patient and closely adheres so that oxygen does not leak out, and in the case of facial treatment the surgeon always apply petrolatum in the hair-bearing areas. We strictly adhere to this guideline.

Compared to the inpatient anesthesia, the advantages of the same-day procedure in outpatient setting have been documented\(^8,\,10\). However, there are many restrictions in same-day procedure, if it falls out of the standard of outpatient anesthesia, patients will be referred to hospital anesthesia facilities. Diseases that accompany other disorders such as Sturge-Weber syndrome are recommended for inpatient anesthesia.

In our hospital, children without underlying diseases are hospitalized to the plastic surgery department. In case of pediatric disorders such as Sturge-Weber syndrome, patients are admitted to the pediatric department, and plastic surgeons perform laser procedure only. We haven’t encountered convulsions following the laser treatment at the moment, it will be beneficial to have a pediatric neurologist to reduce the anxiety of the family. If there is a request for the outpatient laser treatment from the family of a patient who has no underlying disorders, it is necessary to take into consideration that the child and its family can treat as desired, by referring them to the facility that is doing same-day anesthesia.

**Conclusion**

We conducted a study examining complications of cases in which laser treatment was carried out under inpatient general anesthesia at our hospital. Complications were confirmed in 85 cases (26%), and the emergence agitation was most frequently observed. Factors associated with a significantly increased risk of complications were the limbs, the Q-switched Nd: YAG laser, and the anesthesia time of 60 minutes or longer.

We closely cooperated with other departments such as anesthesiology department and pediatrics department, and did not experience serious complications. Safe laser treatment was possible regardless of the existence of underlying diseases.
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Conflict of interest:
There is no conflict of interest with others with respect to this paper.