

Clinical Results of Sevoflurane Inhalation Anesthesia for Botulinum Neurotoxin Treatment in Children with Cerebral Palsy

Serebral Palsili Çocuklara Sevofluran İnhalasyon Anestezisi Altında Botulinum Toksin Uygulamalarında Klinik Sonuçlarımız

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Abstract

Objective	The botulinum neurotoxin type A (BoNT-A) intramuscular injection is a safe and reliable method to treat increased spasticity in spastic cerebral palsy (CP). Although BoNT-A injections may be administered under local anesthesia, many clinicians prefer injections under general anesthesia in the operating room, especially for children. The study intended to report safety and efficacy of sevoflurane inhalation anesthesia during BoNT-A injections for children with spastic CP.
Materials and Methods	Files of 61 children with CP who received 191 BoNT-A injections under sevoflurane mask anesthesia were analyzed retrospectively. The time from the beginning of anesthesia to the end of the procedure was recorded. The BoNT-A dose per muscle was 3–6 IU/kg body weight for lower extremity muscles and 1–3 IU/kg body weight for upper extremity muscles.
Results	The mean age of the children was 42 months. The mean procedure time was 15 min. There were no complications related to anesthesia or the BoNT-A injection procedure.
Conclusion	BoNT-A injections in children with spastic CP may be safely and effectively administered under sevoflurane mask anesthesia without any procedural or anesthetic complications.
Keywords	Botulinum toxin; cerebral palsy; inhalation anesthesia; sevoflurane

Öz

Amaç	Botulinum nörotoksini (BoNT-A) intramusküler enjeksiyonu, serebral palside (CP) görülen spastisitelerin tedavisinde kullanımı güvenli ve güvenilir olan bir araçtır. Lokal anestezi altında uygulaması yapılabilir de çoğu klinisyen, özellikle çocuk hastalar için, uygulamaların ameliyathanedeki genel anestezi altında yapılmasını tercih etmektedir. Bu çalışmanın amacı, CP tanılı çocuklarda BoNT-A enjeksiyonlarının sevofluran kullanılarak uygulanan inhalasyon anestezisi altında yapılmasının güvenliğini ve etkinliğini değerlendirmektir.
Gereç ve Yöntem	Sevofluran kullanılarak maske ile inhalasyon anestezisi altında BoNT-A enjeksiyonu yapılmış 61 çocuğun dosyası retrospektif olarak incelenmiştir. Anestezi işleminin başlamasından prosedürün sonuna kadar olan süreler kaydedilerek değerlendirildi. Kas başına BoNT-A dozu her bir kas için alt ekstremitede 3-6 IU/kg, üst ekstremitede için 1-3 IU/kg olarak uygulanmıştır.
Bulgular	Hastaların ortalama yaşı 42 ay iken ortalama işlem süresi 15 dakikadır. Hastalarda anestezi işlemi ya da BoNT-A uygulamasına bağlı herhangi bir komplikasyon yaşanmamıştır.
Sonuç	Bu çalışmada, CP tanılı çocuklarda yapılan BoNT-A enjeksiyonlarının sevofluran kullanılarak genel anestezi altında uygulanmasının güvenli ve etkin bir yöntem olduğu gösterilmiştir.
Anahtar Kelimeler	Botulinum toksini; serebral palsy; inhalasyon anestezisi; sevofluran

INTRODUCTION

Cerebral palsy (CP) refers to a group of motor disorders caused by a nonprogressive lesion of the immature brain, affecting posture and movements.¹ The spastic type comprises about 80% of all CP cases, and increased spasticity causes significant dysfunction or morbidity.²⁻⁴ Among many method for treatment of spasticity, the botulinum neurotoxin type A (BoNT-A) intramuscular injection has gained widespread acceptance as a safe, reliable and temporary method.⁵⁻⁷ BoNT-A treatment involves injections of the neurotoxin to the neuromotor junction-rich zone of a target muscle to reliably decrease muscle spasticity.^{8,9} Although BoNT-A injections may be administered under local anesthesia in the office setting, many clinicians prefer to provide BoNT-A treatment under general anesthesia or sedation in the operating room (OR) rather than in an office setting because of risk of interruption of the procedure due to agitation of the patient or pain especially in pediatric cases.¹⁰ When administering BoNT-A injections in the OR to children with CP, the safety of general anesthesia would be of paramount concern. At our institution, we prefer inhalation anesthesia with sevoflurane when administering general anesthesia to CP patients prior to BoNT-A treatment. The purpose of the present study was to describe the safety and efficacy of administering BoNT-A injections to children with spastic CP under inhalation anesthesia.,

MATERIALS and METHODS

After institutional review board and ethical committee approval (Haliç Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu, 01.12.2021, No 180), we retrospectively analyzed children who received BoNT-A injections under sevoflurane mask anesthesia at our institution. The work was designed as an epidemiologically descriptive study. The informed consents were obtained from the legal guardians of the patients represented in this article. All of the children had been previously diagnosed with spastic CP. Patients were excluded when additional surgical procedures were performed.

Prior to the BoNT-A injections, the patients were assessed clinically using the Gross Motor Function Classification System (GMFCS).¹¹ Comorbidities were recorded. After 6-8 hours fasting period, oral midazolam (0.5 mg/kg) which was mixed with paracetamol syrup was given at least 30 min before the BoNT-A injections, for pre-procedural sedation. The minimum mandatory monitoring includes ECG, NIBP, pulse oximetry and capnography. The rapid induction of anesthesia was accomplished by using 8% sevoflurane [2,2,2-trifluoro-1(trifluoromethyl) ethyl fluoromethylether] in 40 % oxygen and 60 % NO₂ by a face mask. The time between acceptance of face mask to the end of induction (small pupils, no gross bodily movements, and regular respirations) were recorded for all patients by a trained observer. Vital signs were followed for 2 hours post-procedure. During this period, pulse oximetry monitoring was performed continuously, and respiratory rate and blood pressure measurements were taken every 15 min.

The time from the beginning of anesthesia to the end of the procedure was recorded. Anesthesia-related complications, including aspiration, laryngospasms or bronchospasms, bradycardia, and any loss of airway patency necessitating endotracheal intubation were recorded.

Botox® (Allergan, Inc., Irvine, CA) was used in all cases. The dose per muscle was 3–6 IU/kg body weight for lower extremity muscles and 1–3 IU/kg body weight for upper extremity muscles, to a maximal absolute limit of 30 IU/kg body weight, per session. The targeted muscle group was identified by palpation, and anatomic landmarks were utilized to determine appropriate injection sites.¹² Four injection sites per muscle were used for the gastro-soleus complex; three were used for hamstring muscles, hip adductors, and wrist flexors; and two were used for pronator teres. The targeted muscles, and application of any cast were recorded. Descriptive statistics (mean, median, standard deviation) were evaluated using SPSS 15 (SPSS Inc., Chicago, IL; USA) software.

RESULTS

In total, 191 BoNT-A injections in 61 procedures (61 children) were analyzed. The mean age of the patients was 42 months (range: 15–114 months; SD: 3,4). Slightly more than half the children were males (35 males, 26 females). According to the GMFCS, 19 patients were classified as level 2, 15 patients were classified as level 3, 24 patients were classified as level 4, and 3 patients were classified as level 5. Three patients had a diagnosis of hypothyroidism, and 20 patients had been diagnosed with epilepsy.

Table 1: List of botulinum toxin injection sites and number of injections. (Total number of injections were 191 in 61 children. 34 (56%) children received only one level injection.)

Muscle	Number of injections
Hip adductor	44 (23%)
Gracilis	8 (4%)
Hamstring	8 (4%)
Rectus femoris	1 (0,5%)
Gastrocnemius	99 (52%)
Adductor pollicis	3 (1,5%)
Flexor pollicis longus	2 (1%)
Flexor carpi ulnaris	5 (2,6%)
Pronator teres	19 (10%)
Brachioradialis	1 (0,5%)

The mean procedure time (from entry to the OR to the end of the BoNT-A injection or cast application) was 15.7 ± 6.3 min (range: 4–30 min). In 76 (39.8%) procedures, a short leg cast was used. The number and location of the BoNT-A injections are reported in Table 1. In 38 (62%) patients the BoNT-A injection was administered only in the lower leg. In 23 (38%) patients, it was administered in both the lower and upper extremities. In the lower extremity, 34 (56%) BoNT-A injections were administered at one level, and 26 (43%) injections were administered at two levels. BoNT-A injections were administered at three levels in one (2%) patient.

There were no complications related to anesthesia or the BoNT-A injection procedure.

DISCUSSION

Most of the cases with CP present as spastic movement disorders.³ One of the most common choices for treatment of spasticity is BoNT-A injection.⁵ It was reported to have strong inhibitory effects on the neuromuscular junctions by creating reversible blockade of the motor end plates, resulting in focal muscle relaxation in children with spastic CP.^{6,13,14} Although many studies have focused on technical aspects of BoNT-A injections and functional outcomes, there is a lack of consensus in the literature on whether topical anesthesia only, oral sedation, or general anesthesia should be used when administering BoNT-A injections against any interruption of the injection procedure or agitation of the patient and parents.^{15,16} An average of 50% of unsatisfactory results were found when topical anesthetics were used during BoNT-A injections, and children with neurological impairments were at greater risk.^{17,18} In children with CP, early painful traumatic events, such as admittance to a neonatal or intensive care unit, can alter the neurological and physiological processing of pain signals or procedure-related anxiety.^{19,20} General inhalation anesthesia might also facilitate adequate spasticity and range of motion evaluation, identification of correct muscles for injections, and prevent psychological trauma in patients who might receive repeat injections in the future.

Among alternatives of inhalation anesthetics, sevoflurane is widely used, especially in children with difficulties for intravenous cannulation. It has various advantages, including rapid onset and offset of the action of general anesthesia, a low blood/gas partition coefficient and less pungent odor.^{21,22} It was reported to have bronchodilator and sedative effects which was exploited in treatment of acute asthma attacks and postoperative pain.^{23,24} Additionally, it was shown that sevoflurane caused no airway flash.^{25,26} The study intended to report safety and efficacy of sevoflurane inhalation anesthesia during BoNT-A injections for children with spastic CP.

When BoNT-A injection is decided to be performed under inhalation anesthesia, laryngeal mask airway (LMA) can be considered for airway management in children.²⁷ However when compared with mask anesthesia, LMA has been reported to cause more airway complications, primarily bronchospasm and laryngospasm.²⁸ Therefore, we performed administration of BoNT-A injections under sevoflurane mask anesthesia in this patient cohort and did not record any complication.

The main limitation of inhalation anesthesia might be the need for a close-fitting face mask or nasal mask considering small and very variable sizes of children. Additionally, possible side effects of sevoflurane are postoperative nausea and vomiting.²⁹ Considering respiratory secretions, physical limitations of the upper airway, and airway-related problems among children with CP, experienced anesthesia, orthopaedics and nursery teams are required against such applications when using sevoflurane in children with CP. We performed 191 BoNT-A procedures over a 5-month period under sevoflurane inhalation anesthesia in 61 children with CP. We did not experience any airway-related problems, cardiac complications, or other serious adverse events associated with sevoflurane. In the present study, the mean duration of the BoNT-A procedure was 16 min.

The study should be evaluated together with its limitations. Small number of participants in the study precludes drawing specific conclusions. Other limitations of this study are the lack of quantification of a sedation or pain score and the absence of an objective assessment of parental satisfaction with the child's comfort during the procedure.

In conclusion, the present study showed that sevoflurane mask anesthesia was a safe and effective method of anesthesia in children with CP receiving BoNT-A injections. We experienced no procedural or anesthetic complications.

Compliance with Ethical Standards

Funding statement: No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Conflict of interest statement

Authors declare that they have no conflict of interest related to the article and its results.

Ethical approval

All procedures were performed in accordance with the ethical standards of the institutional research committee (Haliç Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu, 01.12.2021, No 180) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

The informed consents were obtained from the legal guardians of the patients represented in this article.

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