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A simple calculation of the maximum dose of the local anesthetic in pediatric dentistry with nomogram

Jednostavno izračunavanje maksimalne doze lokalnog anestetika u dečijoj stomatologiji uz pomoć nomograma

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Ključne reči:
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Introduction

The World Health Organization (WHO) defines pain as an unpleasant sensory or emotional experience associated with actual or potential tissue damage. Pain can be controlled by various methods, and the most widely used is to block the transmission of painful impulses by afferent nerve fibers [1]. The application of local anesthetics in the immediate vicinity of nerve fibers temporarily prevents the transmission of painful impulses, as long as its concentration at the site of action is sufficient [2]. Local anesthetics are the most commonly used drugs in dental practice and are used to eliminate pain during a variety of dental interventions [3]. To enhance the effect, a vasoconstrictor is added to local anesthetics, thus prolonging the duration of local anesthesia [4].

The most commonly used local anesthetic in pediatric dentistry is lidocaine, and in recent times, articaine has found increasing use. Lidocaine is the first amide-linked local anesthetic and has been the "gold standard" among local anesthetics for more than 50 years. According to the recommendations of the American Academy of Pediatric Dentistry (AAPD), it is used in infiltration and conduction anesthesia in a concentration of 2%, with or without vasoconstrictors. The maximum single dose of lidocaine for children is 4.4 mg/kg body weight, and the total dose should not exceed 300 mg [5]. Articaine is the fastest metabolized anesthetic of all anesthetics used in dentistry, making it less toxic and can be administered in higher doses. Articaine diffuses better into soft and bone tissues, which ensures good anesthesia. According to the recommendations of the AAPD, it is used in infiltration and conduction anesthesia in a concentration of 4%, with or without vasoconstrictors. The maximum single dose of articaine for children is 7.0 mg/kg body weight, and the total administered dose should not exceed 500 mg [5].

Toxicity of local anesthetics

Toxicity of a local anesthetic means the property of causing side effects in the body. Regardless of the method of applying the anesthetic, the anesthetic after application gradually passes from the place of deposition into the circulation and is distributed through the blood throughout the body before it is excreted. The concentration of anesthetic in plasma depends on the balance between the degree of resorption from the site of application and the rate of its detoxification. Toxic concentrations of anesthetics in the blood can occur if this balance is disturbed. This most often occurs as a consequence of an overdose of local anesthetic, extremely rapid application and resorption, unusually slow detoxification, or slow excretion [2]. If properly applied, in the appropriate dose, and in the right place, local anesthetics do not cause side effects [6].

The manifestations of the local anesthetic systemic toxicity (LAST) may appear 30 sec to 60 min after injection, but they typically appear within 1 to 5 min. The manifestations vary widely but are usually consistent with central nervous system (CNS) excitement (e.g., oral numbness, metallic taste, dizziness or lightheadedness, drowsiness or disorientation, visual or auditory disturbances) [7]. There are five

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categories of the LAST manifestation: CNS, cardiovascular, hematologic, allergic, and local tissue responses [8].

Clinicians should identify the risks associated with the use of anesthetics and understand the maximum recommended doses of local anesthetics [9]. The amount of local anesthetic that can be used depends on the type of anesthetic, the patient's health, and the age of the child. Treatment planning and accurate documentation of local anesthetics require careful calculation and dose recording. Errors in calculating the dose of local anesthetics are common due to the widespread use of these agents and the fact that the concentrations of these agents are often presented in non-standard units. Different methods of calculating the dose of a drug have different strengths and weaknesses, and no single method can guarantee error-free calculation. Formulas for calculating the maximum dose of local anesthetics have been described in the literature, but they represent a rather complicated way that takes a lot of time for the dentist [10, 11].

Nomogram

A nomogram is a simple graphical tool on which, without calculation, one can read the result of calculation operations with given numbers (an appropriate nomogram is constructed for each type of problem), i.e., graphical representation of a mathematical formula. Nomograms are widely used in engineering, medicine, statistics, and accounting [12]. Although they have been largely replaced by electronic computers and calculators, nomograms retain numerous advantages over electronic devices. They are easy to use, extremely cheap, and do not require a source of electricity [13].

The nomogram for calculating the maximum dose of local anesthetic enables quick cross-checking of the calculation based on the patient's age or body weight. They are of special importance in the application of local anesthesia in children in order to reduce the chance of toxicity and prolonged duration of anesthesia, which can lead to self-injury of the tongue or soft tissues [13–15].

By drawing a line across the axis, the calculation is performed and a permanent record for medical documentation is provided (Figure 1). The nomogram can be enlarged to ensure greater readability, but it is necessary to keep the original proportions (ratio of width and height) so as not to produce erroneous calculations. Nomograms in Serbian are free for download and easy to use in everyday clinical practice [16].

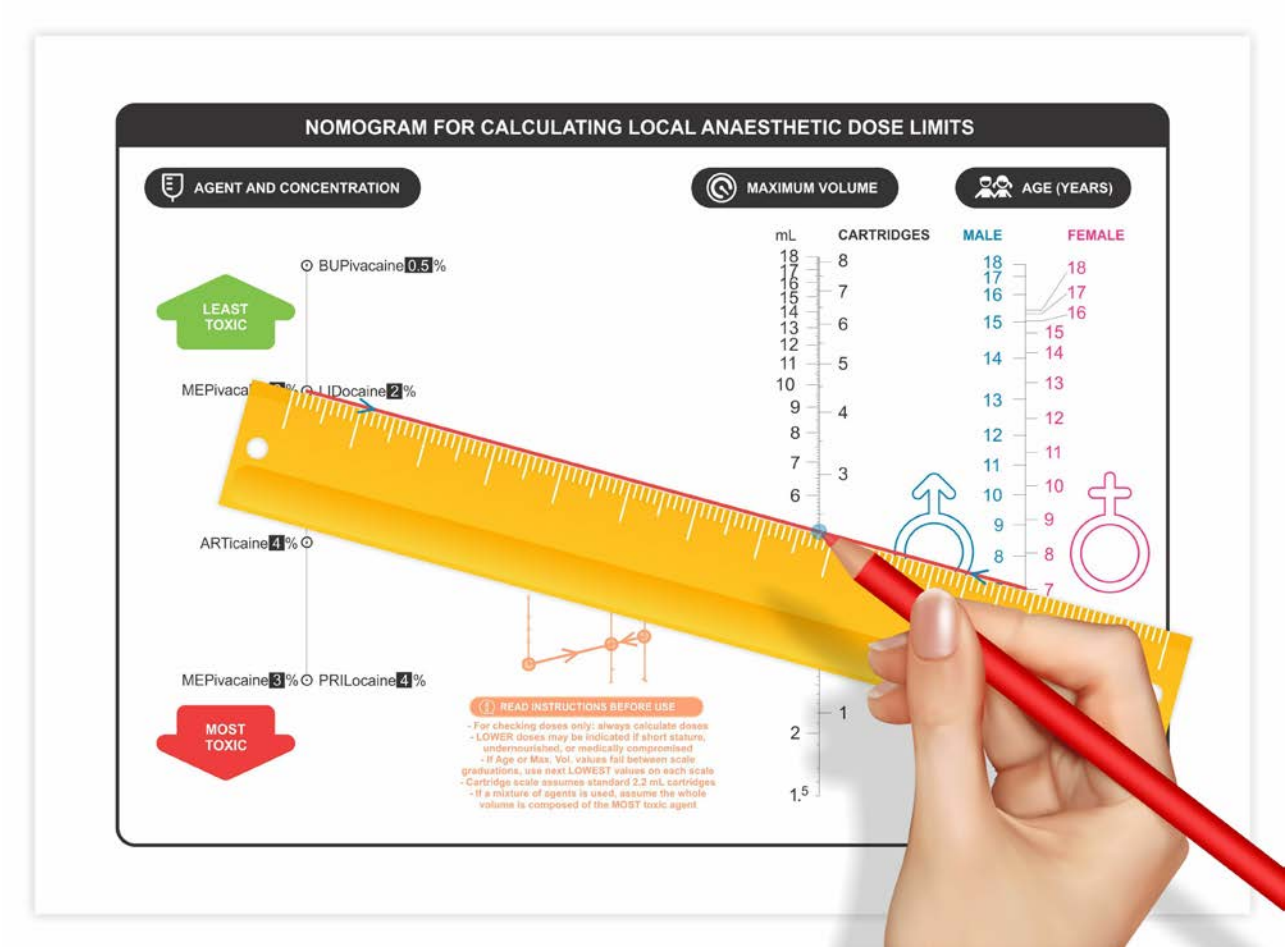


Fig. 1 – How to use the nomogram: by drawing a line from the selected anesthetic on the one hand and the patient's age (or bodyweight) on the other, the value of the maximum dose of the selected anesthetic solution is obtained. Adapted by Raša Mladenović with permission and curtesy of the authors Williams DJ and Walker DJ [14].

Conclusion

This article presents a simple and practical tool that will make it easier for dentists to work with children to calculate the maximum dose of local anesthetic, thus potentially reducing the frequency of toxicity of local anesthetics and improving patient safety.

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