http://dx.doi.org/10.35630/2199-885X/2021/11/2/30

INFERIOR ALVEOLAR NERVE BLOCK BY INJECTION INTO THE PTERYGOMANDIBULAR SPACE USING GUIDING DEVICES: A SYSTEMATIC REVIEW

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INTRODUCTION

Nowadays patients pay great attention to the oral cavity health, particularly the teeth health (Ibrahim et al., 2017), (Yuan et al., 2020). But most of them still have a fear of dentist visiting. This is due the pain not only during treatment, but also during an anesthetic injection (Ushnitsky et al., 2018). According to Iwanaga et al., 2018 and Bhat et al., 2020, the most common mandible local anesthesia method is the inferior alveolar nerve blockage (IANB) (Iwanaga et al., 2018), (Bhat et al., 2020). A study by Rajvanshi, 2016 and Howait and Basunbul, 2019 showed a high efficiency of this method — 85% (Rajvanshi H., Ernest S., Haifa Effendi H., Afidi S., Chhabra M., 2016), (Howait M., Basunbul, 2019). The authors point out that the anesthesia success is an accurate hit in the pterygoid — maxillary space. The most objective way to increase the IANB success is to determine the injection point taking into account the patient anatomical features (Farhangkhoee et al., 2012), (Petrikas A.Zh. et al., 2020). The injection point is located in the once center on the mucosa formed by the protrusion of the anterior inferior alveolar nerve branch edge (outside) and the medial part of the pterygoid muscle (inside) (Iwanaga et al., 2018). There are some intraoral landmarks described for IANB, which may vary depending on an inverted triangle of the individual’s anatomy. It should be noted that according to Al-Moraissi et al., 2021, patients experience less pain during the blockade and it is more successful if using 27-gauge needles (Al-Moraissi et al., 2021).

There are a number of adverse events during the IANB. When the needle is inserted into the medial pterygoid-mandibular fold, the anesthetic may spread to the oropharyngeal tissue and damage the internal pterygoid muscle, which could follow to the development of mandibular contracture (Rabinovich et al., 2018) (Kuzin et al., 2015). When the needle is inserted into the pterygomandibular fold or into its lateral edge, vascular damage, hematoma formation, anesthetic entry into the bloodstream, and the ischemic zones on the lower lip and chin skin appearance are possible (Alhindi et al., 2016). An alldynia, paresthesia, and dysesthesia are most commonly observed

ABSTRACT — The aim of our research was to analyze and compare different inferior alveolar nerve blocking techniques and the effectiveness of various guiding devices. METHODS: A search was conducted on specialized databases for search and selection of works in which a guiding device for lower alveolar nerve block (IANB) was described. Thepropriated articles were evaluated and selected in 3 stages for final review based on predefined criteria, followed by a critical evaluation stage. As the research result - various types of IANB guide devices and the results of its using were recorded and analyzed.

RESULTS: The systematic review of devices for conducting IANB was done. The success of IANB can be achieved by adjusting the syringe with the anesthetic needle trajectory — it increased the probability of a successful hit in the area of the mandible foramen. Examples of devices in which the syringe is fixed at the moment when the tip of the needle is inserted into the medial side of the branch of the lower alveolar nerve are considered. And also, the special techniques based on orientation on the soft tissues are described. However, when creating a device of this type, the following factors must be taken into account: the angle of the needle to the insertion point, the position of the insertion point relative to the anatomical landmarks (taking into account individual characteristics), and the insertion depth. Also, other IANB guiding blockade methods are considered: 3D navigation while local anesthetic injection. Thus, the patient’s discomfort, the risk of nerve damage and the risk of unsuccessful mandible anesthesia could be minimized. CONCLUSION: The advantages and disadvantages of these anesthesia methods, the success rate, and patient comfort were analyzed. Prospects for further research in this area were identified.

KEYWORDS — anesthesia, inferior alveolar nerve blocking (IANB), guide device for anesthesia, pterygomandibular space.
(Ahmad, 2018). This accounts for the need to determine the precision of injection points and the need of a guiding device. (Farhangkhoee et al., 2012). There are some examples of the such devices implementation in the literature but there is no single solution that meets the request for a concise form, ease of use and manufacturer.

**MATERIALS AND METHODS**

A systematic review of several databases was carried out, with the studies selection (Scheme 1).

Scheme 1. Methodology for selecting studies for meta-analysis. The original version is taken from the site: http://www.prisma-statement.org/).

**RESULTS AND DISCUSSION**

The results obtained during the systematic review are presented in Table 1.

Besides, none of the listed devices has a full complete set of necessary functions:
- possibility of a single-use;
- adjustment for the patient’s anatomy;
- secure attachment of the syringe;
- usage of both sides;
- additional maintenance of the patient’s mouth sufficiently open for a dentist full-scale view;
- freeing of the one of the dentist’s hands;
- adjustment for the speed and volume of the anesthetic supply

It should be noted that creating of such device should be based on previous studies and existing models. Also it is necessary to take into account such factors as: the needle angle to the injection point, the position of the injection point relative to anatomical landmarks (taking into account individual characteristics) and the depth of the injection. So the guiding devices for the IANB must meet most of the previously named points to ensure not only the success of the blockade, but also the comfort of the dentist and the patient.

**CONCLUSION**

This systematic review has shown that using various guiding devices increases the IANB success. Such devices can help avoid alodynia, prolonged anesthesia, paresthesia, dysesthesia and many other IANB complications. Also it was shown that there is no one point of view on the criteria for evaluating the advantages and disadvantages of guiding devices, so their further development is needed.
<table>
<thead>
<tr>
<th>Author</th>
<th>Anesthesia type</th>
<th>Device description</th>
<th>Target injection point</th>
<th>Device locking points</th>
<th>Effectiveness</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egorov P.M., 1982 (Egorov P.M., 1982)</td>
<td>By Gow-Gates</td>
<td>Angulator for inferior alveolar nerve block</td>
<td>“The intermuscular triangle”</td>
<td>The mandible branch outer surface, at the level of the mandibular foramen</td>
<td>1 patient</td>
<td>The injection point was objectified</td>
<td>There is no significant simplification in the anesthesia procedure and there is no device fixing possibility</td>
<td>-</td>
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<tr>
<td>Jofré and Münzenmayer, 1998 (Jofré &amp; Münzenmayer, 1998)</td>
<td>By Gow-Gates</td>
<td>Angulator for inferior alveolar nerve block</td>
<td>The point is distal to the second molar of the maxilla, slightly below the mesiopalate protrusion.</td>
<td>The ear part is inserted into the lower border of the tragus. The device itself is oriented in a plane from the lower border of the tragus through the corners of the mouth. After the plane is aligned, the syringe is placed in the device and the injection is made in the designated plane.</td>
<td>97.5% (39 patients at all)</td>
<td>The injection plane was objectified, and objective reference points were selected for all patients</td>
<td>There is no adjustment for: injection angle, depth and height. There is no a convenient way to hold the device.</td>
<td>One of the first objective out-of-mouth landmarks for the blockade was selected. It became possible to objectify the injection point.</td>
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<td>Ushnitsky I.D., Chakhov A.A., 2020</td>
<td>IANB by Halsted</td>
<td>Assembly package for injection point position and the depth determining</td>
<td>It is possible to determine injections parameters during anesthesia individually for each patient</td>
<td>On the mandible branch posterior edge in the area of the greatest concavity and fix the measuring part of the set with the middle finger. Then the rod of this part is fixed in the oral cavity until it reaches the stop in the anterior edge of the lower jaw. According to the obtained measurements, the depth of immersion of the needle is determined. Then the 2nd part of the device is placed in the oral cavity until it stops at the mandible front edge and an injection is made along the guide arches.</td>
<td>1 patient</td>
<td>The ability to determine the depth of the needle injection individually for each patient.</td>
<td>A small amount of data is taken into account in the invention, the anesthesia itself is provided without objective guidelines, there is no possibility of simultaneous adjustment of all necessary parameters, the lack of reliable fixation of the device.</td>
<td>It can be used for mental anesthesia (Chakhov A.A., 2019)</td>
</tr>
<tr>
<td>Zandi and Seyedzadeh Sabounchi, 2008</td>
<td>By Gow-Gates</td>
<td>Angulator for inferior alveolar nerve block</td>
<td>Distal to the maxillary second molar at the level of the mesiopalatyl plane.</td>
<td>The ear part is inserted into the lower border of the trigus. The device itself is oriented in a plane from the lower border of the trigus through the corners of the mouth. After the plane is aligned, the syringe is placed in the device and the injection is made in the designated plane.</td>
<td>93.3% (45 patients at all)</td>
<td>Ease of holding the device, objectified injection plane, selected objective reference points for all patients</td>
<td>There is no adjustment for: injection angle, depth and height</td>
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<tr>
<td>Caillieux N., 2009</td>
<td>By Gow-Gates</td>
<td>The injection sagittal plane fixation along the mandible branch. The injection point selection in accordance to the syringe cylinder most lateral position in that plane.</td>
<td>The most lateral and highly located in the oral cavity, after the device placing.</td>
<td>The ends of the device clamp the mandibular branch between its anterior and posterior edges. The injection plane is selected according to the most lateral position of the syringe. For the injection, the highest possible point in the oral cavity is selected</td>
<td>No data</td>
<td>The easing navigation in the oral cavity</td>
<td>There is no regulation for the patient anatomical features, there is no regulation of the needle penetration depth into soft tissues, it is necessary to use doctor both hands, also devise is not stable, there is no regulation in height</td>
<td>There is a primary possibility of adjustment to the patient individual characteristics</td>
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<tr>
<td>Caillieux, 2017</td>
<td>By Gow-Gates</td>
<td>Angulator for inferior alveolar nerve block</td>
<td>From 7 to 25 mm (on average from 7 to 14 mm) from the mandible posterior edge at an angle of inclination from 53° to 62° (on average 32°)</td>
<td>Fixation behind the mandible posterior edge, with a maximum lag of 25 mm from that.</td>
<td>91.6%</td>
<td>A stable angle of inclination of the syringe to the injection site was created, the syringe was fixed, the calculations are based on the patients CT scans data objective analysis.</td>
<td>There is no regulation for the patient anatomical features, there is no regulation of the needle penetration depth into soft tissues, it is necessary to use doctor both hands, also devise is not stable, there is no regulation in height</td>
<td>A number of parameters were taken into account: the injection angle, the oral cavity parameters in the syringe passing plane, and the syringe was fixed in the appropriate position</td>
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<td>Won and Kang, 2017 (Won &amp; Kang, 2017)</td>
<td>IANB by Halsted</td>
<td>Superimposing a CT scan on the patient’s oral cavity real photo</td>
<td>Direct orientation to the point of entry of the inferior alveolar nerve into the mandible (achieved by superimposing a CT scan on an intraoral photo)</td>
<td>No data</td>
<td>No data</td>
<td>Выход обезболивания в AR пространство, разработан протокол для последующих исследований</td>
<td>There is no simplification in the anesthesia procedure.</td>
<td>This is the convenient method for teaching dental students the IANB method. But it is necessary to expose patients to excessive radiation exposure and to train doctors to work in applications for processing DICOM images.</td>
</tr>
<tr>
<td>Chakhov A.A., Ushnitsky I.D., 2019 (A.A. Chakhov, Ushnitsky, 2019)</td>
<td>By Gow-Gates</td>
<td>Angulator for inferior alveolar nerve block</td>
<td>The lateral edge of the pterygoid-maxillary depression, immediately medial to the temporal muscle tendon. The height of the injection point is determined by the location of the needle tip immediately below the medial-lingual (medial-palatal) maxillary second molar tubercle.</td>
<td>No data</td>
<td>No data</td>
<td>The additional reference point for anesthesia has been found, and a step has been taken to create a one-piece device with only 1 doctor’s hand occupied.</td>
<td>There is no sufficient justification for the use of the technique, there is no way to objectify the injection point, there is no way to regulate the injection point in height</td>
<td></td>
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<tr>
<td>Jundt et al., 2020 (Jundt et al., 2020)</td>
<td>By Gow-Gates</td>
<td>Individual mouthguard for each patient, made according to the patient’s CT scan data</td>
<td>From 3.8 to 10 mm above the occlusal plane, 3 mm medial and 6 mm higher from the point of entry of the inferior alveolar nerve</td>
<td>No data</td>
<td>No data</td>
<td>Potentially high chance of success of anesthesia due to a personalized approach (the ability to take into account additional data)</td>
<td>Excessive radiation exposure of the patient, high cost and long-term manufacturing of the device</td>
<td>Ability to account for more data</td>
</tr>
<tr>
<td>Kojima et al., 2020 Kojima et al., 2020a (Kojima, Sendo, et al., 2020), (Kojima, Murouchi, et al., 2020)</td>
<td>IANB by Halsted</td>
<td>Ultrasound management of anesthesia</td>
<td>Standard for IANB</td>
<td>No data</td>
<td>No data</td>
<td>Easy to perform in-hospital conducting anesthesia, designed for postoperative and rehabilitation</td>
<td>The method is difficult to implement in the conditions of outpatient admission, there is no objectification of the injection point, there is no significant simplification of the blockade, it is necessary to involve a specialist in ultrasound diagnostics.</td>
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</tbody>
</table>
REFERENCES


20. N., Cailleux. (2009). Device for guiding the syringe of a user so as to enable the injection of the analgesic solution of the former as close to the mandibular foramen as possible (Patent No. EU Patent EP2429618B1).


