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

Received 28 April 2021;
Received in revised form 20 May 2021;
Accepted 25 May 2021

***Artem Kashtanov*[1], *Hadi Darawsheh*[3]✉, *Yuriy Vasil'ev*[1,2], *Sameh Ibrahim*[4], *Darina Shirokova*[4], *Ekaterina Shilyaeva*[4], *Valeria Brichagina*[4], *Guseyn Taymurazov*[4]**

[1] *I.M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia;*
[2] *Kazan State Medical University, Kazan;*
[3] *Dental Clinic "Vin-clinic", Moscow;*
[4] *Peoples' Friendship University, Moscow, Russia*

✉ *hadi.darawsheh@gmail.com*

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. The propriated 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 injected 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.

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., Hafsa Effendi H., Afridi 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).

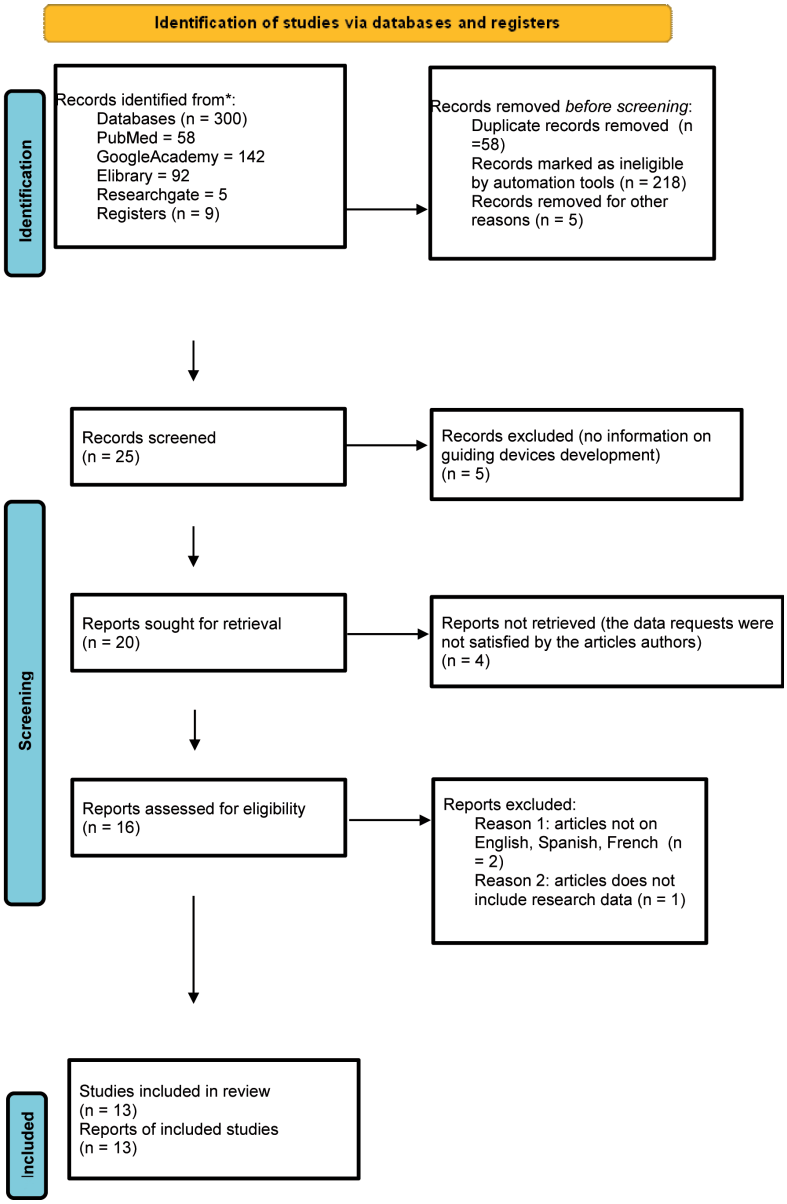
There are a number of adverse events during the IANB. When the needle is inserted into the medial pterygoid-mandibular fold, the anesthetic may spread to the oropharyngeal tissue and damage the internal pterygoid muscle, which could follow to the development of mandibular contracture (Rabinovich et al., 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 allodynia, paresthesia, and dysesthesia are most commonly observed

(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-uwse;

— 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 allodynia, 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 1. *Description of existing devices for guided inferior alveolar nerve blockage (IANB)*

Author	Anesthesia type	Device description	Target injection point	Device locking points	Effectiveness	Advantages	Disadvantages	Notes
Egorov P.M., 1982 (Egorov P.M., 1982)	By Gow-Gates	Angulator for inferior alveolar nerve block	"The intermuscular triangle»	The mandible branch outer surface, at the level of the mandibular foramen	1 patient	The injection point was objectified	There is no significant simplification in the anesthesia procedure and there is no device fixing possibility	-
Jofré and Münzenmayer, 1998 (Jofré & Münzenmayer, 1998)	By Gow-Gates	Angulator for inferior alveolar nerve block	The point is distal to the second molar of the maxilla, slightly below the mesiopalate protrusion.	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.	97,5% (39 patients at all)	The injection plane was objectified, and objective reference points were selected for all patients	There is no adjustment for: injection angle, depth and height.There is no a convenient way to hold the device.	One of the first objective out-of-mouth landmarks for the blockade was selected. It became possible to objectify the injection point.
Tiol A., 2001 (Tiol A., 2001)	IANB by Halsted	A device for targeting soft tissues. The methodology has been improved by Thangavelu et al., 2012. (Thangavelu et al., 2012)	On Tiol A., 2001 method (Tiol A., 2001), - deepening of the pterygoid ligament. On Thangavelu et al., 2012, method (Thangavelu et al., 2012) - from 6 to 8 mm above the midpoint between the upper and lower occlusal planes and the coronal notch and from 8 to 10 mm posteriorly from the anterior border of the branch	On Tiol A., 2001 method (Tiol A., 2001) – metal rod. It's the edge coincides with the recess at the pterygoid ligament, the guide is parallel to the mandibular occlusal plane (Tiol et al., 2010)	On Tiol A., 2001 method - (Tiol A., 2001) method - 94% (Tiol A., 2001) On Thangavelu et al., 2012, method (Thangavelu et al., 2012) – 95% (476 patient)	On Tiol A., 2001 method (Tiol A., 2001), - a convenient and safe method of anesthesia when targeting soft tissues. On Thangavelu et al., 2012, method (Thangavelu et al., 2012) – no additional devices for targeting the target point	The Tiol A., 2001 method (Tiol A., 2001): unsafety method and small evidence base. The Thangavelu et al. methood (Thangavelu et al., 2012): – increased risk of injury to the doctor. The absence of objective and fixed anatomical landmarks in both cases	The suitable method for teaching students to perform intraoral block anesthesia of the inferior alveolar nerve

Author	Anesthesia type	Device description	Target injection point	Device locking points	Effectiveness	Advantages	Disadvantages	Notes
Ushnitsky I.D., Chakhov A.A., 2020 (Ushnitsky, I. D. Chakhov, 2020)	IANB by Halsted	Assembly package for injection point position and the depth determining	It is possible to determine injections parameters during anesthesia individually for each patient	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.	1 patient	The ability to determine the depth of the needle injection individually for each patient.	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.	It can be used for mental anesthesia (Чахов А.А., 2019)
Zandi and Seyedzadeh Sabounchi, 2008 (Zandi & Seyedzadeh Sabounchi, 2008)	By Gow-Gates	Angulator for inferior alveolar nerve block	Distal to the maxillary second molar at the level of the mesiopalatyl plane.	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.	93.3% (45 patients at all)	Ease of holding the device, objectified injection plane, selected objective reference points for all patients	There is no adjustment for: injection angle, depth and height	-
Caillieux N., 2009 (Caillieux N., 2009)	By Gow-Gates	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.	The most lateral and highly located in the oral cavity, after the device placing.	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	No data	The easing navigation in the oral cavity	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	There is a primary possibility of adjustment to the patient individual characteristics
Caillieux, 2017 (Caillieux, 2017)	By Gow-Gates	Angulator for inferior alveolar nerve block	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°)	Fixation behind the mandible posterior edge, with a maximum lag of 25 mm from that.	91,6%	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.	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	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

Author	Anesthesia type	Device description	Target injection point	Device locking points	Effectiveness	Advantages	Disadvantages	Notes
Won and Kang, 2017 (Won & Kang, 2017)	IANB by Halsted	Superimposing a CT scan on the patient's oral cavity real photo	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)	-	No data	Выход обезболивания в AR пространство, разработан протокол для последующих исследований	There is no simplification in the anesthesia procedure.	This is the convenient method for teaching dental students the IANB method. But it is necessary to expose patients to excessive radiation exposure and s to train doctors to work in applications for processing DICOM images.
Chakhov A.A. Ushnitsky I.D., 2019 (A.A. Chakhov, Ushnitsky, 2019)	By Gow-Gates	Angulator for inferior alveolar nerve block	The lateral edge of the pterygoid-maxillary depression, immediately medial to the medial bundle of 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.	The outer ring is installed in the area of the outer surface of the condylar process. The direction of the injection is carried out in such a way that the target moves to the specified point.	No data	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.	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	-
Jundt et al., 2020 (Jundt et al., 2020)	By Gow-Gates	Individual mouthguard for each patient, made according to the patient's CT scan data	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	-	No data	Potentially high chance of success of anesthesia due to a personalized approach (the ability to take into account additional data)	Excessive radiation exposure of the patient, high cost and long-term manufacturing of the device	Ability to account for more data
Kojima et al., 2020 Kojima et al., 2020a (Kojima, Sendo, et al., 2020), (Kojima, Murouchi, et al., 2020)	IANB by Halsted	Ultrasound management of anesthesia	Standard for IANB	-	1 patient (Kojima, Sendo, et al., 2020) 28 patients (Kojima, Murouchi, et al., 2020)	Easy to perform in-hospital conducting anesthesia, designed for postoperative and rehabilitation	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.	-

REFERENCES

1. **A., Tiol. (2001).** Técnica Innovadora Para El Bloqueo Regional Mandibular Con El Uso De Una Guía Metálica. Practica Odontológica, 22(6), 7–14.
2. **A.A. Chakhov, Ushnitsky, I. D.** (2019). A device for performing mandibular anesthesia according to Gow-Gates (Patent No. RU 189949 U1).
3. **A.A. Chakhov, Ushnitsky, I. D., & Isakov, L. O.** (2019). The modified mental anesthesia by malamed technique with Ushnitsky-Chahov's device. Endodontics Today, 17 (4), 12–15. https://doi.org/10.36377/1683-2981-2019-17-4-12-15
4. **A.Zh. Petrikas, E.V. Chestnyh, K.V. Kulikova, I. O. L.** (2020). Topographic and anatomical justification of conduction anesthesia for inferior alveolar nerve block. Tver Medical Journal, 3, 69–78.
5. **Ahmad, M.** (2018). The Anatomical Nature of Dental Paresthesia: A Quick Review. The Open Dentistry Journal, 12(1), 155–159. https://doi.org/10.2174/1874210601812010155
6. **Al-Moraissi, E. A., Al-Selwi, A. M., & Al-Zendani, E. A.** (2021). Do length and gauge of dental needle affect success in performing an inferior alveolar nerve block during extraction of adult mandibular molars? A prospective, randomized observer-blind, clinical trial. In Clinical Oral Investigations. https://doi.org/10.1007/s00784-021-03796-w
7. **Alhindi, M., Rashed, B., & Alotaibi, N.** (2016). Failure rate of inferior alveolar nerve block among dental students and interns. In Saudi Medical Journal (Vol. 37, Issue 1, pp. 84–89). https://doi.org/10.15537/smj.2016.1.13278
8. **Bhat, P., Chanu, H. T., Radhakrishna, S., Ashok Kumar, K. R., Marimallappa, T. R., & Ravikumar, R.** (2020). Comparison of Clinical Efficacy of Classical Inferior Alveolar Nerve Block and Vazirani–Akinosi Technique in Bilateral Mandibular Premolar Teeth Removal: A Split-Mouth Randomized Study. In Journal of Maxillofacial and Oral Surgery. https://doi.org/10.1007/s12663-020-01374-3
9. **Caillieux, N.** (2017). Guiding Device for Dental Anesthesia (Patent No. US Patent 0028143 A1).
10. **Egorov P.M., E. I. P.** (1982). Device for mandible analgesia (Patent No. SU 984480 A1).
11. **Farhangkhoee, H., Lalonde, J., & Lalonde, D. H.** (2012). Teaching medical students and residents how to inject local anesthesia almost painlessly. In Canadian Journal of Plastic Surgery (Vol. 20, Issue 3, pp. 169–172). https://doi.org/10.1177/229255031202000315
12. **Howait M., Basunbul, G. I.** (2019). Prevalence of Failed Inferior Alveolar Nerve Block (IANB) in Achieving Pulpal Anaesthesia in Mandibular Molars with Symptomatic Irreversible Pulpitis. In Egyptian Dental Journal (Vol. 65, Issue 1, pp. 771–776). https://doi.org/10.21608/edj.2019.72859
13. **Ibrahim, H., Lyons, K. M., Armfield, J. M., & Thomson, W. M.** (2017). Performance of the Index of Dental Anxiety and Fear in a population-based sample of adults. In Australian Dental Journal (Vol. 62, Issue 4, pp. 478–484). https://doi.org/10.1111/adj.12541
14. **Iwanaga, J., Choi, P. J., Vetter, M., Patel, M., Kikuta, S., Oskouian, R. J., & Tubbs, R. S.** (2018). Anatomical Study of the Lingual Nerve and Inferior Alveolar Nerve in the Pterygomandibular Space: Complications of the Inferior Alveolar Nerve Block. Cureus. https://doi.org/10.7759/cureus.3109
15. **Jofré, J., & Münzenmayer, C.** (1998). Design and preliminary evaluation of an extraoral Gow-Gates guiding device. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics, 85(6), 661–664. https://doi.org/10.1016/S1079-2104(98)90032-4
16. **Jundt, J. S., Chow, C. C., & Couey, M.** (2020). Computed tomography-guided 3D printed patient-specific regional anesthesia. Journal of Dental Anesthesia and Pain Medicine, 20(5), 325. https://doi.org/10.17245/jdapm.2020.20.5.325
17. **Kojima, Y., Murouchi, T., Akiba, M., & Oka, T.** (2020). Ultrasound-guided inferior alveolar nerve block for postoperative analgesia after mandibular sequestrectomy: A single-center retrospective study. Journal of Clinical Anesthesia, 60(August), 39–40. https://doi.org/10.1016/j.jclinane.2019.08.026
18. **Kojima, Y., Sendo, R., Ohno, S., & Sugimura, M.** (2020). Ultrasound-guided inferior alveolar nerve block for trismus during dental treatment: a case report. JA Clinical Reports, 6(1), 20–23. https://doi.org/10.1186/s40981-020-00400-0
19. **Kuzin, A. V., Semkin, V. A., & Dydykin, S. S.** (2015). Scientific anatomical rationalefor lower teeth local anesthesia. Stomatologiya, 94(4), 35. https://doi.org/10.17116/stomat201594435-38
20. **N., Caillieux.** (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).
21. **Rabinovich, S. A., Vasil'ev, Y. L., & Kuzin, A. N.** (2018). Anatomic rationale for clinical efficacy of intraosseous mental nerve anesthesia. Stomatologiya, 97(2), 41. https://doi.org/10.17116/stomat201897241-43
22. **Rajvanshi H., Ernest S., Hafsa Effendi H., Afridi S., Chhabra M., N. K. N.** (2016). Failure of inferior alveolar nerve block (ianb) and techniques to avoid it. European Journal of Biomedical and Pharmaceutical Sciences, 3(9), 207–210.
23. **Thangavelu, K., Kannan, R., & Kumar, Ns.** (2012). Inferior alveolar nerve block: Alternative technique. Anesthesia: Essays and Researches, 6(1), 53. https://doi.org/10.4103/0259-1162.103375
24. **Tiol, M., Realizar, P., & Dentales, E.** (2010). Luz de maría lazo herrera.

25. **Ushnitsky, I. D. Chakhov, A. A.** (2020). Method of mandibular anesthesia (Patent No. RU 2727580 C1).

26. **Ushnitsky, I. D., Chakhov, A. A., Vinokurov, M. M., Yurkevich, A. V., Savvina, I. L., & Nikitin, Y. G.** (2018). Modern concept of pain syndrome and dental anxiety pathophysiology and prevention. Stomatologiya, 97(6), 67. https://doi.org/10.17116/stomat20189706167

27. **Won, Y.-J., & Kang, S.-H.** (2017). Application of augmented reality for inferior alveolar nerve block anesthesia: A technical note. Journal of Dental Anesthesia and Pain Medicine, 17(2), 129. https://doi.org/10.17245/jdapm.2017.17.2.129

28. **Yuan, S., Freeman, R., Hill, K., Newton, T., & Humphris, G.** (2020). Communication, Trust and Dental Anxiety: A Person-Centred Approach for Dental Attendance Behaviours. Dentistry Journal, 8(4), 118. https://doi.org/10.3390/dj8040118

29. **Zandi, M., & Seyedzadeh Sabounchi, S.** (2008). Design and development of a device for facilitation of Gow-Gates mandibular block and evaluation of its efficacy. Oral and Maxillofacial Surgery, 12(3), 149–153. https://doi.org/10.1007/s10006-008-0126-4