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by Dr. Manfred Nilius

Analysis of patient surveys regarding the use of the anesto device for intraosseous anaesthesia in dental and oro-maxillofacial procedures

bjective

The objective of this study was to assess the effectiveness of intraosseous anaesthesia (IO) as a primary technique or in combination with infiltration or nerve block anaesthesia in dental or oral surgical procedures and to test the handling of the ANESTO device.

Introduction

Intraosseous (IO) injection enables the deposition of local anaesthetic directly into the bone tissue surrounding the tooth. Intraosseous anaesthesia can also be applied in the edentulous jaw. The present study examines IO anaesthesia administered using the ANESTO device (W&H, Bürmoos). Essentially this involves penetration of the cortical bone using a motor-driven handpiece and rotating perforator needle. A cartridge of Ultracaine-DS-Forte (1:100,000 adrenaline) was used as the anaesthetic.

Study design and methodology

Intraosseous anaesthesia (IO) was administered five minutes before the start of treatment to 145 patients, 69 men and 76 women; the study group had various diagnoses and a mean age of 42 years. Ultracaine-DS-Forte (1:100,000 adrenaline) was used as an anaesthetic. Dental and oral surgery procedures were classified in accordance with the overview below, local regions, and gender. In cases where local pain control was inadequate, infiltration anaesthesia (IA) or nerve block anaesthesia (IAN) was additionally administered. Depending on the indication, the procedure was documented using photography.

It is difficult to evaluate IO when it is used with supplementary conventional anaesthesia. Therefore, the present study used a survey to assess the satisfaction of patients who were administered supplementary anaesthesia whilst using the ANESTO system. All patients had received local anaesthesia for dental or oral surgery procedures in the past. The subjects were asked whether they would choose the ANESTO method in future as part of their anaesthesia(response: YES) or whether they would decline it (response: NO).

IO injection technique

Injection in the dentate jaw

The IO injection was performed using the ANESTO system. The planned perforation site was topically anaesthetised with a spray of 2% lidocaine. The planned injection site was located at the intersection of the buccal or labial horizontal line with the interdental vertical line, about 2 mm above the mucogingival junction in the attached gingiva. In case of attachment loss of the epithelial cuff, the injection site was positioned in the mucosa.

The perforation was performed perpendicular to the cortical plate. The tip of the needle was pressed to this point before starting rotation. Drilling without water cooling was performed at a maximum speed of 25,000 rpm while applying slight pressure against the cortical edge. After





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Tooth region	Number of procedures	VAS at puncture	Duration of anaesthesia	Supplemental anaesthesia	Response to method YES/NO	
UM	6	2	20	No	100	
UP	4	2	10	No	100	
UC	2	3	10	No	80/20	
UI	7	3	10	No	80/20	
LI	4	4	5	No	50/50	
LC	2	3	5	No	70/30	
LP	3	3	10	No	80/20	
LM	4	3	10	No	70/30	

perforation of the cortical bone, the anaesthetic was dispensed without applying pressure. The perforation site was covered using sterile cotton gauze with CHX gel to reduce risk of potential haemorrhage and to disinfect the perforation site. In soft bone, the needle was used up to 3 times. In callus bone, the injection needle was switched after each drilling. If local pain control was insufficient after 5 minutes, an additional type of anaesthesia was used.

Injection in partially edentulous or edentulous jaw

In edentulous and partially edentulous patients, the bone was perforated in a submentovertical or transcrestal direction, depending on the transversal and horizontal bone anatomy. In general, the perforation site corresponded to the region to receive surgery, and the direction of perforation depended on the type of procedure. For implantation, for instance, instillation followed the implant axis. In root tip resection, the trepanation with instillation was performed in a horizontal direction. Patients with a history of heart disease or hypertension were excluded from the study.

Results

1. Dental procedures (conservative and prosthetic

treatments)

A total of 22 patients received dental treatment and IO anaesthesia. In some patients, several regions were anaesthetised. The procedures included preparations for veneers, Cerec crowns, circular crowns and fillings. The following tooth regions were differentiated: UM (upper molar), UP (upper premolar), UC (upper canine), UI (upper incisor), LI (lower incisor), LC (lower canine), LP (lower premolar), and LM (lower molar).

Table 1

Patients were asked about pain during the IO perforation (VAS during perforation), the duration of anaesthesia [5 min intervals] and a general assessment of the method [recommend: yes/no]. Supplemental local anaesthesia was also recorded (IA: Infiltration anaesthesia; IAN: Inferior alveolar nerve block).

In general, needle insertion was considered fairly painless by the majority of patients (VAS 1-3; 75%). About 25% of respondents reported moderate pain (VAS 4). Regarding the local duration of anaesthesia, maximum effectiveness was achieved after about 5 minutes, with duration of about 20 minutes after injection of 1 cartridge of Ultracaine DS Forte 1:100,000 adrenaline. After this time, reinnervation took place in conjunction with an increasing sensation of pain. Positive responses to the method were particularly common for injections in the maxilla. The



	Tooth region	Number of procedures	VAS during puncture	Supplemental anaesthesia	Response to method YES/NO
	UM	4	3	IA	90/10
	UP	5	2	IA	95/5
	UC	2	2	IA	100
	UI	2	2	IA	100
	LI	0	N/A	N/A	N/A
	LC	2	3	IA/IAN	70/30
	LP	4	3	IA/IAN	75/25
I	LM	6	3	IA/IAN	75/25

Table II

method was recommended by 80-100% of the respective patients. For the mandibular premolar and molar region, a majority of 70-80% recommended the use of IO. At 50%/50%, IO for anaesthesia in the anterior mandibular area was not favoured over conventional methods.

2. Treatment of infected teeth, root canal treatment, (hot teeth)

A total of 25 patients received endodontic treatment under IO anaesthesia. In this group, IO was used for additional pain control before infiltration or nerve block anaesthesia. In all patients, the interapical regions of the adjacent teeth were also anaesthetised. The following tooth regions were differentiated: UM (upper molar), UP (upper premolar), UC (upper canine), UI (upper incisor), LI (lower incisor), LC (lower canine), LP (lower premolar) and LM (lower molar).

In addition, patients were asked to generally assess the method [recommend: yes/no]. Supplemental local anaesthesia was also recorded as in Table I [IA/IAN].

The bone trepanation associated with IO was considered fairly painless by the majority of patients (VAS 1-3; 100%). IO in the mandible was reported to be somewhat more painful than IO in the maxilla. Since infiltration anaesthesia (IA) or mandibular nerve block (IAN) was administered after IO, the duration of local anaesthesia could not be reliably determined. Positive responses to the method were particularly found for injections in the maxilla, with recommendations from 90-100% of respondents. For the mandibular premolar and molar region, a majority of 70-75% recommended the use of IO. IO was not administered for anaesthesia of the mandibular anterior region.

3. Surgical procedures

In oral and maxillofacial surgery, IO application was generally preceded by nerve block (IAN) in the mandible or infiltration anaesthesia (IA) in the maxilla.

In total, 109 patients received surgical treatment with IO anaesthesia. In some patients, several regions were anaesthetised. The procedures included periodontal surgeries [4], extractions [15], implantations [43], osteotomies [15] and root tip resections [12]. The following intraoral regions were differentiated: UM (upper molar), UP (upper premolar), UC (upper canine), UI (upper incisor), LI (lower incisor), LC (lower canine), LP (lower premolar) and LM (lower molar). Table III shows the results by surgical procedure. A general assessment of the method was requested [recommend: yes/no]. Any supplemental local anaesthesia was also noted.

Periodontal surgery

Positive responses to the method were particularly reported for injections in the premolar regions of the maxilla and mandible (75%/25%). For all other regions, the results were 50%/50%.

Extraction

IO as a supplement to conventional pain control was experienced as positive by the majority of respondents. With a result of 50%/50%, the use of IO for the maxillary premolars and the mandibular anterior region was not preferred. We did not administer IO for anaesthesia of the mandibular canines.



Periodontal surgery				Extractions		
Tooth region	Number of procedures	Supplemental anaesthesia	Response to method	Number of procedures	Supplemental anaesthesia	Response to method
UM	4	IA	50/50	4	IA	100
UP	4	IA	75/25	2	IA	50/50
UC	4	IA	50/50	1	IA	100
UI	4	IA	50/50	2	IA	100
LI	4	IA/IAN	50/50	2	IA/IAN	50/50
LC	4	IA/IAN	50/50	0	N/A	N/A
LP	4	IA/IAN	75/25	2	IA/IAN	100
LM	4	IA/IAN	50/50	2	IA/IAN	100

Implantation				Osteotomy		
Tooth region	Number of procedures	Supplemental anaesthesia	Response to method	Number of procedures	Supplemental anaesthesia	Response to method
UM	7	IA	100	3	IA	70/30
UP	5	IA	100	3	IA	100
UC	4	IA	100	2	IA	100
UI	5	IA	100	0	N/A	N/A
LI	3	IA/IAN	70/30	1	IA/IAN	100
LC	4	IA/IAN	100	1	IA/IAN	100
LP	4	IA/IAN	100	4	IA/IAN	100
LM	7	IA/IAN	100	2	IA/IAN	100

Table III

Implantation

IO as a supplement to nerve block or infiltration anaesthesia was experienced as 100% positive by the majority of patients. With results of 50%/50%, the use of IO for mandibular premolar anaesthesia was not preferred. We did not administer IO for anaesthesia of the mandibular canines.

Root tip resection

A positive response to the method was reported particularly for injections in the maxillary and mandibular premolar regions and the maxillary incisors (100%). For the mandibular molar region, the results were 75%/25%.

Discussion

Primary IO has been known for a long time; it was the subject of publications early in the last century by NOGUE [1907] and MESSELINK [1910] and later by MAGNES [1968]. The clinical studies relevant to the ANESTO device were primarily conducted using the STABIDENT system and predominantly focused on indication [COGGINS et al. 1996; KLEBER et al. 2003] or studied the differences between the employed anaesthetic agents [GROSS et. al 1988; GUGLIELMA et al. 1999].

IO for primary anaesthesia

In dental procedures of non-infected teeth, LEONHARD [1995] observed effective pain control in 95% to 99% of

cases using the Stabident system. For extractions, the reported success rate was 90%.

Our results with the ANESTO device demonstrated sufficient elimination of pain in the maxillary region (80-100%); these results are very similar to the values reported in literature. The success of pain control in the mandibular molar region is reported in the literature at around 75%. Our results for the ANESTO device confirm these results as well. In the literature, about 60% of the study group experienced lip numbness after IO, while in our study, anaesthesia with lip numbness was observed only for IO in the mandibular premolar region.

As an exclusive means of pain control in conservative and prosthetic indications, IO therefore seems primarily advantageous for the treatment of individual teeth rather than for extensive and time-intensive restoration procedures. Because of the anatomic relationships, inexperienced surgeons can more easily achieve maxillary anaesthesia than mandibular anaesthesia. In our study, conservative quadrant restoration was performed in the maxilla, and a successive treatment workflow with reinjection or a combination with infiltration anaesthesia (IA) is recommended.

The results of the present study show that intraosseous injection as a primary technique achieves sufficient pulpal anaesthesia of non-infected teeth in about 80-90% of cases. The duration of local anaesthesia drops continuously after a maximum effectiveness lasting 5-10 minutes, but

anaesthesia can last for up to one hour. Our results confirm the published results for the ANESTO device.

In the anterior mandible, anaesthesia was achieved in 78% of cases. It should be noted that in the anterior mandible, IO with the ANESTO device is only successful when using a steep angle and exercising greater care to avoid bicortical penetration in the direction of the floor of the mouth. This procedure should therefore be reserved for exceptional cases. The problem of bicortical perforation could, however, be technologically resolved by combining the insertion mechanism with a sensory feedback mechanism.

Although the same volume of anaesthetic solution (1.8 ml of anaesthetic) was applied at each site, the volume of stored anaesthetic seems to drop faster in mandibular medial and lateral incisors than in premolars and molars. This is likely a result of the smaller medullary space between the facial and lingual cortical plates. For the mentioned reasons, the duration of anaesthesia varies greatly in the lower incisor region.

With the same volume of anaesthetic, the duration of sufficient anaesthesia in the mandibular anterior region is reported in the literature to range from 27 to 59 minutes. For conservative dental restoration in the mandible, a supplemental inferior alveolar nerve block (IAN) should therefore be administered.

Despite the positive patient response, the success rate of IO is less than 100%. This can be caused by insufficient perforation of the cortical bone or insufficient intracancellous distribution of the anaesthetic. In addition, the medullary space can exhibit anatomic variations with various levels of perfusion. According to LEONHARD, the medication distribution in the medullary space in the maxillary molar region is about twice as high as in the mandibular molar region.

Gingival and bone requirements

The height of the attached gingiva is used as a guide for precise IO administration. Generally, the mean width of the attached gingiva in the canine and anterior region is approximately 4.8 mm in the maxilla and 3.6 mm in the mandible. In the first molar region, the mean values are 3.4 mm for the maxilla and 2.4 mm for the mandible. The gingival widths for third molar region have not been clearly quantified but are generally below those of the other molars. In such anatomical conditions, injection at the mucogingival junction is recommended. The risk of rotation-related damage to the mucosa is distinctly reduced in the ANESTO system thanks to the protective cap, but there is still a risk of epiperiosteal or submucosal haematoma with consequent wound infection.

There seems to be no clear threshold indicating

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the suitability of intraosseous anaesthesia in the posterior molar region versus its relative contraindication in unfavourable anatomic conditions as a result of callus bone.

"Breakthrough" sensation/perforation

Bone tissue and tooth tissue feel noticeably different during injection. It must be noted that the "breakthrough" sensation depends on the strength of the buccal cortical bone and on the gingival thickness. In general, cortical bone is stronger in the mandible than in the maxilla. DENIO et al. [1992] reported the mean width of the cortical bone to be 2.7 to 3.0 mm at the height of the mandibular molars. GOASLIND [1977] reported the mean thickness of the attached gingiva to be 1.25 mm. Together, these data indicate that the cortical bone and attached gingiva have a width of between 3.95 to 4.25 mm. A medium perforator length of 8 to 9 mm is therefore recommended to easily reach the medullary space.

IO in implantology

Gingival width varies considerably in edentulous patients. Depending on the prosthesis and the extent of vertical and transverse bone atrophy, the medullary space may be additionally reduced. Therefore, only low volumes of anaesthetic can be injected, which distinctly limits the duration of the surgical procedure when using IO alone. This may be an advantage to patients, however, such as when the procedure is small and limited in extent. Navigated implantation is one example of such a procedure. As a result of the exact three-dimensional preplanning, IO enables the minimally invasive implantation to be performed with minimal anaesthesia as well. Given sufficient bone volume and appropriate preplanning, this procedure offers three further advantages. First, the intraosseous installation provides initial information about the thickness of the cortical bone (breakthrough) and helps the decision between crestal burs and taps for the further implantation procedure. Second, the volume of injected anaesthetic can assist in estimating the volume of the medullary space and, if needed, optimise the decision on implant bodies (tapered, straight, self-cutting tip, etc.). Third, local vasoconstriction can be achieved by the use of adrenergic additives in the anaesthetic (generally adrenaline 1:100,000 - 1:200,000). Experienced surgeons must initially get used to this partial arrest of blood flow,

but it allows virtually bloodless procedures. Systemic side effects must be noted, however.

Adverse reactions

Increased heart rate

Various authors [MOLLER & COVINO (1993); CANNELL et al. (1993); GUGLIELMO et al. (1999)] have reported increased heart rate following IO injection. REPLONGE et al. reported a subjectively experienced increase in heart rate in 6% of patients after primary IO in the mandibular molar region. The anaesthetic was 2% lidocaine (1:100,000 adrenaline). The echocardiographic examinations confirmed this subjective assessment in 67% of cases and supported the validity of subjective experience. Like comparable IO methods, ANESTO® IO is subject to the pharmacokinetics of the employed medications. The informed consent discussion should take this into account. Care should also be exercised in patients with contraindications [BOURKE; 1974].

Lip numbness in mandibular injections

Temporary lip numbness with IO is reported for 58% of cases in the literature [DUNBAR; 1996]. The phenomenon is generally observed when IO is administered in the mandibular premolar region. Lip numbness is rarely found with injections distal to the mandibular first molar. The majority of patients in DUNBAR's study reported *less extensive and less profound* lip numbness than in conventional nerve block. Given the small number of cases in our study group with conservative indications, our lip numbness data are not very meaningful, however, and this topic should be revisited on the basis of further studies.

Needle breakage

Needle breakage was observed in 5 cases. In all of these cases, the metal needle broke at the junction to the plastic shaft. The metal needle was easily removed.

Other notes

Intraosseous instillation may lead to temporary swelling around the puncture site. In case of reflux of the anaesthetic or premature pressure on the cartridge syringe at the beginning of trepanation, they can be located subperiostally, epiperiostally or subgingivally. The literature reports this phenomenon in about 3% of cases. DA



Dr. Manfred Nilius graduated with his MD in Germany (RUB; Bochum) and France (Louis-Pasteur-University) in 1993 and his DMD 1999 in Munich. He has been Chairman of the European Institute for facial and dental aesthetics, [EUGEZA Birmingham; Dortmund] since 2005 and Director of the Niliusklinik in Dortmund (www. niliusklinik.de). Additionally he has been awarded: the Annual award for Chemistry of the German "Jugend-Forscht"-Association, the Annual Dentsply-Prize of the German Association for Dentistry and Oral and Maxillofacial Surgery (DGZMK/ BZÄK 2000), as well as presenting Best-Prize-Scientific-Poster during the NB-World-Tour Germany (Dresden 2006), NB-WT BeNeLux (Maastricht 2008) and Best-Poster Worldwide (Las Vegas 2007).