

## OPHTHALMOLOGICAL COMPLICATIONS AFTER LOCO-REGIONAL ANAESTHESIA OF SUPERIOR ALVEOLAR NERVES – LITERATURE REVIEW

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### Abstract

The superior alveolar nerves ensure the innervation of the maxillary teeth either directly or indirectly, after the formation by anastomoses of the superior dental plexus (the superior alveolar plexus). In dentistry, intraoral loco-regional anaesthesia of these nerves is particularly common, being necessary for various conservative or radical therapeutic procedures at the level of the upper teeth and for dento-alveolar surgical procedures at the maxillary level. During the loco-regional anaesthesia of the superior alveolar nerves, various accidents and complications can occur, some of them being ophthalmological, due to anatomical variations, proximity to the orbital region and sometimes due to technical errors. The present study proposes a review of the recent specialized literature on the occurrence of these ophthalmic complications in order to draw the attention of clinicians to their aetiology and management.

*Key words:* oral rehabilitation, remote complications, haematoma, diplopia, mydriasis

### Introduction

The superior alveolar nerves are direct or indirect branches of the maxillary nerve that provide together innervation to the maxillary teeth. Thus, the posterior superior alveolar nerves detach from the maxillary nerve and are distributed to the maxillary molars. Middle superior alveolar nerves are inconstant (they are present in 23-72% of the cases). When middle superior alveolar nerves do exist, they

emerge from the infraorbital nerve and they are distributed to the maxillary premolars. Anterior superior alveolar nerves derive from the infraorbital nerve and are distributed to the maxillary incisors and maxillary canine. In case of absence of the middle superior alveolar nerves, the anterior superior alveolar nerves also innervate the maxillary premolars. Sometimes the superior alveolar nerves form through anastomoses a nervous

plexus, the superior dental plexus (the superior alveolar plexus) from which dental branches are distributed to all the maxillary teeth [1-3].

Loco-regional anaesthesia of the posterior superior alveolar nerves is performed by depositing the anaesthetic at the level of the maxillary tuberosity. Achieving anaesthesia of the other superior alveolar nerves requires local infiltration in the infraorbital canal.

In the current dental practice of oral rehabilitation it is necessary to obtain an effective and uncomplicated loco-regional anaesthesia in order to achieve pain relief and to relieve the fear and anxiety of the patients.

As a result of loco-regional anaesthesia of the superior alveolar nerves, a wide range of complications can occur, such as: hypersensitivity, allergy, toxicity, haematoma, trismus, paraesthesia, neuralgia, palpebral ptosis, transient paresis translated by double vision (diplopia), difficulty in the abduction of the affected eyeball or penetration of the eyeball (with resulting pain), chemosis (oedema of the conjunctiva), haemorrhage in the vitreous body, mydriasis (dilation of the pupil) and loss of vision [4-6].

Cases with complications after anaesthesia of the superior alveolar nerves occur quite quickly, a few minutes after the injection of the anaesthetic agent, but benefit from a complete resolution, without sequelae, after the disappearance of the effect of anaesthesia [6].

Under these conditions, practitioners must know and present to patients the possible complications after loco-regional anaesthesia that occur in daily practice.

The purpose of this article is to present a review and systematization of ophthalmological complications following anaesthesia of the superior alveolar nerves in dental medical practice, as well as their management, according to data from recent specialized literature.

### **Materials and methods**

A systematic search in the scholarly literature was conducted, in order to identify articles which presented ophthalmologic complications following intraoral loco-regional anaesthesia. Thirty-four summaries of scientific works and forty-nine in extenso articles, published after 2000, were accessed through ISI Thomson Web of Knowledge and PubMed databases using the following keywords: ophthalmologic complication, loco-regional anaesthesia, superior alveolar nerves. Any type of article, case report, review or clinical study on human subjects was included. Additionally, a manual search in three books was performed. Of these scholarly papers, forty-five were considered to be relevant for this study.

### **Results and discussion**

Complications associated with loco-regional anaesthesia performed in dental medicine can be systemic and local. Common systemic reactions reported are: psychogenic reactions, systemic toxicity, allergy and methemoglobinemia. The usual local complications associated with loco-regional anaesthesia are: pain at injection, needle rupture, prolongation or lack of anaesthesia, different sensory disorders, trismus, infection, edema, bleeding, haematoma, vascular and soft lesions and remote complications, ophthalmological complications [4, 7-8].

We will continue to present only the remote (ophthalmological) complications and the related discussions on these complications following the anaesthesia of the superior alveolar nerves, according to recent data from specialized literature.

Thus, a number of ocular and extraocular symptoms can occur by passive diffusion of the anaesthetic into the orbit during the loco-regional anaesthesia of the posterior superior alveolar nerves at the level of the maxillary tuberosity. The symptoms include: paralysis of the extrinsic muscles of the eyeball, with associated diplopia and even temporary blindness by the involvement of the optic nerve. Moreover, manifestations similar to Horner syndrome may also occur, including enophthalmos (recession of the eyeball), miosis (constriction of the pupil) and palpebral ptosis, and even occasionally temporary unilateral loss or unilateral blurring of vision [8].

Fortunately all these complications are transient, they disappear with the disappearance of anaesthesia, but the patient should be aware of their possible occurrence.

After Alamanos C et al., 2016 [9], most ophthalmological complications following loco-regional anaesthesia in dental medicine manifest themselves in the form of double vision (diplopia), and 8% of complications have caused permanent functional damage, either in the form of vision impairment or in the form of anisocoria (pupils of different sizes). The authors of the study showed that these eye complications as a result of local dental anaesthesia can be considered rare events, which usually exhibit a low intensity.

However, the visual function could become permanently impaired [9].

Other papers have also pointed out that diplopia is one of the most common complications following loco-regional anaesthesia of the superior alveolar nerves alongside of ophthalmoplegia, palpebral ptosis and mydriasis [4, 10-12].

Aguado-Gil JM et al., 2011, showed that the frequency of diplopia was 65% [11].

According to data published by several authors, the most common reported ophthalmological complication, diplopia, was mainly associated with loco-regional anaesthesia of posterior superior alveolar nerves [13-16]. After Von Arx T et al., 2014 [17], the most common reported ophthalmological complication was diplopia with a prevalence of 39.8%. The study states that diplopia was, particularly, a consequence of the paralysis of the lateral rectus muscle of the eyeball. Other relatively common ophthalmological complications described were: palpebral ptosis with a frequency of 16.7%, mydriasis with a frequency of 14.8% and amaurosis (loss of sight) with a frequency of 13%. These complications, completely reversible, were mainly associated with loco-regional anaesthesia of posterior superior alveolar nerves, in 40.3% of the cases and in far fewer cases with the anaesthesia of the middle superior alveolar nerves, which occurred in 6.9% of the cases, respectively. Only in 1.4% of the cases the complications followed anterior superior alveolar nerve anaesthesia [17].

In addition to visual perception, the eyes are critical components of facial expression and non-verbal communication. Visual disturbances can lead to a sense of uncertainty and psychological pressure,

especially when such an eye manifestation occurs suddenly and unexpectedly [17].

Moreover, in the medical literature there have also been described situations in which other nerves may be inadvertently affected during intraoral local anaesthesia, leading to anaesthetic complications away from the oral cavity. These complications include transient paralysis of the oculomotor nerve and transient loss of vision. Thus, we must keep in mind that the bone plate separating the infraorbital canal from the contents of the orbit thins posteriorly until it disappears. This particular situation of the thinning separating bone plate favours complications after the anaesthesia of the inferior branch of the oculomotor nerve which is distributed to the inferior rectus muscle and to the oblique muscles of the eyeball. Different manifestations might occur, like: a transient paresis translated by double vision (diplopia) or penetration of the anaesthetic into the eyeball with the onset of pain, haemorrhage and mydriasis. Therefore, clinicians should also consider these possible ophthalmological complications following intraoral anaesthesia in dental medicine [1, 5, 18-19].

Knowledge of these possible remote complications should be a warning to the dentist about the importance of compliance with loco-regional anaesthesia techniques and protocols.

Vascular complications such as haemorrhage or haematoma may occur as a result of posterior and anterior superior alveolar nerves anaesthesia and they may spread as extraoral or intraoral swellings (orbital swellings). If a vein is affected, the bleeding will be minimal, and if an artery is affected, a rapid bleeding will occur with

the formation of the haematoma that can be quite locally or remotely extended [8].

In the event of these vascular complications the patient should be observed for one to two days and antibiotic therapy should be instituted because there is a risk of per secundam infection of the haematoma.

The following mechanisms for the occurrence of ophthalmological complications following intraoral loco-regional anaesthesia were mentioned in the medical literature: intravascular injection of the anaesthetic, reflex vasospasm of the central artery of the retina, anaesthesia of the superior ganglion of the cervical sympathetic chain, diffusion of the anaesthetic from the infratemporal region into the orbit through the lower orbital fissure or by the use of a long needle for anaesthesia. Multiple anatomical variations and vascular anastomoses may promote intravascular injection of the anaesthetic [10-11, 14, 17].

Vascular morphological variations regarding the origin, trajectory and distribution of the external carotid artery and its anterior and terminal branches are presented in the scientific literature. Dental clinicians should be aware of these variations of the external carotid artery and the existing morphological patterns in order to avoid or lessen possible ophthalmological complications arising from intravascular injection of the local anaesthetic [20-26].

In order to minimize the possible complications mentioned above, it is also of utmost importance the knowledge of the various topographic morphological patterns of the alveolar nerves, their canals and the trigeminal exit anatomical landmarks (foramina) [27-32].

Particular morphologic patterns both at vascular level and at bone level (such as the relation of the mandible to the maxillae) might suggest predisposition to certain ailments and complications [33].

Therefore, when performing loco-regional anaesthesia for superior alveolar nerves it is best not to underestimate the importance of the neurovascular topographic patterns. Although experimental animal models have been much discussed in the dental medical literature, we believe that experimental human models would be much more beneficial in preventing complications [34-38].

The diffusion of local anaesthetics from the infratemporal region into orbit is possible due to the absence of the anatomical barriers and is favoured by the supine position of the head during loco-regional anaesthesia. In addition, it should also be taken into account the high diffusion properties of local anaesthetics [18, 39].

Most of the ophthalmological complications following loco-regional anaesthesia of the superior alveolar nerves had a rapid onset, immediately or within minutes after administration of anaesthesia [17].

Compared to the onset of ophthalmic complications, their duration was more inhomogeneous and sometimes even longer than the duration of anaesthesia [40].

However, there are studies that show that these ophthalmological complications following intraoral loco-regional anaesthesia are rare, 0.04-0.1% of all complications. This reduced percentage may also be due to the fact that these ophthalmological complications are

transient and have been very rarely reported [41].

Transient paralysis of the cranial, oculomotor, trochlear and abducens nerves, which innervate the extrinsic muscles of the eyeball, were considered by several authors as being frequent ophthalmological complications [10, 18, 41-42]. The lateral rectus muscle of the eyeball, which is innervated by the abducens nerve, is the muscle most commonly affected by the diffusion of the anaesthetic into the orbit (66.6% of all these paralysees), due to its closer relationship to the lower orbital fissure [43].

Some authors stated that these ophthalmological complications following anaesthesia of the posterior and middle superior alveolar nerves are more common than those complications occurring after anaesthesia of the inferior alveolar nerve [39, 44].

The precautions that the dentist should take into account in order to prevent ophthalmological complications following loco-regional anaesthesia are: avoiding injections of intravascular anaesthetic, performing the early injection suction test and slow administration of anaesthetic fluid, knowledge of neurovascular anatomical structures and proper use of appropriate anaesthesia techniques [44].

In case the ophthalmological complications do not disappear after five to six hours, the dental practitioner should refer the patient to the ophthalmologist for appropriate treatment [45].

### Conclusions

Ophthalmological complications following loco-regional anaesthesia of the superior alveolar nerves in dental medicine

should not be neglected, even if they are not very common. The rarest ophthalmological complications are consecutive to anaesthesia of anterior superior alveolar nerves.

Although most of these complications are transient and disappear after the anaesthetic effect has stopped, the clinician should be aware of their aetiology

and pathophysiology and ensure their appropriate management.

#### Author contribution

Author #1 (Dan Ionuț Sălăvăstru), author #2 (Maria Justina Roxana Vîrlan), author #3 (Victoria Roxana Ivașcu) and author #4 (Alexandru Poll) have equal contributions to this paper and thus they are main authors.

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