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# Ophthalmologic complications after intraoral local anesthesia

## An analysis of 65 published case reports

**KEYWORDS**
Ophthalmologic complication, intraoral local anesthesia, literature analysis

**SUMMARY**

Introduction: The first ophthalmologic complication in conjunction with a dental anesthesia was reported in 1936. The objective of the present study was a detailed analysis of case reports about that topic.

Material and methods: After conducting a literature search in PubMed this study analyzed 108 ophthalmologic complications following intraoral local anesthesia in 65 case reports with respect to patient-, anesthesia-, and complication-related factors.

Results: The mean age of the patients was 33.8 years and females predominated (72.3%). The most commonly reported complication was diplopia (39.8%), mostly resulting from paralysis of the lateral rectus muscle. Other relatively frequent complications included ptosis (16.7%), mydriasis (14.8%) and amaurosis (13%). Ophthalmologic complications were mainly associated with block anesthesia of the inferior alveolar nerve (45.8%) or the posterior superior alveolar nerve (40.3%). Typically, the ophthalmologic complications in conjunction with intraoral local anesthesia had an immediate to short onset, and disappeared as the anesthesia subsided.

Discussion and conclusion: The increased number of ophthalmologic complications after intraoral local anesthesia in females may suggest a gender effect. Double vision (diplopia) is the most frequently described complication, which is usually completely reversible like the other reported ophthalmologic complications.

## Introduction

Local anesthetics represent dentistry's most important drugs, and intraoral local anesthesia is probably the most frequent of all dental interventions (Malamed 2006). Nevertheless, complications such as anesthesia failures, hematomas, infections, neural injuries or adverse reactions are very rare (Williams et al. 2011, Steenen et al. 2012). Details about the frequency of ophthalmologic complications following dental anesthesia are seldom reported in the literature. In a prospective study, Hidding & Khoury (1991) reported only two patients with ophthalmologic complications in a total of 1518 dental anesthesia (0.13%). Peñarrocha & Sanchis (2000) described only 14 patients with ophthalmologic complications in an observation period of 15 years with about 50,000 intraoral anesthesia (0.03%).

Besides visual perception the eyes constitute critical components of facial expression and non-verbal communication. Disorders of the eyesight can result in a feeling of uncertainty and psychological pressure, particularly when an ocular reaction occurs suddenly and unexpectedly.

Typical ophthalmologic complications after intraoral local anesthesia include (in alphabetical order): accommodation disturbance, amaurosis (loss of sight), diplopia (double vision), enophthalmos (recession of eyeball), miosis (contraction of pupil), mydriasis (dilation of pupil), ophthalmoplegia (paralysis of all muscles responsible for eye movements), and ptosis (drooping of upper eye lid). Generally, the ophthalmologic complications in conjunction with intraoral local anesthesia have an immediate to short onset, and disappear as the anesthesia subsides. These symptoms are most often attributed to the anesthetic solution reaching the orbit or nearby structures (Boynes et al. 2010).

Since the first description of an ophthalmologic complication after dental anesthesia by Brain in 1936, several case reports and review articles have been published (Madrid et al. 1990, Peñarrocha & Sanchis 2000, Choi et al. 2009, Aguado et al. 2011, Williams et al. 2011, Steenen et al. 2012).

The objective of the present article is to analyze in detail case reports about ophthalmologic complications after intraoral local anesthesia.

## Material and methods

Initially, a PubMed search was performed using English key words (Fig. 1). In addition, the references of selected full text articles were screened to identify other articles related to ophthalmologic complications following intraoral local anesthesia. Only articles published in English were accepted for this analysis. Any type of article, i.e. case report, case series, clinical study, review article, was included provided it yielded information concerning the ophthalmologic complication related to intraoral local anesthesia. Articles based on non-human subjects were excluded. Reports about facial palsy and periorbital blanching were ignored since those complications involve periorbital structures rather than the eye directly. Altogether 44 articles with a total of 65 case reports fulfilled the inclusion criteria.

The following data, if available, were extracted from each case report (Tab. I): age and gender of patient; application site of the intraoral local anesthesia; type, quantity and concentration of the local anesthetic; type and concentration of vasoconstrictor; gauge of injection cannula; type, onset and duration of the ophthalmologic complication.

## Results

Out of a total of 65 case reports with ophthalmologic complications following intraoral local anesthesia, 18 affected males (27.7%) and 47 females (72.3%). The mean age of the patients was 33.8 years, the median age was 31 years, and the age range was 4 to 73 years. Most patients were in the third or fourth decades of age (Fig. 2). In 37 patients only a single complication occurred, whereas 28 patients experienced multiple symptoms per manifestation (Tab. II). A total of 108 ophthalmologic complications were reported in those 65 patients (Tab. III). In 41.5% of the cases the left eye was affected while the right eye was affected in 35.4% of the cases (in 23.1% no such information was available).

Diplopia (43 cases, 39.8%) was the most frequently described ophthalmologic complication after intraoral local anesthesia, with a very high rate of females (81.4%). In 25 patients, diplopia was the only complication, whereas in the other 18 patients, diplopia was associated with one other or multiple ophthalmologic complications. Most often, diplopia was combined with mydriasis (10 cases) and/or ptosis (9 cases). In 30 out of the 43 cases with diplopia, information was available regarding the affected eye muscle. In 26 of these 30 patients (86.7%), a paralysis of the lateral rectus muscle or anesthesia of the abducens nerve, respectively were reported. With the exception of three cases, the diplopia had disappeared completely within six hours.

Ptosis was the second most frequent ophthalmologic complication with 18 case reports (16.7%). Females again predominated (72.2%). Regarding the duration, two thirds of the ptosis cases exhibited a complete remission within one hour. As a single complication, ptosis only occurred in one patient while in the other 17 patients ptosis was associated with other complications, most frequently with diplopia (in 10 patients) and/or mydriasis (in 9 patients). In four patients, diplopia was associated with Horner's syndrome. A mydriasis of the pupil was reported in 16 patients (14.8%) after intraoral local anesthesia, therefore it was the third-most frequently reported complication. In every third patient with mydriasis, it lasted longer than five hours. Amaurosis in conjunction with dental anesthesia was described in 14 patients (13%). In three of those cases, amaurosis did not show remission and remained permanent. The other reported complications like accommodation disturbance, enophthalmos, miosis and ophthalmoplegia were only observed in few patients.

The time period between anesthesia administration and onset of the eye complications ranged from immediate to four hours (Tab. III). Most frequently, an immediate onset was noted (Fig. 3). A wide variation was observed for the duration of the different ophthalmologic complications ranging from only five minutes up to four months (Tab. III). However, the majority of complications did not last for longer than five hours (Fig. 4).

The most frequent causes of ophthalmologic complications were block anesthesia of the inferior alveolar nerve (45.8%) and of the posterior superior alveolar nerve (40.3%) (Tab. IV). Data regarding injection needles was only presented in 31 cases (47.7%). Most commonly 25-gauge injection needles were utilized (Tab. V). Lidocaine (45.6%) and articaine (31.6%) were the most frequently applied local anesthetics (Tab. VI). The vast majority of anesthetics contained epinephrine as the vasoconstricting agent (87.2%), with a concentration of 1:100,000 as the most frequently administered (50.9%; Tab. VII). Information regarding the amount of administered local anesthetic was available in 46 cases. In 35 cases, the amount was ≤2 ml, in ten cases the amount ranged from 2.1 to 4 ml, and only in one case the amount exceeded 4 ml.

## Discussion

The present article analyzed 65 case reports of ophthalmologic complications after intraoral local anesthesia with regard to patient factors, type and agents of local anesthesia, and varieties of ophthalmologic complications. Among the 108 documented ophthalmologic complications, diplopia (39.8%) prevailed. Ptosis (16.7%), mydriasis (14.8%) and amaurosis (13.0%) were less frequent. Other ophthalmologic complications such as accommodation disturbance, enophthalmos, miosis and ophthalmoplegia were reported only in very few cases. In 37 patients (56.9%), only a single complication occurred, with diplopia again as the predominating symptom (24 cases).

It was striking that 72.3% of the evaluated patients were females suggesting the possibility of different anatomic features between genders (Steenen et al. 2012): anatomical variants (see

**Tab. I** Overview of all 65 case reports with ophthalmologic complications after intraoral local anesthesia

| # | Author(s) and year | Patient age | Patient gender | Intraoral local anesthesia (side) | Local anesthetic | Injection cannula | Ophthalmologic complication(s) | Onset of complication(s) | Duration of complication(s) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Cooper 1962 | 46 | Female | Inferior alveolar nerve (right) | 2.3 ml carbocaine 2% with 1:20,000 neo-cobefrin | N/A | Diplopia (lateral rectus m.) | 5 minutes | DI 5 hours |
| 2 | Blaxter & Britten 1967 | 16 | Female | Inferior alveolar nerve (right) | 2 ml procaine (% N/A) with 1:300,000 epinephrine | N/A | Amaurosis<br>Diplopia (medial rectus m.) | Immediate | AM 20 minutes<br>DI 10 minutes |
| 3 | Blaxter & Britten 1967 | 30 | Male | Inferior alveolar nerve (right) | N/A | N/A | Diplopia | N/A | DI 20 minutes |
| 4 | Blaxter & Britten 1967 | 39 | Male | Inferior alveolar nerve (left) | 3 ml procaine (% N/A) with 1:300,000 epinephrine | N/A | Amaurosis<br>Mydriasis | N/A | AM/MY some hours |
| 5 | Lavine & Stoopack 1968 | 7 | Male | Inferior alveolar nerve (right) | 1 ml butethamine with 1:100,000 epinephrine | N/A | Mydriasis<br>Ptosis | Immediate | MY/PT 30 minutes |
| 6 | Hales 1970 | 16 | Male | Posterior superior alveolar nerve (left) | 3 ml lidocaine 1% with epinephrine (concentration N/A) | N/A | Mydriasis | N/A | MY 4 days |
| 7 | Leopard 1971 | 25 | Female | Posterior superior alveolar nerve (right) | 2 ml lignocaine 2% with 1:80,000 epinephrine | 27-gauge | Diplopia (lateral rectus m.) | Immediate | DI 30 minutes |
| 8 | Rood 1972 | 24 | Female | Inferior alveolar nerve (right) | 1.5 ml lignocaine 2% with 1:80,000 epinephrine | N/A | Diplopia (medial rectus m.)<br>Ptosis | Immediate | DI 45 minutes<br>PT 20 minutes |
| 9 | Hyams 1976 | 34 | Female | Middle superior alveolar nerve (left) | (ml N/A) procaine with epinephrine (concentration N/A) | N/A | Diplopia (lateral rectus m.)<br>Mydriasis<br>Ptosis | N/A | DI 4 weeks<br>MY 2 weeks<br>PT >4 months |
| 10 | Campbell et al. 1979 | 34 | Female | Inferior alveolar nerve (left) | N/A | N/A | Miosis<br>Ptosis (Horner's syndrome) | 2 minutes | MI/PT 2 hours |
| 11 | Petrelli & Steller 1980 | 42 | Female | Middle superior alveolar nerve (right) | 1.8 ml mepivacaine 3% without vasoconstrictor | 27-gauge | Diplopia (medial rectus m.) | 5 minutes | DI 90 minutes |
| 12 | Norris 1982 | 17 | Female | Inferior alveolar nerve (left) | (ml N/A) prilocaine 3% with 0.03 IU felypressin | 27-gauge | Diplopia | Immediate | DI 10 minutes |
| 13 | Goldenberg 1983 | 58 | Male | Inferior alveolar nerve (left) | 1.8 ml lidocaine (% N/A) with 1:100,000 epinephrine | 27-gauge | Amaurosis<br>Diplopia | 3 minutes | AM/DI 20 minutes |
| 14 | O'Connor & Eustace 1983 | 61 | Female | Inferior alveolar nerve (right) | (ml N/A) lignocaine 2% with 1:80,000 epinephrine | N/A | Diplopia (lateral rectus m.)<br>Mydriasis | Immediate | DI 4 weeks<br>MY >4 weeks |
| 15 | Kronman & Kabani 1984 | 37 | Female | Anterior superior alveolar nerve (left) | (ml N/A) carbocaine (% N/A) (vasoconstrictor N/A) | N/A | Diplopia | 4 minutes | DI 50 minutes |
| 16 | Tomazzoli-Gerosa et al. 1988 | 21 | Female | Inferior alveolar nerve (right) | N/A | N/A | Amaurosis | Several hours | AM permanent |
| 17 | Fish et al. 1989 | 29 | Male | Inferior alveolar nerve (left) (Gow-Gates technique) | 1.8 ml lidocaine 2% with 1:100,000 epinephrine | N/A | Diplopia<br>Mydriasis<br>Ophthalmoplegia<br>Ptosis | 3 minutes | DI/MY/OP/PT 20 minutes |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | Goldenberg 1990 | 31 | Female | Posterior superior alveolar nerve (right) | 1.8 ml xylocaine (% N/A)% with 1:100,000 epinephrine | N/A | Accommodation disturbance<br>Diplopia (lateral rectus m.) | 40 minutes | AC/DI 3 hours |
| 19 | McNicholas & Torabinejad 1992 | 38 | Female | Posterior superior alveolar nerve (right) | 1.8 ml lidocaine 2% with 1:100,000 epinephrine | 27-gauge | Diplopia (lateral rectus m.)<br>Mydriasis | N/A | DI 80 minutes<br>MY N/A |
| 20 | Dryden 1993 | 33 | Female | Inferior alveolar nerve (right) (Gow-Gates technique) | (ml N/A) lidocaine 2% with 1:100,000 epinephrine | N/A | Diplopia<br>Ptosis | 30 seconds | DI/PT 45 minutes |
| 21 | Marinho 1995 | 25 | Male | Inferior alveolar nerve, superior posterior alveolar nerve (right) | 2 × 4 ml lignocaine 2% with 1:80,000 epinephrine | N/A | Diplopia (lateral rectus m.) | A few minutes | DI 3 hours |
| 22 | van der Bijl & Lamb 1996 | 14 | Female | Inferior alveolar nerve (left) | 1.8 ml lidocaine 2% with 1:80,000 epinephrine | N/A | Diplopia | 4 hours | DI 24 hours |
| 23 | Spierer & Spierer 1999 | 4 | Male | Inferior alveolar nerve (left) | 1ml mepivacaine 3% | N/A | Ptosis | 5 minutes | PT 20 minutes |
| 24 | Spierer & Spierer 1999 | 5 | Female | Inferior alveolar nerve (left) | 1ml mepivacaine 3% | N/A | Diplopia (lateral rectus m.) | 5 minutes | DI 15 minutes |
| 25 | Peñarrocha & Sanchis 2000 | 22 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.)<br>Mydriasis | N/A | DI/MY 60 minutes |
| 26 | Peñarrocha & Sanchis 2000 | 24 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (superior oblique m.) | N/A | DI 30 minutes |
| 27 | Peñarrocha & Sanchis 2000 | 25 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.)<br>Mydriasis<br>Ptosis | N/A | DI/MY/PT 60 minutes |
| 28 | Peñarrocha & Sanchis 2000 | 29 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Enophthalmos<br>Miosis<br>Ptosis (Horner's syndrome) | N/A | EN/MI/PT 20 minutes |
| 29 | Peñarrocha & Sanchis 2000 | 32 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.) | N/A | DI 45 minutes |
| 30 | Peñarrocha & Sanchis 2000 | 35 | Male | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.) | N/A | DI 90 minutes |
| 31 | Peñarrocha & Sanchis 2000 | 40 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.)<br>Ptosis | N/A | DI/PT 2 hours |
| 32 | Peñarrocha & Sanchis 2000 | 40 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.) | N/A | DI 30 minutes |
| 33 | Peñarrocha & Sanchis 2000 | 49 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100'000 epinephrine | 25-gauge | Diplopia (lateral rectus m.)<br>Mydriasis<br>Ptosis | N/A | DI/MY/PT 45 minutes |

N/A = not available m. = muscle AC = Accommodation disturbance AM = Amaurosis DI = Diplopia EN = Enophthalmos MI = Miosis MY = Mydriasis OP = Ophthalmoplegia PT = Ptosis

**Tab. I** Overview of all 65 case reports with ophthalmologic complications after intraoral local anesthesia (continued)

| # | Author(s) and year | Patient age | Patient gender | Intraoral local anesthesia (side) | Local anesthetic | Injection cannula | Ophthalmologic complication(s) | Onset of complication(s) | Duration of complication(s) |
|---|---|---|---|---|---|---|---|---|---|
| 34 | Peñarrocha & Sanchis 2000 | 53 | Male | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Enophthalmos<br>Miosis<br>Ptosis<br>(Horner's syndrome) | N/A | EN/MI/PT<br>40 minutes |
| 35 | Peñarrocha & Sanchis 2000 | 60 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia<br>(lateral rectus m.)<br>Mydriasis<br>Ptosis | N/A | DI/MY/PT<br>30 minutes |
| 36 | Peñarrocha & Sanchis 2000 | 65 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Enophthalmos<br>Miosis<br>Ptosis<br>(Horner's syndrome) | N/A | EN/MI/PT<br>50 minutes |
| 37 | Peñarrocha & Sanchis 2000 | 65 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia<br>(lateral rectus m.) | N/A | DI 50 minutes |
| 38 | Peñarrocha & Sanchis 2000 | 73 | Female | Posterior superior alveolar nerve (N/A) | 1.8 ml articaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia<br>(lateral rectus m.) | N/A | DI 2 hours<br>10 minutes |
| 39 | Wilkie 2000 | 45 | Male | Inferior alveolar nerve (right) | 2.2 ml lignocaine 2% with 1:80,000 epinephrine | N/A | Amaurosis<br>Diplopia<br>Mydriasis<br>Ophthalmoplegia<br>Ptosis | Immediate | AM/DI/MY/OP/PT<br>30 minutes |
| 40 | Koumoura & Papageorgiou 2001 | 22 | Female | Posterior superior alveolar nerve (left) | (ml N/A) articaine (% N/A) with epinephrine (concentration N/A) | N/A | Diplopia<br>(lateral rectus m.) | N/A | DI 2 hours |
| 41 | Walker et al. 2004 | 29 | Male | Inferior alveolar nerve (right) | 1.8 ml lidocaine 2% with 1:100,000 epinephrine | 25-gauge | Diplopia<br>(lateral rectus m.) | 5 minutes | DI 60 minutes |
| 42 | Dogan & Dora 2005 | 19 | Female | Posterior superior alveolar nerve (left) | 5 mg prilocaine (vasoconstrictor N/A) | N/A | Enophthalmos<br>Miosis<br>Ophthalmoplegia<br>(Horner's syndrome) | Immediate | EN/MI/OP 6 hours |
| 43 | Horowitz et al. 2005 | 26 | Female | N/A (left maxilla) | N/A | N/A | Amaurosis | Immediate | AM several days |
| 44 | Horowitz et al. 2005 | 30 | Female | N/A (right maxilla) | N/A | N/A | Diplopia<br>Mydriasis | N/A | DI/MY a few hours |
| 45 | Horowitz et al. 2005 | 45 | Male | N/A (left maxilla) | N/A | N/A | Amaurosis | 3 hours | AM permanent |
| 46 | Rishiraj et al. 2005 | 73 | Male | Posterior superior alveolar nerve, greater palatine nerve, inferior alveolar nerve (right) | 144 mg prilocaine without epinephrine | N/A | Amaurosis | N/A | AM permanent |
| 47 | Magliocca et al. 2006 | 36 | Female | Middle superior alveolar nerve, posterior superior alveolar nerve, greater palatine nerve (left) | 3.4 ml articaine 4% with 1:100,000 epinephrine | 25-gauge | Diplopia | 15 minutes | DI 3 hours |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 48 | Ngeow et al. 2006 | 20 | Female | Inferior alveolar nerve (right) | 4.4 ml lidocaine 2% with 1:80,000 epinephrine | N/A | Accommodation disturbance | Immediate | AC 15 minutes |
| 49 | Ngeow et al. 2006 | 21 | Female | Inferior alveolar nerve (left) | N/A | N/A | Accommodation disturbance | N/A | AC 10 minutes |
| 50 | Uckan et al. 2006 | 30 | Female | Inferior alveolar nerve (N/A) | (ml N/A) articaine 4% with 1:100,000 epinephrine | 27-gauge | Amaurosis | Immediate | AM 20 minutes |
| 51 | Scott et al. 2007 | 28 | Female | Inferior alveolar nerve (left) | 4 ml lidocaine 2% with 1:80,000 epinephrine | N/A | Diplopia (lateral rectus m.) | Immediate | DI N/A |
| 52 | Choi et al. 2009 | 15 | Male | Inferior alveolar nerve (right) | 1.8 ml lidocaine 2% with 1:100,000 epinephrine | 27-gauge | Diplopia | Immediate | DI 60 minutes |
| 53 | Choi et al. 2009 | 34 | Female | Inferior alveolar nerve (left) | 1.8 ml lidocaine 2% with 1:100,000 epinephrine | 27-gauge | Diplopia | Immediate | DI 15 minutes |
| 54 | Prakasm et al. 2009 | 47 | Female | Middle superior alveolar nerve, posterior superior alveolar nerve (left) | 1.5 ml lignocaine 2% with 1:80,000 epinephrine | N/A | Mydriasis<br>Ptosis | A few minutes | MY/PT 5 hours |
| 55 | Al-Sandook & Al-Saraj 2010 | 28 | Female | Inferior alveolar nerve (left) | (ml N/A) lidocaine 2% with 1:100,000 epinephrine | N/A | Amaurosis<br>Diplopia | Immediate | N/A |
| 56 | Balaji 2010 | 32 | Female | Posterior superior alveolar nerve (right) | 1.8 ml lignocaine 2% with 1:80,000 epinephrine | 24-gauge | Diplopia (lateral rectus m.) | A few minutes | DI 30 minutes |
| 57 | Boynes et al. 2010 | 27 | Female | Inferior alveolar nerve (left) | 1.8 ml lidocaine 2% with 1:100,000 epinephrine | N/A | Accommodation disturbance<br>Amaurosis | Immediate | AC/AM 20 minutes |
| 58 | Inchingolo et al. 2010 | 47 | Male | Posterior superior alveolar nerve (left) | (ml N/A) mepivacaine 3% without epinephrine | N/A | Mydriasis | N/A | MY 3 hours |
| 59 | Surej Kumar et al. 2010 | 40 | Female | Inferior alveolar nerve (left) | 2 ml lignocaine 2% with 1:200,000 epinephrine | 25-gauge | Diplopia (lateral rectus m.) | 5 minutes | DI 10 minutes |
| 60 | Pragasm & Managutti 2011 | 50 | Female | Posterior superior alveolar nerve, greater palatine nerve (right) | N/A | N/A | Diplopia (lateral rectus m.) | N/A | DI 4 hours |
| 61 | Williams et al. 2011 | 25 | Female | Inferior alveolar nerve (left) | 2.7 ml lignocaine 2% with 1:80,000 epinephrine | 28-gauge | Amaurosis<br>Mydriasis<br>Ophthalmoplegia<br>Ptosis | Immediate | AM 5 minutes<br>MY/OP/PT 2 hours |
| 62 | Kini et al. 2012 | 50 | Female | Middle superior alveolar nerve, posterior superior alveolar nerve (right) | 2.1 ml lignocaine (% N/A) with 1:200,000 epinephrine | 26-gauge | Diplopia (lateral rectus m.)<br>Ptosis | 10 minutes | DI/PT 3 hours |
| 63 | Steenen et al. 2012 | 22 | Female | Posterior superior alveolar nerve, greater palatine nerve, inferior alveolar nerve (right) | 5.1 ml articaine 4% with 1:100,000 epinephrine | 27-gauge | Diplopia (lateral rectus m.) | A few minutes | DI 6 hours |
| 64 | Verma et al. 2013 | 25 | Male | Inferior alveolar nerve (left) | 1.2 ml lignocaine 2% with 1:80,000 epinephrine | 26-gauge | Amaurosis | 5 minutes | AM 2 hours<br>30 minutes |
| 65 | Verma et al. 2013 | 32 | Male | Inferior alveolar nerve (left) | 1.2 ml lignocaine 2% with 1:80,000 epinephrine | 26-gauge | Amaurosis | N/A | AM 3 hours |

N/A = not available m. = muscle AC = Accommodation disturbance AM = Amaurosis DI = Diplopia EN = Enophthalmos MI = Miosis MY = Mydriasis OP = Ophthalmoplegia PT = Ptosis

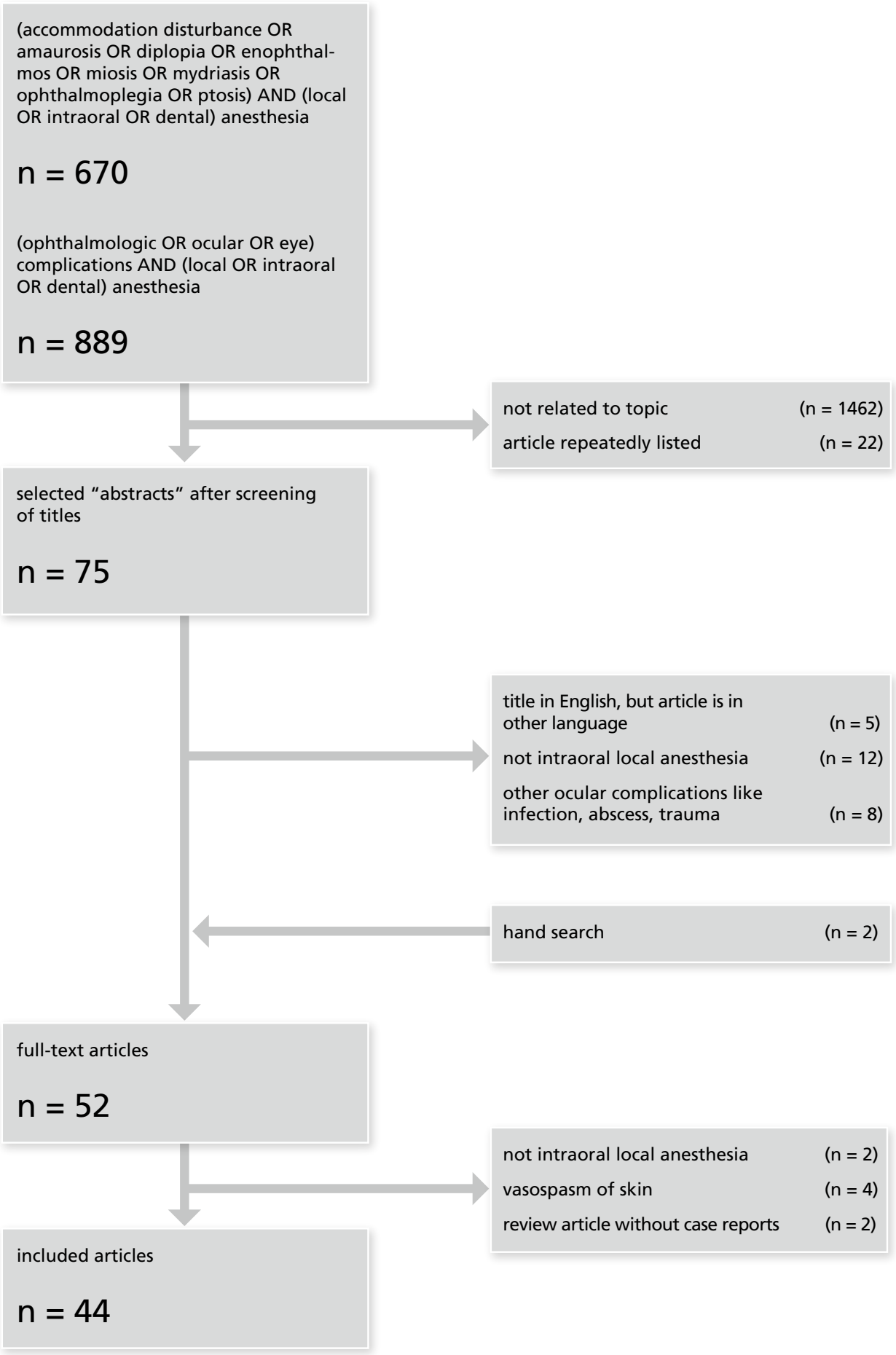


**Fig. 1** Flow chart of literature search

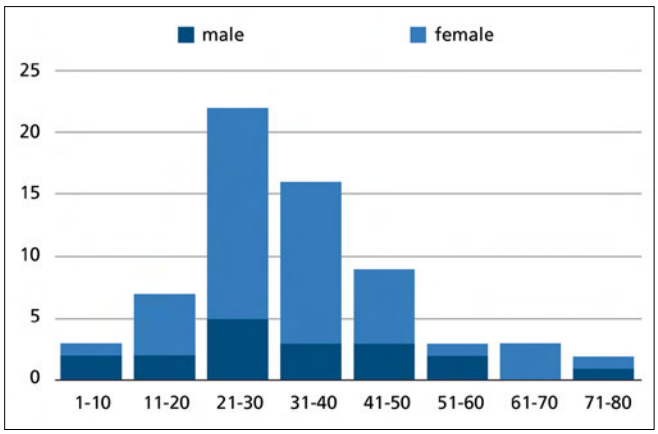


**Fig. 2** Patient distribution regarding age decades (n=65)

**Tab. II** Number of ophthalmologic complications per patient (n=65)

| Complication(s) per patient | N patients | N complications |
|---|---|---|
| 1 | 37 | 37 |
| 2 | 17 | 34 |
| 3 | 8 | 24 |
| 4 | 2 | 8 |
| 5 | 1 | 5 |
| **Total** | **65** | **108** |

**Tab. III** Overview of gender, age, onset and duration per complication (n=108)

| | | Gender of patient | | | Age (years) of patient | | Onset of complication | | Duration of complication | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ophthalmologic complication** | **N (%)** | **Male** | **Female** | **% of females per group** | **Mean** | **Range** | **Most frequent** | **Range** | **Most frequent** | **Range** |
| Accommodation disturbance | 4 (3.7%) | 0 | 4 | 100.0 | 24.8 | 20–31 | Immediate | Immediate to 40 minutes | * | 10 minutes to 3 hours |
| Amaurosis | 14 (13.0%) | 7 | 7 | 50.0 | 35.0 | 16–73 | Immediate | Immediate to 3 hours | 20 minutes | 5 minutes to permanent |
| Diplopia | 43 (39.8%) | 8 | 35 | 81.4 | 34.7 | 5–73 | Immediate | Immediate to 4 hours | 30 minutes | 10 minutes to 4 weeks |
| Enophthalmos | 4 (3.7) | 1 | 3 | 75.0 | 41.5 | 19–65 | * | * | * | 20 minutes to 6 hours |
| Miosis | 5 (4.6%) | 1 | 4 | 80.0 | 40.0 | 19–65 | * | Immediate to 2 minutes | * | 20 minutes to 6 hours |
| Mydriasis | 16 (14.8%) | 6 | 10 | 62.5 | 35.9 | 7–61 | Immediate | Immediate to a few minutes | 30 minutes | 20 minutes to 4 weeks |
| Ophthalmoplegia | 4 (3.7%) | 2 | 2 | 50.0 | 29.5 | 19–45 | Immediate | Immediate to 3 minutes | * | 20 minutes to 6 hours |
| Ptosis | 18 (16.7%) | 5 | 13 | 72.2 | 36.3 | 4–65 | Immediate | Immediate to 10 minutes | 30 minutes | 20 minutes to 4 months |

*Not sufficient data available to make a statement

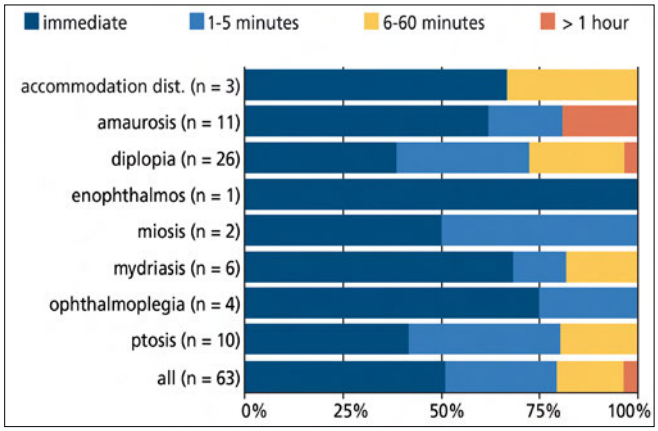


**Fig. 3** Onset of ophthalmologic complications (n=63)

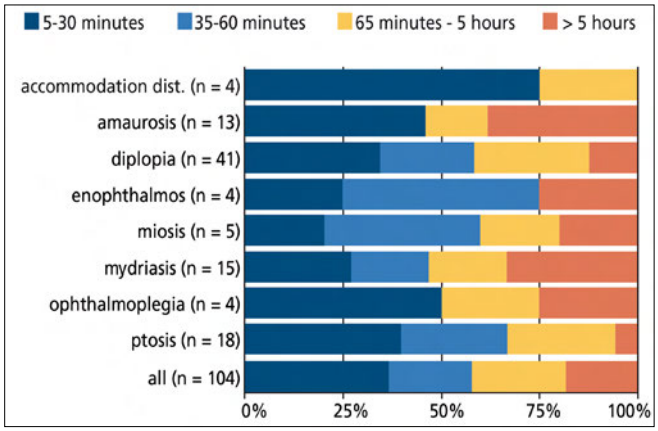


**Fig. 4** Duration of ophthalmologic complications (n=104)

below) might be more frequent in females than in males, and in females application sites of local anesthesia might be closer to the orbit because of smaller body size. It remains unclear why patients aged 21 to 30 were most frequently affected in the analyzed case reports. One may speculate that block anesthesia in possible "risk areas" of triggering ophthalmologic complications are more commonly applied in that age group.

**Tab. IV** Type of anesthesia associated with ophthalmologic complication (n=72*)

| Type of anesthesia | N | Percentage |
|---|---|---|
| Inferior alveolar nerve | 33 | 45.8 |
| Anterior superior alveolar nerve | 1 | 1.4 |
| Middle superior alveolar nerve | 5 | 6.9 |
| Posterior superior alveolar nerve | 29 | 40.3 |
| Greater palatine nerve | 4 | 5.6 |
| **Total** | **72** | **100.0** |

* N is greater than 65 since in 7 patients multiple anesthesia were performed. In 3 patients no information was available about the type of intraoral local anesthesia.

**Tab. V** Type of injection cannula (n=31*)

| Gauge of cannula | N | Percentage |
|---|---|---|
| 24 | 1 | 3.2 |
| 25 | 17 | 54.8 |
| 26 | 3 | 9.7 |
| 27 | 9 | 29.0 |
| 28 | 1 | 3.2 |
| **Total** | **31** | **100.0** |

* Information about the injection cannula was not available in 34 cases.

Indeed, administration of intraoral local anesthesia to the inferior alveolar nerve (45.8%) or to the posterior superior alveolar nerve (40.3%) was the main cause of ophthalmologic complications, i. e. injections given in possible "risk zones". Although a positive aspiration test may not be associated necessarily with an intravascular application, up to 30% of positive aspiration has been reported in anesthesia of the inferior alveolar nerve (Hidding & Khoury 1991, Lustig & Zusman 1999). But aspiration was also positive in 2.4% of cases with anesthesia of the posterior superior alveolar nerve (Lustig & Zusman 1999). With regard to the thickness of the injection cannula, larger cannula (58%) with 24–25 gauge (approximately 0.5 to 0.6 mm of external diameter) was more frequently used than smaller cannula (33%) with 27–28 gauge (approximately 0.4 mm of external diameter) in the reported cases. Consequently, the gauge of the cannula might play a role. With regard to the causative anesthetic agent, lidocaine and articaine reflect the anesthetic drugs most frequently used in dentistry (Malamed 2006). In what way the diffusion characteristics of local anesthetics play a role in ophthalmologic complications after intraoral local

**Tab. VII** Type of vasoconstrictor used (n=55*)

| Vasoconstrictor | N | Percentage |
|---|---|---|
| Epinephrine 1:80,000 | 13 | 23.6 |
| Epinephrine 1:100,000 | 28 | 50.9 |
| Epinephrine 1:200,000 | 2 | 3.6 |
| Epinephrine 1:300,000 | 2 | 3.6 |
| Epinephrine of unknown concentration | 3 | 5.5 |
| Felypressin 0.03 IU | 1 | 1.8 |
| Neo-cobefrin 1:20,000 | 1 | 1.8 |
| Preparation without vasoconstrictor | 5 | 9.1 |
| **Total** | **55** | **100.0** |

* In 10 patients no information was available about the type of vasoconstrictor.

**Tab. VI** Type of local anesthetic (n=57*)

| | Concentration of anesthetic agent | | | | | | |
|---|---|---|---|---|---|---|---|
| **Anesthetic agent** | **1%** | **2%** | **3%** | **4%** | **Unknown** | **Total** | **Percentage** |
| Articaine | – | 14 | – | 3 | 1 | 18 | 31.6% |
| Butethamine | – | – | – | – | 1 | 1 | 1.8% |
| Lidocaine (incl. lignocaine and xylocaine) | 1 | 22 | – | – | 3 | 26 | 45.6% |
| Mepivacaine (incl. carbocaine) | – | 1 | 4 | – | 1 | 6 | 10.5% |
| Prilocaine | – | – | 1 | – | 2 | 3 | 5.3% |
| Procaine | – | – | – | – | 3 | 3 | 5.3% |
| **Total** | **1** | **37** | **5** | **3** | **11** | **57** | **100.0%** |

* Information about the anesthetic drug was not available in 8 cases.

anesthesia remains unclear. However, several authors have emphasized the high diffusion capacity of articaine (Malamed 2004, Choi et al. 2009, Wilkie et al. 2000, Boynes et al. 2010). A bolus of local anesthetic (with or without vasopressor) might provoke untoward effects far distant from the application site of intraoral local anesthesia resulting in ophthalmologic complications. With respect to the injected quantity of local anesthetic, the amount did not exceed 2 ml (the content of about one dental carpule) in the majority of cases (76.1%). Hence, large doses of local anesthetic do not necessarily cause ophthalmologic complications, but can result from relatively small aliquot volumes.

Various pathophysiologic mechanisms of ophthalmologic complications after intraoral local anesthesia are discussed in the literature:

- intravascular injection of local anesthetic
- reflex vasospasm
- cervical sympathetic block
- diffusion of local anesthetic

After (inadvertent) intravascular application of the local anesthetic, the agent and the vasopressor (if present) may reach the orbit or may get into the neurovascular structures leading to the orbit, and they may cause ophthalmologic complications (Aldrete et al. 1977, Pretterklieber et Al. 1991, Williams et al. 2011). Multiple anatomic variants may favor an inadvertent intravascular injection: for example a so-called "downward looping" of the maxillary artery approaching the mandibular foramen or anastomoses of the middle meningeal artery (a branch from the maxillary artery) with the lacrimal artery or with the ophthalmic artery, respectively. Venous anastomoses may also favor retrograde transportation of local anesthetics towards the middle cranial fossa (cavernous sinus) and to the orbit (Singh & Dass 1960, Hayreh & Dass 1962, Lacouture et al. 1983, Roda & Blanton 1994, Blanton & Jeske 2003, Magliocca et al. 2006, Perrini et al. 2007, Scott et al. 2007, Liu & Rhoton 2001). In some patients, similar repetitive ocular complications were observed on successive occasions (Petrelli & Steller 1980, Williams et al. 2011). Such recurrent signs within the same patient may indicate the presence of anatomical variants in those patients.

A mechanical injury such as scraping the vessel walls in the supply area of the common carotid artery by the anesthetic needle may activate sympathetic fibers and cause angiospasm (Kronman & Kabani 1984). A reflex vasoconstriction of the ophthalmic artery and the central retinal artery are feared since such events may harm the optic nerve and the retina, and may even lead to complete loss of sight. In contrast, anesthesia of postganglionic fibers in the posterolateral pharynx (cervical sympathetic block or even block of the superior cervical ganglion) may cause vasodilation, pupillary constriction, ptosis, and possibly enophthalmos as well as increased temperature of the skin in the head-neck area (Horner's syndrome) (Campbell et al. 1979).

Diffusion of local anesthetic agents to the orbit is also possible from the posterior maxilla/infratemporal fossa via the pterygopalatine fossa and the inferior orbital fissure. The absence of anatomical barriers and a supine position of the head during administration of intraoral anesthesia favor the diffusion of local anesthetics towards the orbit (Magliocca et al. 2006). High diffusion properties of local anesthetics administered in the posterior vestibular area of the maxilla may explain the development of ophthalmologic complications due to the proximity of the anesthesia site and the orbit (Heasman 1984, Boynes et al. 2010).

In previous articles about ophthalmologic complications after intraoral local anesthesia, most often a case report has induced the authors to perform a literature review (Choi Et Al. 2009, Williams et al. 2011, Steenen et al. 2012). In accordance with the present analysis, those review articles have reported a predominance of females and diplopia to be the most frequent ophthalmologic complications after intraoral local anesthesia. Compared to the present article (n=108), Steenen et al. (2012) observed a clearly higher number of complications (n=131). However, those authors also included complications such as retrobulbar pain (in 6.1% of the 131 complications), blanching of (periorbital) skin and mucosa (9.9%), as well as dizziness/vertigo (6.9%) in their analysis.

Parallel to the onset of the anesthesia, most of the ophthalmologic complications analyzed in this study demonstrated a fast onset (immediate to a few minutes) after administration of the local anesthesia. Only in two cases of amaurosis and in one case of diplopia the complications showed a delayed onset. In a 14-year girl, diplopia was only apparent four hours after mandibular block anesthesia and the authors ruled out the possibility of an intravascular spread of the local anesthetic (van der Bijl & Lamb 1996). Probably the local anesthetic reached the orbita by very slow diffusion explaining the delayed onset of four hours.

Compared to the onset of the ophthalmologic complications, their duration was more inhomogeneous, and sometimes clearly longer than the period of anesthesia; in 18.3% of all cases, the complications lasted more than five hours, especially in cases of amaurosis (38.5%) and of mydriasis (33.3%). In three patients, amaurosis did not show remission and remained permanent. Interestingly, two of the three cases had a very long onset time of three hours and several hours, respectively (in one patient, no such information was available). In one case report, the 45-year old patient also lost the eyesight in the other eye one year later without any apparent provoking factors (Horowitz et al. 2005), pointing to a predisposing cardiovascular disease. Amaurosis as a complication after intraoral local anesthesia is caused either directly by anesthesia of the optic nerve by the misdirected local anesthetic, or indirectly by ischemia due to vasospasm of the central retinal artery by sympathetic activation or effect of the vasopressor agent (Tomazzoli-Gerosa et al. 1988). Other causes include an "oily" embolization of the central retinal artery by the local anesthetic, or a toxic effect of the local anesthetic upon the cells of the retina (Grosskreutz et al. 1999, Verma et al. 2013). The latter might explain the long duration of amaurosis in some cases (Horowitz et al. 2005). In two patients, the amaurosis was associated with multiple other ophthalmologic complications, suggesting an intravenous misdirection of the local anesthetic to the cavernous sinus (Wilkie 2000, Williams et al. 2011). Several important structures course through the cavernous sinus (internal carotid artery, abducens nerve) or lie within its lateral wall (oculomotor nerve, trochlear nerve, ophthalmic and maxillary divisions of the trigeminal nerve). These structures eventually reach the orbit explaining the occurrence of multiple ophthalmologic complications (Wilkie 2000, Williams et al. 2011). The abducens nerve would be more vulnerable to the effect of the anesthetic because of its immediacy within the cavernous sinus (Boynes et al. 2010).

## Conclusions

A total of 108 ophthalmologic complications after intraoral local anesthesia were reported in 65 patients. Among the analyzed complication, diplopia (39.8%) was the most frequent complications, of which 86.7% affected the lateral rectus muscle and the abducens nerve, respectively, resulting in disturbance of eye abduction. The rate of females was very high in diplopia cases (81.4%) as well as in all case reports (72.3%); therefore, a gender effect (anatomical variants) has been suggested in the literature. Ophthalmologic complications after intraoral local anesthesia were mostly associated with anesthesia of the inferior alveolar nerve (45.8%) or the posterior superior alveolar nerve (40.3%).

## Résumé

Introduction: La première complication ophtalmologique après une anesthésie dentaire fut décrite en 1936. L'objectif de notre étude était une analyse précise des rapports de cas de telles complications.

Matériels et méthodes: Après une recherche de littérature dans PubMed, 65 rapports de cas avec 108 complications ophtalmologiques après une anesthésie locale dentaire ont été analysés en fonction des facteurs: patient, anesthésie et complications.

Résultats: L'âge moyen des patients était de 33,8 ans, et les femmes étaient affectées beaucoup plus fréquemment (72,3%). La complication la plus fréquente était la diplopie (39,8%), le plus souvent en conséquence d'une paralysie du muscle rectus latéral. Les autres complications relativement fréquentes étaient le ptosis (16,7%), la mydriase (14,8%) et l'amaurose (cécité) (13%). Les complications ophtalmologiques se manifestaient surtout après les anesthésies du nerf alvéolaire inférieur (45,8%) ou du nerf alvéolaire supérieur postérieur (40,3%). Les complications ophtalmologiques se manifestaient en règle générale immédiatement ou rapidement après l'anesthésie locale, et elles disparaissaient dès que l'effet de l'anesthésie s'atténuait.

Discussion et conclusion: La haute fréquence des complications ophtalmologiques après une anesthésie locale dentaire chez les femmes laisse penser qu'il existe un facteur spécifique du sexe. La double vue (diplopie) est la complication la plus fréquente décrite dans la littérature, mais elle est, comme les autres complications ophtalmologiques, en règle générale totalement réversible.


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