Intraoperative complications during oral implantology

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Abstract
Dental implant placement is a controlled, programmed surgical procedure, not without its complications. The aim of the present paper is to study the intraoperative complications in implant surgery, carrying out a review of articles appearing in Medline over the last 10 years.
Among the intra operative complications related with surgery, hemorrhagic accidents occur most frequently in the interforaminal region, since the majority of the vascular branches enter the mandibular bone in this region. Nerve damage can arise as a consequence of inferior alveolar nerve transposition or lateralization; or the excessive intrusion of drills or implant fixture into the mandibular canal. Mandibular fractures secondary to implant placement occur more easily when placing implants in atrophic mandible. Occasionally, incorrect positioning or lack of relative parallelism in the placing of the implants causes damage to an adjacent tooth. Absence of primary stability may occur as a result of overworking the implant bed during preparation, also to poor bone quality, and more frequently to immediate post-extraction implantation. Another possible complication is the migration of implants into the maxillary sinus.

Key words: *Intra operative complications, dental implants.*

Introduction
In oral implantology, the most serious complications and those most frequently described in the literature occur during surgery. They may result from inadequate planning, overworking of the implant bed, contamination of the implant by incorrect manipulation or mishandling; by poor implant orientation, or by the surgical procedure itself, which is not without risk.

- *Complications related with surgery*
Among the intraoperative complications related with surgery are hemorrhages, neurosensory alterations, damage to teeth adjacent to the implant, and mandibular fractures.

Hemorrhages: in the mandible, these occur most frequently in the interforaminal region (1). Arterial supply to the mandible is provided by three arteries and their branches: the inferior alveolar artery and its branch the mylohyoid artery, the facial artery and its branch the submental artery, and the lingual artery and its branch the sublingual artery.
Perforation of the mandibular lingual cortical plate and damage to the above-mentioned arteries or any of their branches during osteotomy may even compromise the life of the patient (2). The high risk of damaging the arteries of the floor of the mouth is explained by the close proximity of the vessels to the lingual cortical and the sublingual fossa (1). Damage to the mandibular lingual cortical plate

is the most frequently described in association with hemorrhagic accidents during dental implant placement.

Blood supply to the mandibular lingual surface is provided by the submental, sublingual and mylohyoid arteries, with anastomoses between them. The submental artery (branch of the facial artery), borders the lower mandible, supplies the anterior body of the digastric muscle and mylohyoid muscle, and gives off the perforating branches of the mylohyoid muscle, which anastomose with branches of the sublingual artery.

The sublingual artery (branch of the lingual artery), supplies the sublingual gland, the mucosa of the floor of the mouth and the mylohyoid muscle. It anastomoses with the submental artery. If the sublingual artery is absent, it is substituted by a branch of the submental artery perforating the mylohyoid muscle. In this variation, the origin of the sublingual artery in the facial artery instead of the lingual artery is clinically important. The opposite may also occur, where the submental artery is absent and in this case is substituted by a branch of the sublingual artery perforating the geniohyoid muscle.

The mylohyoid artery arises from the inferior alveolar artery just before its entry into the mandibular canal and courses following the route of the mylohyoid nerve to the muscle of the same name, where it anastomoses with branches of the submental artery. It supplies the most posterior portion of the gingiva which covers the inferior alveolar process.

The arteries that dispute practically the entire vascularization of the floor of the mouth are the sublingual and submental arteries. Bavitz JB et al. (3) consider the submental artery to provide the main arterial blood supply to the floor of the mouth; since in 53% of the cases studied, the sublingual artery was found to be either small, insignificant or absent. However, Hofschneider U et al. (1) found a sublingual artery in 71% of their cases, while a large branch of the submental artery perforating the mylohyoid muscle appeared in 41% of the cases.

Arterial hemorrhage in the posterior, lingual, mandibular region will originate in the mylohyoid artery and may be controlled by strong finger pressure at the point of bleeding or in the medial mandibular area just distal to the roots of the third molar. An attempt to ligate this artery would be difficult or impossible, and dissection of the artery could complicate the situation even further (2). When the arterial hemorrhage occurs in the medial, lingual, mandibular region, the damaged vessel would probably be the submental, and would therefore require control of both the lingual and facial arteries through surgical ligation. Bleeding stopped by strong compression of the inferior medial mandibular border, where the facial artery crosses towards the face and the submental artery originates, would indicate the bleeding artery to be the submental or the facial, and surgical ligation may be necessary. If said compression does not obtund bleeding, it may be necessary to ligate the lingual artery. On occasions, the presence of anastomoses necessitates the ligation of the facial and lingual arteries.

Arterial bleeding in the anterior, lingual, mandibular region, would be a consequence of injury to the terminal branches of the sublingual or submental arteries. Hemorrhage of these terminal arteries, generally of small caliber, is usually controlled by compression, infiltration of a vasoconstrictor, or ligation (2). In the last 10 years various cases have been described of respiratory obstruction due to perforation of the above-mentioned arteries or one of their branches (2,4-9). The vascular injury sets off a massive internal hemorrhage in the floor of the mouth, the resulting swelling produces protrusion and displacement of the tongue, obstructing the airway. The surgeon should be prepared for such possible complications and have a rehearsed plan of action for their treatment (4). Computed tomography seems to be the best presurgical radiographic test for the prevention of such complications, as it visualizes the area of the vascular branches enter the anterior mandibular region through the bone canals, determines the presence of the lingual fossa, and generally provides a three-dimensional image of the bone structures (1,4,10). In order to minimize the possibility of perforating the lingual cortical, some authors recommend placing shorter implants, less than 14 mm, in the mandible (6).

In the maxilla, hemorrhages can occur fundamentally by damage to the descending palatin artery or the posterior palatin artery. Hemorrhage resulting from perforation of the posterior palatin artery during implant placement in the retromolar trigone of the maxilla, or the pterygoid apophyses, is obtunded by inserting the implant itself, the length of which generally varies between 15 and 20 mm (11). Given the danger of vascular injury in this area, preparation of the implant bed using osteotomes, avoiding the use of drills is preferred (12).

Krepler K et al. (13) described an intraocular hemorrhage in a patient with arterial hypertension, caused by the Valsalva maneuver in combination with an increase in blood pressure during maxillary implant placement.

Other complications related to surgery are neurosensory alterations, which manifest during the immediate postoperative period in the form of anesthesia, hypoesthesia, paresthesia or dysesthesia. The sensory disturbances produced following implant placement in the mandible are the result of injury to one or more of the branches of the mandibular nerve, which include he inferior alveolar nerve, the mental nerve, and the lingual nerve (14). Damage to one of these nerves may produce inadvertent biting in the affected area, tongue, lip or cheek; drooling; pain and changes in mastication (15). Many etiological factors are associated with these lesions, such as complicated surgical techniques (16), the inferior alveolar nerve block (17,18), the transposition and lateralization of the inferior alveolar nerve (19-23), or the excessive intrusion of the drill or implant

into the mandibular canal. The lingual nerve can be damaged by careless raising of lingual flaps, lingual anesthesia using inferior alveolar nerve block, or even by excessive separation of the soft tissue from the lingual cortical. The inferior alveolar nerve may be affected by perforation of the mandibular canal during drilling, or positioning the implant close to the canal and the subsequent formation of an adjacent hematoma that presses against the nerve, or even by damage to a double or supplementary dental canal (24). For this reason, for the placing of implants in the mandible, an anesthetic technique of terminal block by infiltration of the mandible has been proposed, with the aim of maintaining sufficient sensation to advise on the proximity of the roof or the inferior alveolar nerve during implant placement (25,26). However, this technique is not generally used, arguing that the bone possesses sensitive nerve endings that could cause discomfort to the patient during surgery (27). Transposition of the inferior alveolar nerve can cause some disturbance in the incisor and mental area (23).

Walton (15) published a study on neurosensory alterations in the chin and lower lip related to placing implants in the anterior mandible. Out of 74 patients, 24% reported sensory alterations two weeks after implant surgery, with 4% maintaining said alteration at 6 months, reducing to 1% at 12 months. Preventative measures suggested are correct presurgical planning using the appropriate radiographic techniques, placing implants at least 5 mm from the mental foramen and 2 mm from the mandibular canal; likewise the use of radiographic follow-up immediately after surgery, with rectification of the implant position if necessary. CT (computed tomography) is the radiographic technique of choice for the exact localization of the anatomical structures involved in the area for implantation, and correct surgical planning. If nerve damage is slight, it is usually short-term and transient in the best of cases.

Regarding treatment, if the patient suffers paresthesia, and the implants are correctly located, with no evidence of damage to the inferior alveolar nerve, it is recommended to wait some time for recovery. Removal of the implant is not advised if it is successfully osseointegrated and the nerve is not directly damaged (28). However, when the implants press against the inferior alveolar nerve, the damage manifests in the majority of cases by anesthesia that may be painful or painless. In these cases it is recommended to remove the implants so as to avoid permanent neural damage (24). Levitt DS (26), described treatment of a dysesthesia produced during the placing of an implant in place of a lower molar, carrying out an apicectomy of the implant, cutting the apex with an angulation of 45° in the buccal to lingual direction. They also advised of the concomitant risk, and the need to completely visualize the exit of the mental nerve.

Another undesirable effect is the damage to adjacent teeth through lack of parallelism of the implant with neighbouring teeth or by excessive proximity to the contiguous teeth. Implant placement should respect a minimum distance of 1.5 mm, with respect to adjacent teeth. In the case of damage, and according to its degree, treatment of the affected tooth may require canal treatment, periapical surgery, apicectomy, or even extraction (29).

Although mandibular fractures, secondary to the placing of implants are an infrequent complication, they have been widely described in the literature in the past. This complication occurs when implants are placed in atrophic mandible, and usually occur in elderly patients seeking implant treatment in the anterior area in order to improve adaptation of complete lower prostheses. Raghoebar GM et al. (30) describe four cases (two of their own and two referred) of mandibular fractures related to the placing of implants in atrophic alveolar processes. Three of the cases required bone grafts to repair the fracture, and the other was treated with osteosynthesis plates. During the period 1990 to 2000, the authors placed 2734 implants in edentulous mandible with a maximum height of the symphysis of 15 mm; two patients suffered mandibular fractures during the insertion or explantation of the implants.

Presentation of this complication may occur sometime after surgery, and to minimize these complications, implant placement in atrophic mandible requires a minimum bone height and width of 7 and 6 mm respectively (30). When placing implants in atrophic mandible, periodic follow-ups including clinical and radiographic examination become even more necessary, as well as instructing the patient to avoid occlusal overloading during the osseointegration period. On other occasions, the mandibular fractures are related to complex surgical techniques, such as the transposition or lateralization of the inferior alveolar nerve (21,23).

- *Complications associated with implant placement*

With respect to the surgical procedure for implant placement, the absence of primary stability constitutes one of the most significant complications during surgery and may imply its failure. Primary implant stability is compromised by overworking the implant bed, by poor bone quality, using implants that are too short, or when placing of immediate post-extraction implants in which there is a discrepancy between the diameter of the alveolus and the implant. Sequential drilling is essential, controlling speed, using sharp drills and constant cooling with physiological serum to avoid overheating. The increase in temperature, produced by excessive drill speed produces necrosis, fibrosis, osteolytic degeneration and an increase in osteoclastic activity (31). The thickness of the necrotic area that appears around the bone defect is directly proportional to the amount of heat generated during surgery (31).

Since Eriksson and Albrektsson, in their studies in the 1980s (32,33), proposed heating of 47° centigrade as the maximum limit that the bone may withstand without

necrosis, no later studies have appeared to modify this proposal. Likewise, they reported that heating of 47° C for five minutes, produces high bone resorption (around 20%) over the following 30 days (32).

Controversy remains today over the use of external or internal irrigation for cooling. However, Benington et al. (34) in a recent study, found no differences between the two systems.

When primary stability is lacking, the implant should be substituted by a wider and longer self-tapping implant, or if this is not possible then delay surgery by two months (35).

With regard to the technique of placing implants in one or two surgical visits, no significant differences have been observed for osseointegration or failure (36).

Another possible complication is the manifestation of dehiscence and/or fenestration during implant surgery. Goodacre et al. (37), reported an incidence of 7% in the appearance of these defects from a total of 3156 implants placed. Other studies speak of variations between 2% and 13% (38). Treatment consists of filling the bone defect with materials such as bone grafts, preferably autologous, obtained from the actual implant bed or other locations such as the tuberosity, a mixture of autologous bone graft with lyophilized bone and resorbable or non-resorbable membranes.

When placing implants in the maxilla in areas close to the maxillary sinus, or directly during sinus lift procedures, complications such as the rupture of the Schneider membrane may occur. Depending on the width of the tear, a resorbable membrane is placed, which serves to contain the bone graft material, or if the tear is very wide, then surgery is postponed. Another complication described in the literature is the displacement of the implants into the interior of the maxillary sinus during surgery or in the postoperative period. While in some cases implant migration causes sinusitis (39,40), in others, the patients remain asymptomatic (41-43). Theories to explain the displacement of the implants to the interior of the maxillary sinus include changes in intrasinal and nasal pressures that generate a suction effect, bone destruction secondary to an infection at the implant site before or after its implantation, or an improper distribution of occlusal forces (43).

These complications and dental failures can be minimized when taking into account certain aspects of treatment such as correct presurgical planning, the use of adequate surgical techniques, postsurgical follow-up, respecting the osseointegration period, appropriate design of the superstructure, the study and correct distribution of occlusal loads, and meticulous hygiene during the maintenance phase (2,4,5).

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