Biodegradable polyurethane for closure of oroantral communications

Visscher, Susan Henrieke

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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2016

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):

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Chapter 2

Closure of oroantral communications: a review of the literature.

Susan H. Visscher, Baucke van Minnen, Rudolf R.M. Bos

Edited version of:
Abstract

Oroantral communications (OACs) are usually caused by extraction of maxillary posterior teeth. Although the incidence is relatively low, OACs are frequently encountered due to the high number of extractions.

This article provides an overview of the most common surgical treatment strategies of oroantral communications, as well as the alternative treatment options, including their advantages and disadvantages. The treatment strategies are divided into techniques using autogenous soft tissue flaps or autogenous bone grafts, alloogenous grafts, xenografts and synthetic materials or metals.

In this literature search no prospective randomized comparative study has been found with patients groups that are large enough to generate reliable, statistically significant results on the superiority of one technique compared with another one.

Furthermore, it can be concluded that a very wide range of treatment techniques has been proposed during the year of which most did not manage to gain wide acceptance. Nowadays, surgical closure of OACs by means of a buccal or palatal flap is therefore still the treatment of choice.

Introduction

An oroantral communication is an open connection between the oral cavity and maxillary sinus. The maxillary sinus occupies a large part of the body of the maxilla, normally extending into the alveolar process adjacent to the apices of the posterior teeth.

Oroantral communications (OACs) are usually caused by extraction of maxillary posterior teeth (1,2). The thinness of the antral floor in that region ranges from 1 to 7 mm (3). Although the incidence is relatively low (5%) (4,5), OACs are frequently encountered due to the high number of extractions.

OACs may close spontaneously especially when the defect has a size below 5 mm (6). Nevertheless, to our knowledge it has never been actually proven that small OACs (< 5 mm) will heal by itself. Also, it is difficult to determine the size of the OAC clinically. To prevent chronic sinusitis and the development of fistulas, it is generally accepted that all of these defects should be closed within 24 to 48 hours (7).

Nowadays, closure of OACs is usually performed by means of a surgical procedure. In case of a small OAC, suturing the gingiva might be sufficient to close the perforation. When this does not provide adequate closure, a flap procedure is the treatment of choice. As Awang (8) suggested, flap procedures can be divided into local flaps and distant flaps. Local flap procedures include palatal flaps and various buccal flaps, of which Rehrmann’s and Mőczär’s techniques are widely known.

When determining how to treat an OAC, several aspects should be taken into account: the size of the communication, the time of diagnosing and the presence of an infection (1). Furthermore, the selection of the treatment strategy is influenced by the amount and condition of the tissue available for repair (8), and the possible placement of dental implants in the future.

Surgical therapy of OACs has several disadvantages, like the need for surgical expertise and equipment, postoperative pain and swelling and possibly a permanent decrease of the buccal sulcus depth (9). Several alternative techniques have been presented throughout the years. An overview of these treatment modalities is given in Figure 1.

The goal of this literature review was twofold; to answer the question if the buccal sliding flap still is the treatment of choice 20 years after the last review, and secondly to provide an overview of the most common surgical treatment strategies of OACs, as well as the alternative treatment options, including their advantages and disadvantages.
Materials and methods

A database was created, initially via PubMed, focusing on articles published in English, German or Dutch journals, and kept updated until November 2008. No beginning data limit was imposed. Articles were searched for OAC, OAP, OAF, oroantral, antrooral, antrooral, orosinusal, oro-sinusal, communication, fistula, perforation, Mundkieferhöhle, Mund-Antrum-Verbindung and combinations of these terms in title, abstract and Mesh terms. Citations were referenced to identify further relevant articles. Studies not involving patients, as well as articles in other languages than the above mentioned, were excluded. Studies with a small population and case reports were included. The treatment strategies for OACs that we found in this literature search were subsequently divided in the following groups; autogenous soft tissue grafts, autogenous bone grafts, allogenous materials, xenografts, synthetic closure and other techniques.

Autogenous soft tissue flaps

Although a large number of surgical methods have been described throughout the years, only a few seem to have gained wide acceptance. The most common surgical treatment of an oroantral communication is the buccal advancement flap procedure designed by Rehrmann (1936). In this procedure a broad based trapezoid mucoperiosteal flap is created and sutured over the defect. Its broad base assures adequate blood supply. Consequently, high success percentages (93%) have been reported (10). Disadvantages of the Rehrmann's method include the risk of reduction of the buccal sulcus depth, and manifest postoperative pain and swelling. A prospective follow-up study by Von Wowern (11) demonstrated that the reduction of sulcus depth after Rehrmann's method is permanent in half of the cases.

An alternative method for closure of OACs is Mőczár's flap; this method involves a buccal mucoperiosteal flap which is displaced one tooth-width distally. Mőczár's flap is recommended for edentulous patients because the large denuded area, which is the result of the distally displacement of the buccal sliding flap, may give rise to periodontal disease in dentate patients. Besides, buccal sulcus depth is minimally influenced by advancement of the Mőczár's flap, in comparison to Rehrmann's method (11).

Instead of buccal tissue, mucous membrane of the hard palate may be used to close an OAC. Full thickness mucoperiosteal palatal flaps in its various forms may especially be useful for closure of OACs larger than 10 mm (12). Lee (13) reported a success percentage of 76% of random palatal flaps in 21 patients. Furthermore, he concluded that an appropriate length/width ratio is the most important factor determining the clinical outcome of palatal flaps.

A palatal flap, either anteriorly based as described by Salins and Kishore (14) or...
posteriorly based, contains a large palatine vessel to ensure adequate blood flow. It is less vulnerable to rupture than a buccal flap because of the thickness of the palatal mucosa. Furthermore, the buccal sulcus depth remains intact. Negative aspects of the palatal flap include the denuded palatal donor area, and a soft tissue bulge at the axis of rotation. The denuded area remains until secondary epithelialization occurs. This causes relatively greater discomfort for the patient compared to other soft tissue techniques. Nevertheless, as Awang (8) mentioned, many surgeons prefer the palatal flap over the buccal flap procedure.

The buccal fat pad (BFP) is a lobulated mass of fatty tissue surrounded by a slight capsule, located inside the masticatory spaces (15;16). The size of the BFP has proven to be constant among individuals, regardless of the body weight and fat distribution (17). Blood supply to the BFP depends on branches of the superficial temporal, maxillary and facial arteries. Its use as a pedicled graft for reconstruction in oral surgery, including the closure of oroantral communications, has first been described by Egyedi (18) in 1977. One of the advantages of the BFP is the proximity of the BFP near the recipient area, permitting quick grafting. According to Neder (19) this is an important aspect in successful grafting. Hanazawa (20) used the BFP successfully in 13 of 14 patients for closure of OACs. Clinical findings showed that the BFP, after grafting, changed into granulation-like tissue over a period of 14 days, followed by complete epithelialization. These positive findings are in line with other studies (15;16;21;22). Furthermore, the buccal sulcus depth is not affected by the BFP technique (20–22). The easy mobilisation, its excellent blood supply and minimal donor site morbidity are clear advantages of the buccal fat pad as a graft material (16;22;22;23). On the other hand, the BFP requires very careful manipulation, and although success rates in literature are high (close to 100%) (16;21–23), closure of large defects could involve complications like graft necrosis or new fistulae (15). According to several authors, the indication for use of the BFP lies especially in cases with damage to the alveolar buccal or palatal mucoperiosteum, or cases that have failed with other methods (16;16;17;20;21).

Tongue flaps are suitable for reconstruction in various areas, including lip, cheek and palatal or oroantral fistulas, because they offer rich blood supply and pliability (8;16). Tongue flaps can be created from the ventral, dorsal or lateral part of the tongue (24). In general, the location of the defect dictates the choice of tongue flap. Especially the lateral tongue is suitable for closure of oroantral communications (25). Siegel et al. (26) used a full thickness pedicled flap from the lateral border of the tongue to close a large oroantral communication after partial maxillectomy. Healing was uneventful in this patient. The authors (26) stated that the lateral tongue flap is suitable for large oroantral defects in general, allowing instant repair with rarely failure. Kim et al. (24) also used a posteriorly based full thickness lateral tongue flap to close an OAC, with success.

General disadvantages of the tongue flaps are the requirement for general anaes-

**Autogenous bone grafts**

Proctor (27) first suggested bone grafts harvested from the iliac crest for closure of large oroantral communications in 1969. Nevertheless, bone grafting for closure of OACs has the disadvantage of requiring a second surgical procedure for bone harvesting. This second procedure elongates surgical time and increases patient morbidity. Despite these disadvantages, bone grafting for closure of OACs has gained attention over the past years, because of the rising demand for implant rehabilitation.

Harvesting bone from the iliac crest involves significant donor site morbidity, like prolonged post-operative pain and possible sensory disturbance (28). Moreover, harvesting bone from intra-oral donor areas significantly reduces the demands made on the patients postoperatively and can be performed under local anaesthesia (29;30). Therefore, alternative donor areas have been investigated, including bone grafts from the retromolar area, zygomatic process and the chin (31–33).

Watzak (31) harvested retromolar bone for press-fitted closure of oroantral communications in 4 patients. After placing the bone graft, soft tissue closure was realised by means of a Rehrmann buccal flap. No re-opening of the sinus was observed.

A limiting factor of the retromolar donor area is the confined amount of bone available (29;31). However, in most cases only a small amount of bone will be needed for closure of OACs. Besides, retromolar bone seems to form a solid base for implant rehabilitation (31).

Chin bone for oroantral fistula closure was studied in 5 patients by Haas (33). In 3 patients a stable press-fit of the bone graft in the OAC was accomplished. In 2 patients additional plates and screws were used to obtain a rigid fixation of the graft. Secondly, a Rehrmann flap was used in all patients for soft tissue closure. Wound dehiscence occurred in 1 patient, but the sinus remained unaffected. The use of a monocortical (chin) bone block for closure of an OAC is recommended for patients affected by maxillary atrophy requiring sinus augmentation before implant placement (39).

Peñarrocha-Diago used zygomatic bone as a bone graft for closure of an OAC in 1 patient. Subsequently 2 dental implants were placed. This technique offers the advantage of the proximity of the donor area to the recipient area, which benefits to minimization of surgical time and patient discomfort (32). As in retromolar bone grafts, limited bone is obtainable from the zygomatic process. Furthermore, accidental sinus membrane perforation may occur (32).
Allogenous materials

Several authors achieved closure of oroantral communications using lyophilized fibrin glue of human origin (34;35;36). Kniha (34) and von Gattinger (36) used the fibrin glue in combination with a collagen sheet, where Stajcic (35) solely used fibrin glue. Preparation of the fibrin glue takes about 15 to 20 minutes. The glue is then applied in the socket with a syringe, together with the collagen sheet. Hereafter the oral surface is sealed with the rest of the fibrin glue. After 2 hours the glue has reached its maximum strength. Both authors using fibrin glue in combination with collagen reported high success percentages. An advantage of this strategy is clearly the fact that no flaps need to be raised. Therefore, intra-oral anatomy remains intact. Furthermore, the method is straight-forward and gives rise to little post operative complaints (36). Stajcic (35) reported excellent results with the use of fibrin glue by itself. He stressed the importance of inserting the syringe above the floor of the antrum to protect the clot from airflow.

Disadvantages of the method are the, according to the manufacturer, small risk of transmitting viral hepatitis, and the preparation time needed for the fibrin glue.

Kinner and Frenkel (37) used lyophilized dura to treat OACs in 29 patients. The sterilized dura is placed in a saline solution to regain its flexibility. Hereafter it is cut to size to make it cover the bony margins of the defect. Sutures are placed at the corners of the graft after which it is covered with a plastic plate for protection. The dura exfoliated after 2 weeks. Uncomplicated healing was observed in 28 of 29 patients. This successful and simple technique involves no surgical intervention, which makes it an attractive strategy. However, the small risk of transmitting pathogens can not be ruled out completely.

Xenografts

Mitchell and Lamb (38) as well as Shaker et al. (39) used lyophilized porcine dermis (Zenoderm) for closure of oroantral perforations. Mitchell and Lamb (38) left the porcine graft exposed to the oral environment. Conversely, Shaker and colleagues (39) placed both buccal and palatal sliding flaps over the porcine collagen. Both authors report good results (1 failure of 10 patients and 1 failure of 30 patients, respectively).

The collagen does not have to be removed because it is ultimately replaced by fibrous tissue. Nevertheless, it remains in place for a sufficient length of time to allow for mucosal overgrowth across the communication (38,39).

Mitchell and Lamb (38) showed that covering the graft by buccal and palatal flaps is not necessary to obtain optimal results, apparently offering a far more straightforward strategy than Shaker and colleagues (39).

A new surgical management of OACs was described by Ogunsalu (40). The author used both Bio-Guide® (porcine collagen membrane) and Bio-Oss® (bovine bone grafting material) to close an OAC in 1 patient. For this purpose the Bio-Oss® granules were sutured in a prefabricated Bio-Guide® envelope. A full thickness mucoperiosteal flap was then raised and the Bio-Oss® - Bio-Guide® sandwich placed underneath. Hereafter the flap was repositioned, resulting in primary closure. Healing was uneventful in this patient. According to the author, the radiograph showed bony healing of the defect 8 months after closure, permitting placement of an endosseous implant. Nevertheless, bony regeneration has not been objectively quantified in this patient. Disadvantage of this technique is the need for a mucoperiosteal flap to cover the sandwich. An advantage is the fact that seemingly both bony and soft closure is accomplished, without donor site surgery.

Synthetic closure

Various synthetic materials have been described in literature for closure of oroantral communications. Several studies report on the use of gold foil or gold plate for closure of oroantral communications (41-47).

The gold foil is burnished into place with its edges on healthy bone, thus acting as a bridge for overgrowing sinus mucosa. The mucoperiosteal flaps, that were raised to expose the bony margins of the defect, are sutured across the gold foil without attempting to realize primary closure. In general, the gold foil exfoliates after a period of 6 weeks (41;43-45). The value of the gold foil technique seems to lie in the closure of large OACs that failed in previous attempts, and in the unaltered intra-oral anatomy (42-43). Disadvantage of this rather expensive technique is the relatively long period of time needed for complete closure and healing (43).

Steiner (48) proposed 36-gauge pure aluminium plates for closure. In line with the gold technique, the aluminium plate is used as a protective plate to aid in closure. Sutures are placed only for approximation of the buccal and palatal tissue; the aluminium plate is therefore visible at all times. After 6 weeks, the aluminium is displaced from its initial position due to the reparative tissue formed underneath. Healing was uneventful in all 8 patients. Advantages of the aluminium are its malleability and softness, besides its low cost compared to gold.

In addition, tantalum foil was used by Mc Clung and Chipp (49) for closure of 4 OACs in edentate patients, using the same method as in the gold technique. No complications were observed. The tantalum foil had been exfoliated after 9 weeks, revealing new granulation tissue across the defect.

Al-Sibahi et al. (50) described a technique for closure of OACs using self curing polymethylmethacrylate (PMMA) in 10 patients. The technique resembles the methods using metals as described above. The PMMA plate is immersed for 24 hours in a sterilizing solution, cut to size and placed over the defect. Mucoperiosteal flaps are then
replaced without attempting to cover the acrylic plate. After 3–4 weeks the PMMA plate becomes visible and is removed as soon as the edges become exposed. Results were satisfying for all 10 patients. A disadvantage of this method, compared to the use of gold or aluminium, is the needed preparation in advance; e.g. mixing the powder and liquid, allowing it to set, and sterilizing it for 24 hours.

Dense hydroxyl apatite (HA) has also been used for closure of OAC (51,52). Zide et al (52) used hydroxyl apatite blocks which were carved to fit the defect, and encircled with a wire for stability when needed. The authors observed natural extrusion of the blocks without recurrence of a fistula in all 6 patients.

Becker et al (51) used hydroxyl apatite implants in 5 different sizes for closing oro-antral defects. Hydroxyl apatite granules were used to fill any remaining space in the socket. Oral mucosa was approximated without complete closure. Healing was uneventful in all 20 patients. By contrast, these authors observed no extrusion of the HA implants. Due to this, dental implants could not be placed in a later stadium.

Disadvantages of hydroxyl apatite for closure of OAC are the expensiveness of the material, and the need for a variety of implant sizes to allow for size selection.

Root analogue made of β-tricalcium phosphate was used by Thoma et al (53) in 20 patients with OACs. The root replicas were fabricated chair side, using a mould of the extracted tooth. Replicas could be placed in only 14 of 20 patients due to the necessity of a proper recipient socket to ensure tight fitting of the root replica. No complications were observed. This technique proved to be fast and simple, but can not be performed in all patients due to technical limitations (53).

Other techniques

Third molar transplantation for closure of oroantral communications has been described by Kitagawa et al. (54). The authors successfully used a transplanted upper and lower third molar for closure of OACs in 2 patients. Donor teeth were placed in slight infraocclusion, fixed by firm finger pressure and light tapping, without the need for additional stabilization. Endodontic therapy of the donor teeth was performed after 3 weeks. The authors concluded that third molar transplantation is a successful but challenging procedure, depending on a proper recipient socket and perfect fitting of the donor tooth. Besides the obvious need for a donor tooth, the method is not recommended when there are space limitations for the donor tooth in the recipient area, and when mucoperiosteal tissue is damaged.

Hori et al. (55) described the successful application of interseptal alveolotomy for closure of small oroantral communications in 8 patients. This technique is derived from Dean’s preprosthetic technique and originally designed for smoothing the alveolar ridge. In the extended Dean’s technique the interseptal bone is removed, followed by fracturing of the buccal cortex in the direction of the palate. Finally, sutures are used for soft tissue closure. According to the authors the advantages of the extended Dean’s technique lie in the fact that a bony base is created for closure, with less postoperative swelling compared to a flap procedure. Furthermore, the buccal sulcus depth is not influenced. Nevertheless, this method is restricted to cases with at least 1 cm of space across the fistula (44). In addition, the required breaking of the buccal bone carries the risk of inflammation due to formation of bone sequestrums and possible deficient closure of the soft tissue in case the fracture is incomplete.

A technique for the closure of OACs using guided tissue regeneration is described by Waldrop and Semb (56). The technique involves an absorbable gelatine membrane, allogenic bone graft material, and a non-resorbable polytetrafluoroethylene (ePTFE) membrane. First a flap is reflected and an absorbable gelatine membrane is placed over the OAC with its edges on the bony margins of the perforation, to act as a barrier for the bone graft material. A layer of allogenic bone graft material is put on the membrane. Hereafter, the non-resorbable ePTFE membrane is used to cover the bone graft material and the soft tissue flap placed over the membrane. Eight weeks after placement, the ePTFE membrane is removed, after removal of the inner aspect of the flap adjacent to the ePTFE membrane, and the mucoperiosteal flap replaced. Two patients were successfully treated with this technique. Clinically bone formation was seen by the authors after removal of the ePTFE, although this has not been confirmed histologically. Disadvantages of the method are the need for a full thickness flap, and a second procedure to remove the non-resorbable ePTFE membrane. The authors did not provide information concerning the tolerance of the patients to the procedure.

Prolamin occlusion gel is an alkaline alcoholic solution based on corn protein. The prolamin gel has been used by Götzfried and Kaduk (57) as well as Kinner and Frenkel (37) for closure of OACs. The solution is injected in the perforation and hardens within a few minutes. After a week, granulation tissue is formed and the prolamin gel completely dissolved after 2–3 weeks (37). According to the authors, the procedure was well tolerated by the patients (37). This simple treatment strategy results in less postoperative complaints compared to the standard flap procedure. Besides, it does not influence the buccal sulcus depth. Disadvantages of this technique are high material costs, and the fact that the technique is less suitable for OAC larger then 3 mm, or shallow OACs (37,57).

Laser light was suggested by Grzesiak-Janas and Janas (58) to establish closure of OACs without surgical intervention. Laser light in low doses has also been used successfully in the prevention and/or healing of chemotherapy induced oral mucositis (59,60). Grzesiak-Janas and Janas used a biostimulative laser of 30 mW power for 3 cycles of extraoral and intraoral irradiation. In this study, sixty-one patients were exposed to the laser light for 10.5 minutes for 4 consecutive days. Patients were treated. No reopening of the OACs was observed. The technique was well tolerated by the patients. The elimination of the necessity of a surgical procedure is an obvious advan-
tage of the laser treatment. Disadvantages seem the costs of the laser therapy, and the number of visits necessary to accomplish complete closure.

Lastly, Logan and Coates (61) proposed a treatment strategy for OACs in immunocompromised patients. A HIV-infected patient was treated with this technique. Firstly, the OAC was de-epithelialized under local anaesthesia. Secondly, an acrylic surgical splint was fitted that covered the fistula and the edentulous area including the hard palate. The patient wore the splint continuously over a period of 8 weeks, removing it only for cleaning. An oral candidiasis developed, probably in relation to xerostomia, which was successfully treated with miconazole oral gel.

Complete healing was established after 8 weeks. The technique proved a very useful option when a surgical intervention is contraindicated because of immunosuppression. Sokler et al (62) reported that the palatal splint technique in combination with simultaneous antibiotics is, with success, routinely applied in non-immunocompromised patients in Croatia.

Discussion and conclusions

A literature search of the English, Dutch and German literature concerning closure of oroantral communications has been performed to provide an overview of the different treatment options.

Mostly, the studies in this review reporting on a new strategy for closure of OACs were either case reports, or prospective studies. Unfortunately, none of the authors have implemented randomized controlled clinical trials allowing for comparison of the new strategy with, for example, standard surgical closure. Secondly, in a significant number of studies the number of patients treated was rather low, and no further studies were implemented in a larger number of patients.

Thirdly, most studies did not provide information concerning the length of the proposed procedure, which seems an important aspect to assess its feasibility.

Lastly, in several studies, the description of the treatment strategy did not provide enough details necessary to gain a complete impression of its quality.

Nevertheless, all of these studies were included in this article to provide a complete overview of the treatment strategies of oroantral communications.

Ideally, a treatment of OACs is quick, safe, straightforward, well tolerated by the patients, has low costs, and results in both good bony and soft tissue healing with a low complication rate. However, such a treatment simply does not seem to exist until now.

Therefore, soft tissue closure using a buccal or palatal flap still seems to be the treatment of choice for OACs, in case primary suturing of the gingiva does not provide adequate closure of the communication. The buccal flap, despite its risk of reducing the buccal sulcus depth, appears more popular than the palatal flap, which results in a denuded palatal donor area requiring secondary epithelialization. Nevertheless, a number of surgeons seem to prefer the palatal flap because of its excellent blood supply and the fact that the buccal sulcus remains intact. On the other hand, a reduction of the buccal sulcus depth is nowadays becoming less of a problem with the possibility of implant retained overdentures.

At the present time, bony closure of OACs seems to gain interest. This is probably as stated before a result of the rising demand for implant rehabilitation. When placement of an endosseous implant is desired, bone grafting for closure of the OAC might be the best option. Nowadays, intraoral bone harvesting is the strategy of choice for bone harvesting, reducing patient morbidity compared to extraoral bone harvesting.

Some of the alternative treatment strategies of OACs also claim good bone regeneration at the site of the perforation. Most of these studies, however, did not assess bone formation objectively. Therefore, strategies that do not involve autogenous bone grafts like for example the Bio-Gide® – Bio-Oss® technique (40), root analogue (53) or metals like gold (10;12;49-54) and aluminium (55), might also result in adequate bone formation for implant rehabilitation, although this has not yet been objectified.

Lastly, there is a tendency in medicine to prefer synthetic materials above materials of animal derived origin. Reason for this is possible transmission of pathogens of animal derived products.

Based on this review it may be concluded that a wide range of techniques has been proposed in literature, of which only a few have gained wide acceptance. Reason for this may be found in the costs of the proposed method, where other alternative treatments did not offer any simplification compared to the standard closure. Surgical closure of OACs by means of a buccal or palatal flap therefore remains the treatment of choice.
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