

Closure of Oroantral Communications: A Review of the Literature

Susan H. Visscher, MD,* Baucke van Minnen, DDS, MD, PhD,†
and Rudolf R.M. Bos, DMD, PhD‡

An oroantral communication (OAC) is an open connection between the oral cavity and maxillary sinus. The maxillary sinus takes up a large part of the body of the maxilla, generally extending into the alveolar process bordering the apices of the posterior teeth.

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 large number of extractions.

OACs may close spontaneously especially when the defect has a size smaller than 5 mm.⁶ Nevertheless, to our knowledge, it has never been actually proven that small OACs (<5 mm) will heal by themselves. 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

Currently, closure of OACs is usually performed by 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 Awang⁸ 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's⁹ and Móczáir's¹⁰ techniques are widely known.

When deciding 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 repair⁸ and the possible placement of dental implants in the future.

Surgical therapy of OACs has several disadvantages, such as the need for surgical expertise and equipment, postoperative pain and swelling, and possibly a permanent decrease of the buccal sulcus depth.¹¹ 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 2-fold: to answer the question if the buccal sliding flap still is the treatment of choice 20 years after the last review and to provide an overview of the most common surgical treatment strategies of OACs and the alternative treatment options, including their advantages and disadvantages.

Materials and Methods

A database was created, initially with 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*, *antro-oral*, *antrooral*, *orosinusal*, *oro-sinusal*, *communication*, *fistula*, *perforation*, *Mundkieferböhle*, *Mund-Antrum-Verbindung*, and combinations of these terms in title, abstract, and Medical Subject Heading terms. Citations were referenced to identify further relevant articles. Studies not involving patients and articles in other languages than those mentioned earlier 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 into the following groups: autogenous soft tissue grafts, autogenous bone grafts, allogeneous materials, xenografts, synthetic closure, and other techniques.

AUTOGENOUS SOFT TISSUE FLAPS

Although many surgical methods have been described throughout the years, only a few seem to have

Received from the Department of Oral and Maxillofacial Surgery, University Medical Centre Groningen, University of Groningen, Groningen, The Netherlands.

*Research Associate.

†Resident, Research Associate.

‡Professor.

Address correspondence and reprint requests to Dr Visscher: Department of Oral and Maxillofacial Surgery, University Medical Centre Groningen, University of Groningen, Hanzeplein 1, PO Box 30.001, 9700 RB, Groningen, The Netherlands; e-mail: s.visscher@kchir.umcg.nl

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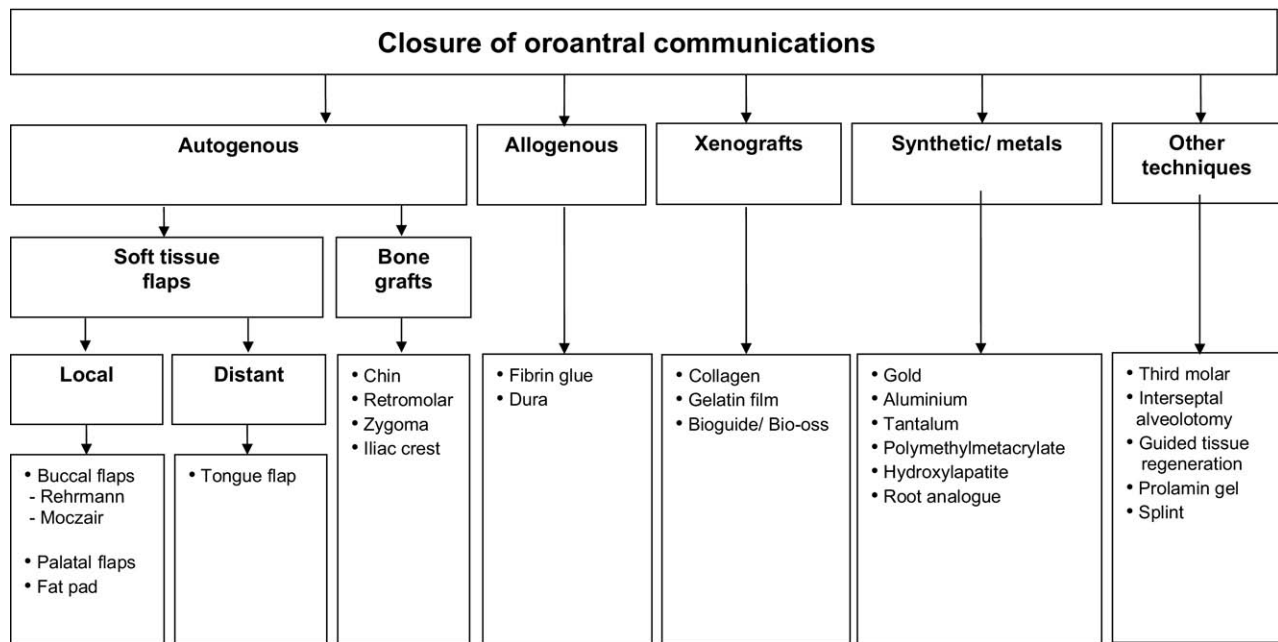


FIGURE 1. Overview of the treatment modalities of oroantral communications.

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gained wide acceptance. The most common surgical treatment of an OAC is the buccal advancement flap procedure designed by Rehrmann.⁹ 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.¹² Disadvantages of the Rehrmann method include the risk of reduction of the buccal sulcus depth and manifest postoperative pain and swelling. A prospective follow-up study by von Wowern¹³ demonstrated that the reduction of sulcus depth after the Rehrmann method is permanent in half of the cases.

An alternative method for closure of OACs is the Móczáir flap¹⁰; this method involves a buccal mucoperiosteal flap that is displaced 1 tooth width distally. The Móczáir flap is recommended for edentulous patients because the large denuded area, which is the result of the distal displacement of the buccal sliding flap, may give rise to periodontal disease in dentate patients. In addition, buccal sulcus depth is minimally influenced by advancement of the Móczáir flap in comparison with the Rehrmann method.¹³ Haanaes and Pedersen¹⁴ obtained a success rate of 95.7% in their study using the Móczáir surgical approach.

Instead of buccal tissue, mucous membrane of the hard palate may be used to close an OAC. Full-thickness mucoperiosteal palatal flaps in various forms may especially be useful for closure of OACs larger than 10 mm.¹⁵ Lee et al¹⁶ reported a success rate of 76% of random palatal flaps in 21 patients. Furthermore, they

concluded that an appropriate length-width ratio is the most important factor determining the clinical outcome of palatal flaps.

A palatal flap, anteriorly based as described by Salins and Kishore¹⁷ 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 with other soft tissue techniques. Nevertheless, as Awang⁸ 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.^{18,19} The size of the BFP has proved to be constant among individuals, regardless of the fat distribution and body weight.²⁰ 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 OACs, was first described by Egyedi²¹ in 1977. One of the advantages of the BFP is the proximity of the BFP near the recipient area, permitting quick grafting. According to Neder²² this is an important aspect in successful grafting. Hanazawa et al²³ 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.^{18,19,24,25} Furthermore, the buccal sulcus depth is not affected by the BFP technique.²³⁻²⁵ The easy mobilization, its excellent blood supply, and minimal donor-site morbidity are clear advantages of the BFP as a graft material.^{19,25,26} In contrast, the BFP requires very careful manipulation, and although success rates in the literature are high (close to 100%),^{19,24-26} closure of large defects could involve complications such as graft necrosis or new fistulas.¹⁸ According to several investigators, the indication for use of the BFP occurs especially in cases with damage to the alveolar buccal or palatal mucoperiosteum or cases that have failed with other methods.^{19,20,23,24}

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.^{8,19} Tongue flaps can be created from the ventral, dorsal, or lateral part of the tongue.²⁷ In general, the location of the defect dictates the choice of tongue flap. Especially the lateral tongue is suitable for closure of OACs.²⁸ Siegel et al²⁹ used a full-thickness pedicled flap from the lateral border of the tongue to close a large OAC after partial maxillectomy. Healing was uneventful in this patient. The investigators²⁹ stated that the lateral tongue flap is suitable for large oroantral defects in general, allowing instant repair with rare failure. Kim et al²⁷ 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 anesthesia, although the cutting of the pedicle 14 days after attachment may be performed under local anesthesia,¹⁹ and the requirement for a 2-stage or 3-stage procedure to gain ultimate results.

AUTOGENOUS BONE GRAFTS

Proctor³⁰ first suggested bone grafts harvested from the iliac crest for closure of large OACs 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 recent years, because of the rising demand for implant rehabilitation.

Harvesting bone from the iliac crest involves significant donor-site morbidity, such as prolonged postoperative pain and possible sensory disturbance.³¹ Moreover, harvesting bone from intraoral donor areas

significantly reduces the demands made on the patients postoperatively and can be performed under local anesthesia.^{32,33} Therefore, alternative donor areas have been investigated, including bone grafts from the retromolar area, zygomatic process, and the chin.³⁴⁻³⁶

Watzak et al³⁴ harvested retromolar bone for press-fitted closure of OACs in 4 patients. After placing the bone graft, soft tissue closure was realized by a Rehrmann buccal flap. No reopening of the sinus was observed.

A limiting factor of the retromolar donor area is the confined amount of bone available.^{32,34} However, in most cases only a small amount of bone will be needed for closure of OACs. Further, retromolar bone seems to form a solid base for implant rehabilitation.³⁴

Chin bone for oroantral fistula closure was studied in 5 patients by Haas et al.³⁶ 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. 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.³⁶

Peñarrocha-Diago et al³⁵ 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 minimizes surgical time and patient discomfort.³⁵ As in retromolar bone grafts, limited bone is obtainable from the zygomatic process. Furthermore, accidental sinus membrane perforation may occur.³⁵

ALLOGENOUS MATERIALS

Several investigators have achieved closure of OACs using lyophilized fibrin glue of human origin.³⁷⁻³⁹ Kniha et al³⁷ and Gattinger³⁹ used the fibrin glue in combination with a collagen sheet, whereas Stajcic et al³⁸ 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. Thereafter, the oral surface is sealed with the rest of the fibrin glue. After 2 hours the glue has reached its maximum strength. Investigators 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, intraoral anatomy remains intact. Furthermore, the method is straightforward and gives rise to few postoperative complaints.³⁹ Stajcic et al³⁸

reported excellent results using fibrin glue alone. They stressed the importance of inserting the syringe above the floor of the antrum to protect the clot from airflow.

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

Kinner and Frenkel⁴⁰ used lyophilized dura to treat OACs in 29 patients. The sterilized dura is placed in a saline solution to regain its flexibility. Then 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 is 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 cannot be ruled out completely.

XENOGRAFTS

Mitchell and Lamb⁴¹ and Shaker et al⁴² used lyophilized porcine dermis (Zenoderm; Ethicon LTD, Edinburgh, Scotland) for closure of oroantral perforations. Mitchell and Lamb⁴¹ left the porcine graft exposed to the oral environment. Conversely, Shaker et al⁴² placed buccal and palatal sliding flaps over the porcine collagen. Both groups reported good results (1 failure in 10 patients and 1 failure in 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.^{41,42}

Mitchell and Lamb⁴¹ 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 et al.⁴²

A new surgical management of OACs was described by Ogunsalu.⁴³ Ogunsalu used Bio-Guide (porcine collagen membrane) and Bio-Oss (bovine bone grafting material) (Geistlich Pharma AG, Wolhusen, Switzerland) 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. Then the flap was repositioned, resulting in primary closure. Healing was uneventful in this patient. According to the researcher, the radiograph showed bony healing of the defect 8 months after closure, permitting placement of an endosseous implant. Nevertheless, bony regeneration was not objectively quantified in this patient. A disadvantage of this technique is the need for a muco-

periosteal flap to cover the sandwich. An advantage is the fact that seemingly bony and soft closures are accomplished, without donor-site surgery.

SYNTHETIC CLOSURE

Various synthetic materials have been described in the literature for closure of OACs. Several studies have reported on the use of gold foil or gold plate for closure of OACs.⁴⁴⁻⁵⁰

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, which 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.^{44,46-48} 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 intraoral anatomy.^{45,46} A disadvantage of this rather expensive technique is the relatively long period needed for complete closure and healing.⁴⁶

Steiner et al⁵¹ proposed 36-gauge pure aluminum plates for closure. In line with the gold technique, an aluminum plate is used as a protective plate to aid in closure. Sutures are placed only for approximation of the buccal and palatal tissues; the aluminum plate is therefore visible at all times. After 6 weeks, the aluminum plate is displaced from its initial position due to the reparative tissue formed underneath. Healing was uneventful in all 8 patients. Advantages of the aluminum are its malleability and softness and its low cost compared with gold.

In addition, tantalum foil was used by McClung and Chippis⁵² for closure of 4 OACs in edentate patients, using the same method as in the gold technique. No complications were observed. The tantalum foil was exfoliated after 9 weeks, revealing new granulation tissue across the defect.

Al Sibahi and Shanoon⁵³ described a technique for closure of OACs using self-curing polymethylmethacrylate in 10 patients. The technique resembles the methods using metals as described earlier. The polymethylmethacrylate 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 to 4 weeks the polymethylmethacrylate 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 with the use of gold or aluminum, is the needed preparation in advance, eg, mixing the power and liquid, allowing it to set, and sterilizing it for 24 hours.

Dense hydroxylapatite has also been used for closure of OAC.^{54,55} Zide and Karas⁵⁵ used hydroxylapatite blocks that were carved to fit the defect and

encircled with a wire for stability when needed. The investigators observed natural extrusion of the blocks without recurrence of a fistula in all 6 patients.

Becker et al⁵⁴ used hydroxylapatite implants in 5 different sizes for closing oroantral defects. Hydroxylapatite 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. In contrast, these researchers observed no extrusion of the hydroxylapatite implants. Due to this, dental implants could not be placed at a later stage.

Disadvantages of hydroxylapatite for closure of OAC are the expense of the material and the need for a variety of implant sizes to allow for size selection.

A root analog made of β -tricalcium phosphate was used by Thoma et al⁵⁶ in 20 patients with OACs. The root replicas were fabricated chair side, using a mold 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 cannot be performed in all patients due to technical limitations.⁵⁶

OTHER TECHNIQUES

Third molar transplantation for closure of OACs has been described by Kitagawa et al.⁵⁷ The investigators successfully used a transplanted upper and lower third molar for closure of OACs in 2 patients. Donor teeth were placed in slight infraocclusion and 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 researchers concluded that third molar transplantation is a successful but challenging procedure, depending on a proper recipient socket and perfect fitting of the donor tooth. In addition to 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 al⁵⁸ described the successful application of interseptal alveolotomy for closure of small OACs in 8 patients. This technique is derived from the Dean preprosthetic technique and originally designed for smoothing the alveolar ridge. In the extended Dean technique the interseptal bone is removed, followed by fracturing of the buccal cortex in the direction of the palate. Sutures are used for soft tissue closure. According to the investigators the advantages of the extended Dean technique are that a bony base is created for closure with less postoperative swelling compared with 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 sequestrs 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 was described by Waldrop and Semba.⁵⁹ The technique involves an absorbable gelatin membrane, allogenic bone graft material, and a nonresorbable polytetrafluoroethylene (ePTFE) membrane. A flap is reflected and an absorbable gelatin 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. The nonresorbable ePTFE membrane is used to cover the bone graft material, and the soft tissue flap is 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 investigators after removal of the ePTFE, although this was not confirmed histologically. Disadvantages of the method are the need for a full-thickness flap and a second procedure to remove the nonresorbable ePTFE membrane. The researchers did not provide information concerning the tolerance of 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 Kaduk⁶⁰ and Kinner and Frenkel⁴⁰ 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 dissolves after 2 to 3 weeks.⁴⁰ According to the investigators, the procedure was well tolerated by patients.⁴⁰ This simple treatment strategy results in fewer postoperative complaints compared with the standard flap procedure. In addition, it does not influence buccal sulcus depth. Disadvantages of this technique are high material costs and the fact that the technique is less suitable for OACs larger than 3 mm or shallow OACs.^{40,60}

Laser light was suggested by Grzesiak-Janias and Janias⁶¹ 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.^{62,63} Grzesiak-Janias and Janias used a biostimulative laser of 30-mW power for 3 cycles of extraoral and intraoral irradiation. In this study, 61 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 advantage of the laser treatment. Disadvantages are the cost of laser therapy and the number of visits necessary to accomplish complete closure.

Logan and Coates⁶⁴ proposed a treatment strategy for OACs in immunocompromised patients. One patient with human immunodeficiency virus was treated with this technique. First, the OAC was de-epithelialized under local anesthesia. Second, 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 al⁶⁵ reported that the palatal splint technique in combination with simultaneous antibiotics is, with success, routinely applied in nonimmunocompromised patients in Croatia.

Discussion

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

First, most studies in this review reporting on a new strategy for closure of OACs were case reports or prospective studies. Unfortunately, none of the investigators implemented randomized controlled clinical trials allowing for comparison of the new strategy with, eg, standard surgical closure. Second, in a significant number of studies the number of patients treated was rather small, and no further studies were implemented in a larger number of patients.

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

Fourth, in several studies, the description of the treatment strategy did not provide enough necessary details 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 OACs.

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

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, many surgeons seem to prefer the palatal flap because of its excellent blood supply and the fact that the buccal sulcus remains intact. In contrast, a reduction of the buccal sulcus depth is currently 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 earlier, 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. Intraoral bone harvesting is the current strategy of choice for bone harvesting, reducing patient morbidity compared with extraoral bone harvesting.

Some of the alternative treatment strategies for 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 such as the Bio-Guide-Bio-Oss technique,⁴³ root analog,⁵⁶ or metals such as gold^{10,12,49-54} and aluminum⁵⁵ might also result in adequate bone formation for implant rehabilitation, although this has not yet been objectified.

There is a tendency in medicine to prefer synthetic materials above materials of animal-derived origin. The reason 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 the literature, of which only a few have gained wide acceptance. The reason for this may be found in the costs of the proposed method, where other alternative treatments did not offer any simplification compared with the standard closure. Surgical closure of OACs by a buccal or palatal flap therefore remains the treatment of choice.

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