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Another Way of Treating Fractures of the Atrophic Edentulous Mandible

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Summary

The treatment of fractures of the edentulous, atrophic mandible with the usual surgical methods has proved unsatisfactory in our hands. We have therefore, searched for a more successful procedure and believe we have found a method utilizing autogenous or deep frozen rib grafts to immobilize the fragments. The grafts are placed around the mandibular ridge to include the fracture sites and are maintained and stabilized with at least two circum-mandibular wires for each fragment. With the use of autogenous bone, as described in this procedure, the fracture can be stabilized and at the same time the alveolar ridge augmented and shaped for prosthetic purposes. The treatment of 5 cases is presented: one includes an extensive bilateral nonunion of the edentulous mandible, the defect of which was bridged by a circular autogenous iliac crest graft. In the remaining 4 cases autogenous or deep frozen bank rib grafts were used. On the basis of the presented cases, the ideal treatment and possible errors are discussed.

Key-Words: Mandibular fractures; fractures – edentulous mandible; bone grafting to mandible; alveolar crest augmentation.

Introduction

Fractures of the edentulous mandible, in most cases, require treatment with a surgical procedure (*Rowe* and *Killey* 1968). Treatment of fractures of the extremely atrophic mandible is very difficult with any of the methods known to date. The main reason for this difficulty lies in the fact that sometimes the atrophy has progressed to the point at which the mandible is only pencil thin, leaving very little bony contact between the fracture surfaces. We will describe a method in which most of the existing difficulties of treatment may be overcome, and in which the extremely atrophied mandible may be augmented with bone to provide the mandible with a better ridge. The patient may then later wear a full lower denture more comfortably.

Method

The method is based on the principle that fractures, including comminuted fractures of the extensively atrophied mandible, may be treated by overlaying the fracture site with bone transplants, fulfilling the following objectives:

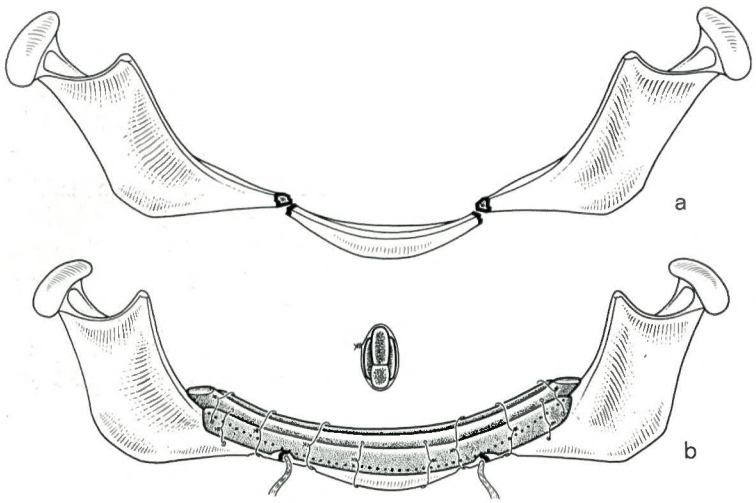
1. By bridging the fracture site, the very small fracture surfaces of the atrophic mandible are augmented by the bone graft, thus increasing the surface of bony contact for better stability. The overlayed bone graft also acts as a splint for better immobilisation of the segments in position.
2. By overlaying the bone graft on the atrophied lower jaw the alveolar ridge will be augmented and reconstructed. Therefore, at the same time, a fracture is treated and a necessary preprosthetic operation is accomplished, using an autogenous bone graft.

The bone for the graft may be either an autogenous iliac crest graft or rib graft. If the patient's general pre-operative condition precludes the use of an autogenous graft, deep frozen homologous rib grafts may be utilized.

With the patient nasally intubated and under general aneasthesia, the operation proceeds via an intraoral approach. An incision is made at the height of the alveolar ridge, from the retromolar triangle to the midline. In the case of the extremely atrophied mandible, there is generally a bilateral fracture present. Most frequently, the fractures are in the area of the mental foramina bilaterally. In this case, the mucoperiosteal incision continues to the retro-molar triangle on the opposite side. After reflecting the muco-periosteal tissue and visualizing the fractures, the segments are placed in their normal anatomical position and held in place by an assistant. The bone graft that has been contoured to the anticipated aug-

mented shape of the mandible is placed on the atrophic mandible, bridging the fractures and extending a minimum of 2 1/2 cm anterior and posterior to the fracture sites. The graft may then be wired into this position with circum-mandibular wires, fixing the mandibular fractures firmly in a stabilized position. It is occasionally necessary to thin out the cortical bone on the surface of the mandible to be grafted, with a vulcanite bur, until small bleeding points appear. This is especially necessary when a relatively thick layer of cortical bone is present. Bur holes can be made through the cortical layer as an alternative method of obtaining bleeding points.

When ribs are used as the grafting material, two 14–16 cm lengths of rib are required. A full thickness rib is shaped with large contouring pliers corresponding to the curve of the lower jaw. The rib is then placed on the crest of the ridge, in a semi-circular fashion, to cover the bilaterally fractured mandible. The rib graft is splinted to the fractured mandible with circum-mandibular wires, at least two distal and two mesial to the fracture site. The rib tapers distally to end in front of the retro-molar triangle. The second rib is split longitudinally with a chisel. After shaping each half with contouring pliers, one half of the rib is placed on the bucco-labial aspect and the other half on the lingual aspect of the mandible. In the region of the exit of the mental nerve, the rib half to be placed on the buccal surface is grooved to accommodate the nerve. The rib halves are then fixed into place with additional wires which encircle the lower



a) Situation of a bilateral fracture in an extremely atrophic mandible.

b) Situation at the end of treatment: one full thickness rib graft is placed over the ridge of the atrophic mandible far enough beyond the fracture lines and each of 2 split rib grafts are placed on the buccal and lingual surfaces of the fractured mandible. The rib grafts are wired to the mandibular fragments with circum-mandibular wires, at least two on each side of the fracture line, thus splinting the fractured mandible from three surfaces. The labially placed split rib grafts are notched to accommodate the exit of the mental nerves at the mental foramina.

Fig. 1 a + b Schematic drawing of Obwegeser's procedure for the immobilization of fractures of the atrophic mandible by rib grafts.

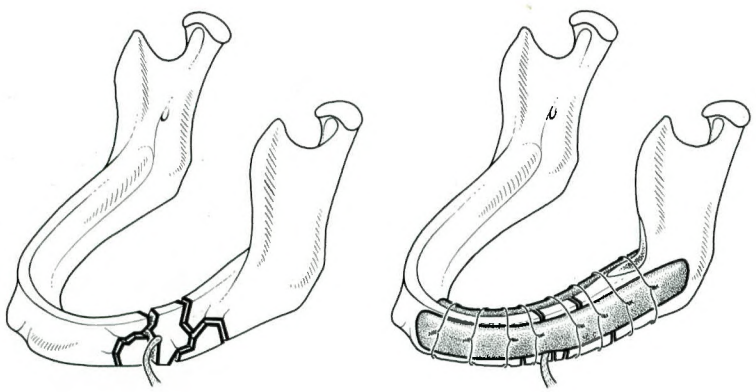


Fig. 2 Proposed treatment of a comminuted fracture of a non atrophic edentulous mandible: split autogenous or bank rib grafts are bound on the lingual and buccal surfaces of the fragments for immoblilization.

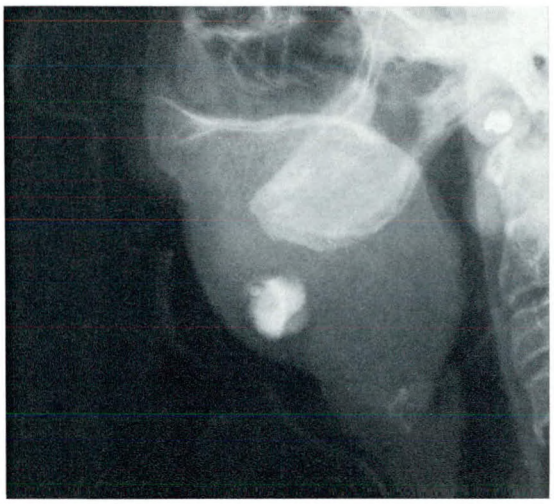


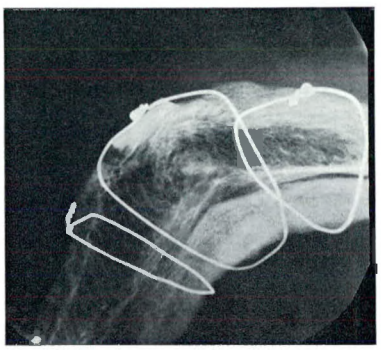


Fig. 3 a—c A bilateral defect pseudoarthrosis of an atrophic mandible after osteomyelitis of fracture lines.
a) Lateral radiograph after healing of the osteomyelitis. The symphysis fragment is pulled downwards and backwards resulting in a large bilateral defect pseudoarthrosis.
b) Profile X-ray view after reconstruction by a huge bone graft followed by a vestibuloplasty with a skin graft and subsequent construction of dentures.

jaw. In this manner, the fracture sites are onlayed and overlayed with rib grafts on 3 sides, and the fragments are well fixed into position *(Figs. 1 a, b* and *2)*.

The closure of the soft tissue is accomplished in the same manner as in an alveolar ridge augmentation *(Obwegeser* 1967). The tight periosteum under the mucous membrane is scored so that it will stretch and the mucous membrane is undermined just enough to permit wound closure without tension. It is also very desirable to cover the grafted bone segments satisfactorily without dead space present, so as to prevent haematoma formation. We may place a vacuum drain.

We have not found it necessary to use additional splinting: either with acrylic splints, intermaxillary fixation, extraoral appliances, or bone plates and screws. Occasionally however, a crossed intraosseous wire in the region of the fracture may be an advantage.



c) Occlusal X-ray view demonstrating the symphysis area after the reconstruction of a bilateral defect by a large U-shaped iliac crest bone graft leaving the original fractured mandibular symphysis fragment below and behind the reconstructed symphysis.

Cases

Naturally, the number of edentulous severely atrophic mandibular fracture cases treated in a single clinic is not very large, especially since the edentulous patient is becoming ever less common. As we have learned something new from each of the cases we have treated we feel justified in describing them here.

Case 1: A 70-year-old patient (F. E., med. rec. No. 2754) involved in a traffic accident sustained a bilateral fracture of his edentulous atrophic mandible. The fracture was first treated in another hospital by extraoral open reduction and stabilization of the segments with intraosseous wires. In addition upper and lower prostheses were wired to the jaws and then into intermaxillary fixation for a period of 3 months. A bilateral fistula formed to the facial skin in the region of incision lines. After removal of the intra-oral

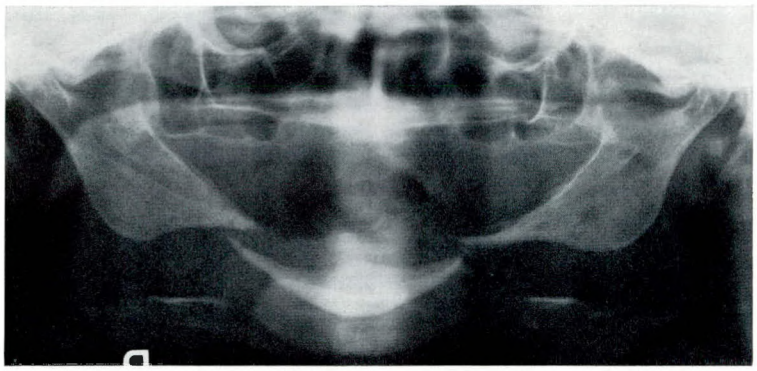
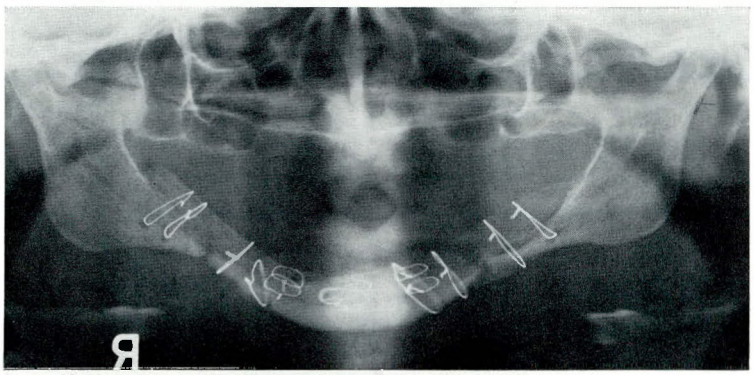
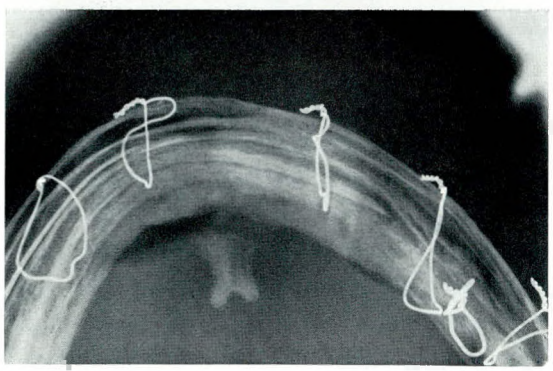


Fig. 4 a–c Typical case of a bilateral fracture of an edentulous atrophic mandible treated according to the method demonstrated in Fig. 1 b. Autogenous rib grafts have been used for immobilizing the fragments and simultaneous augmentation of the alveolar crest.

a) X-ray before treatment.



b) X-ray demonstrating the rib grafts with the various wires fixing the fragments to the rib grafts.



c) Occlusal view demonstrating the layers of rib grafts.

prostheses, the patient was referred to us for treatment of an extensive bilateral fracture-line osteomyelitis and an inferiorly displaced anterior mandibular segment. We removed the intra-osseous wires in the region of the fracture-lines and performed a sequestrectomy and saucerization of the fracture-line osteomyelitis; and then waited for resolution of the infection. This resulted in a large bilateral bone defect with pseudoarthrosis of the horizontal portion of the mandible, with an inferiorly displaced symphysis *(Fig. 3 a)*.

On 28-9-1965 we treated this non-union fracture in the following manner: The inferiorly displaced symphysis segment was partially rotated superiorly and a horseshoe-shaped autogenous iliac crest graft was onlayed over the symphysis *(Fig. 3 c)*. The bone graft was mortised posteriorly into the distal segments. The iliac crest graft was fixed to the distal and symphysis segments successfully utilizing intra-osseous and circum-osseous wires which insured additional stabilization. The postoperative course was without complication and a

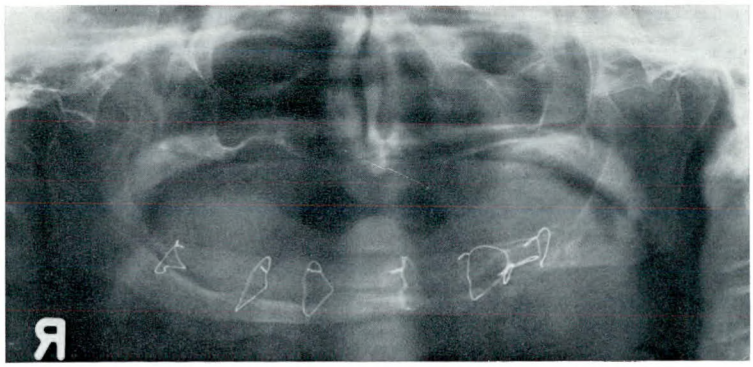


Fig. 5 A unilateral spontaneous fracture of an extremely atrophic mandible. The method of treatment as illustrated in Fig. 1 b, however, the autogenous rib graft does not extend sufficiently over the distal aspect of the fracture therefore adequate stabilization and immobilization is not possible. This resulted in a pseudo-arthrosis. A second operation was performed with adequate onlaying of a deep frozen homologous bank rib graft and sufficient immobilization was provided so that healing could progress. Orthopantomogram demonstrating that the rib does not reach far enough distally beyound the fracture line, and on the otherside, however, that the simultaneous true alveolar crest augmentation by the rib grafts is producing a favourable situation to support a full lower denture.

perfect union of the fracture was achieved. Six months later a lowering of the floor of the mouth and vestibuloplasty with skin graft was performed for the patient's prosthodontic rehabilitation: and at the same time the bone wires were removed. A satisfactory result was obtained both functionally and aesthetically *(Fig. 3 b)*.

Case 2: A 43-year-old patient (R. O., med. rec. No. 4663) fell down a flight of stairs sustaining a bilateral fracture of his extremely atrophic mandible. This fracture was treated at another hospital over a period of 4 months and treatment included 2 operations. The patient stated that his dentures were wired to his jaws to enable intermaxillary fixation. Because of the failure of the treatment, the patient came to our clinic and was admitted with a bilateral pseudoarthrosis in the region of the mental foramina in his extremely atrophic mandible. The symphysis segment was clearly depressed in a stepwise fashion and slightly dorsally displaced. The treatment was accomplished in the manner described in *Fig. 1* (fec.: *H. L. Obwegeser)*. Satisfactory stabilization of the fragments in their desired position and, at the same time, successful augmentation of the alveolar ridge was obtained *(Fig. s. 4 a–c)*. Additional splinting or immobilization of the fragments was not utilized. Four weeks postoperatively the patient received a temporary prosthesis with which he could masticate relatively well. Since this treatment, there has been no abnormal mobility of the fracture site. Three and half months after the fracture was treated, the bone wires were removed and 9 days later the patient received his permanent denture. A lowering of the floor of mouth and vestibuloplasty were not performed because the vestibular condition following the augmentation of the ridge gave sufficient alveolar height for prosthetic rehabilitation.

Case 3: A 68-year-old patient (R. H., med. rec. No. 7085) was referred with an abnormal mobility in the left mandible, and for consultation for pre-prosthetic surgery necessary to prepare him for a prosthesis. From the history we found that he had sustained a fracture of his edentulous mandible which was treated in another hospital. On admission, we found him to have an extremely atrophic mandible with slight abnormal movement in the area of the left mental foramen. From the Orthopantomogram we noticed that the right and left intraosseous wires were visible in the region of both mental foramina. This implies that, at one time, a bilateral mandibular fracture must have been present. In addition there was a callus-like enlargement with a small centralized sequestrum-like opacity surrounded by an irregular radiolucent halo present at a short distance distal to the left circum-osseous wire. There was also demonstrable abnormal mobility present. To treat this patient, autogenous rib grafts were layed over the highly atrophic mandible (fec.: Dr. *Chausse)*. The grafts extended distally just slightly over the pseudoarthrosis *(Fig. 5)*. The graft was fixed successfully with bone wires which went through the mandibular body and over the rib graft. The postoperative course was uneventful.

However, 3 months after surgery, the pseudoarthrosis was still present. The wires were completely removed and a deep frozen rib graft was placed over the pseudoarthrosis and again fixed with bone wires. The postoperative course was uneventful. Two months later the area of pseudoarthrosis was found to be clinically consolidated. A sufficient amount of ridge height was attained from the ridge augmentation for prosthetic purposes. Preceding the definitive prosthodontic treatment, however, a lowering of the floor of the mouth and vestibuloplasty with skin graft had to be performed.

Case 4: A 85-year-old patient (G. J. med. rec. No. 6760) fell, sustaining a bilateral fracture of her extremely atrophic mandible. An oblique fracture of the body of the mandible was present on the left side, and a transverse fracture was present in the region of the mental foramen on the right side. The treatment of the fracture was as follows (fec.: Dr. *Chausse):* to immobilize the oblique fracture on the left side, a circum-mandibular wire was bound around the fragments. On the right side, the fracture had a small wedge-shaped segment inferiorly displaced. This was bridged by onlaying deep frozen bank rib grafts over the fracture site and stabilizing it on the mesial and distal aspects with circum-mandibular wires. The mandible was then stabilized and the postoperative course was uneventful. The fracture had healed, without pseudoarthrosis, at the 2-month postoperative examination, even though only a relatively short deep-frozen bank rib graft was used to bridge and immobilize the fragments *(Fig. 6).*

Case 5: A 54-year-old patient, involved in an automobile accident, sustained a bilateral fracture of her extremely atrophic mandible in the region of both mental foramina. She was presented for treatment 5 days after the accident. The treatment (fec.: Dr. *Chausse)* consisted of repositioning the fragments intra-orally, and grafting over the fracture sites with relatively short, halved, deep frozen rib graft. These were onlayed on the buccal aspect of the mandible only. There was no circular rib graft overlayed on the top of the atrophic mandible. Postoperatively, a dehiscence occurred at the right fracture site which was resutured. In spite of a postoperative course free of infection, $3^1/_2$ months after the surgical treatment, there was persistent abnormal mobility present on the side of the former suture dehiscence. On the opposite side, the fracture was clinically united. The pseudoarthrosis was treated $4^1/_2$ months after the first surgical treatment, with an autogenous rib graft, in order to bridge the fracture site and at the same time augment the ridge. Once again, however, a suture dehiscence occurred on the right side with localized infection of the overlying tissue. This was treated with local irrigations of an antibiotic solution and with vaseline gauze drains. 4 months after the autogenous rib overlay graft was accomplished the operation site was fully healed and the fracture clinically united. The patient was then listed for a lowering of the floor of the mouth and vestibuloplasty with skin graft preparatory for denture rehabilitation.

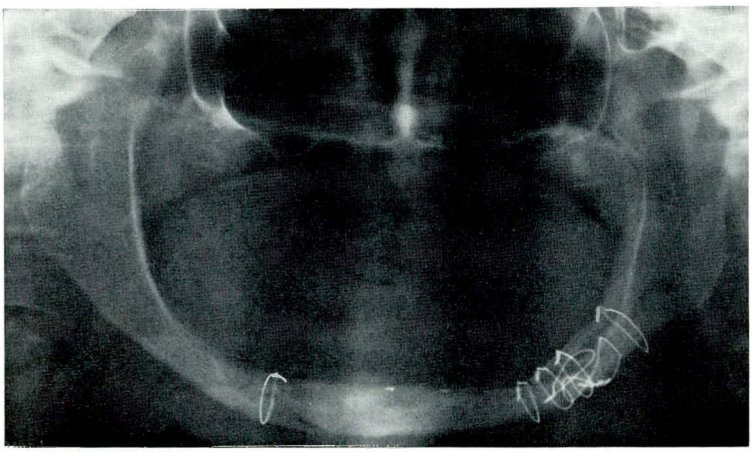


Fig. 6 Bilateral mandibular fracture in an 85-year-old patient. On the right side the oblique fracture line permits fragment adaptation by circumferential wiring. The transverse fracture on the left side of the extremely atrophic mandible can best be immobilized by direct osseous wiring with an overlayed deep frozen bank rib gaft. Fracture healing is uncomplicated.

Discussion

The treatment of fractures of the edentulous mandible may always be considered from 2 points of view. The first is the restoration of the continuity of the fractured mandible in the most ideal position and the second is the restoration of the prosthetic capability, and, with this, functional capability of the fractured mandible. In our opinion, the intraoral open reduction of the fractured edentulous mandible is always indicated. The only exception to this rule is the conservative closed reduction of a fractured mandible where there is no dislocation of the segments and where there is adequate adherence of the periosteum around the fracture acting as a splint to support the fractured segments. The conservative surgical treatment which only utilizes the patient's own prostheses or some other form of acrylic splints bound to the jaws *(Mathis* 1956, *Rowe* and *Killey* 1968) is, in our opinion, insufficient and contraindicated: because displacement of fragment occurs soon, due to the small diameter of the mandibular body in the fracture area. The fracture-oedema prevents absolute immobilization of the fragments with a wired prosthesis. Adequate adaptation of the denture splint to the lower jaw is impossible due to the oedema present, therefore, satisfactory stabilization of the segments is not secured, and there is a possibility of infection of fracture site resulting from pressure ulceration and necrosis of the soft tissues. Bone consolidation is not then assured.

Direct inter-osseous wiring, with or without the additional wired acrylic splint, provides sufficient immobilization for most cases of fractured edentulous mandible. When only moderate atrophy is present, the application of horizontal wires on the upper and lower borders, or the combination of an upper border horizontal wire, and a lower border figure-of-eight wire, is usually sufficient for stabilization of the fractured segments without the use of a splint.

When a wedge-shaped segment of bone is separated from the inferior border of the mandible, however, it should always be adapted and fixed to the main segments with a figure-of-eight-wire. Direct osseous wiring will fail to immobilize the fragments perfectly in the case of the extremely atrophic mandible because the approximated surfaces of the fractured segments are so small in diameter that the suprahyoid musculature, which attaches anteriorly in the region of the fracture, can easily rotate or displace the symphysis segment inferiorly. In the case of a fractured atrophic mandible, when a free floating wedge-shaped segment is present, our method *(Obwegeser* 1953) of treatment utilizing the figure-of-eight wiring technique is suggested and briefly described as follows: One end of a pre-stretched 0,5 or 0,6 mm thick length of stainless steel wire is placed through the lingual side of a bur hole drilled in the mesial segment of the fracture and the other end of the wire through the lingual side of a bur hole in the distal segment of the fracture. Both ends of the wire are then pulled tight and crossed over the lower border of the mandibular fracture area bridging the wedge-shaped segment and again passed through the bur holes from the lingual side. Both wires are pulled tightly on the buccal surface and twisted together. With this method of wiring, the fragments are adapted and locked together in a triangular fashion *(Fig. 6).*

The treatment of the slightly atrophic mandible with bone plates *(Roberts* 1964, *Luhr* 1969, *Spiessl* and *Schroll* 1972, a. o.) is certainly an excellent method. This can be accomplished through the

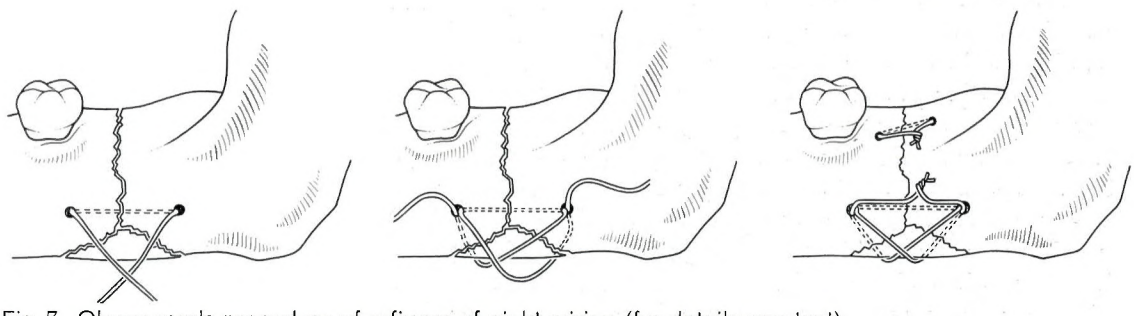


Fig. 7 Obwegeser's procedure of a figure-of-eight wiring (for details see text).

intraoral approach so that a scar is avoided in the patients' submandibular region. But, this method also fails in the case of the extremely atrophic mandible. The plates cannot be adapted well to the curve on the buccal surface of the mandible. In most cases, when the fracture is in region of the mental foramen, the mental nerve is in the way of the plate. In addition, the fractured surfaces of the fragments are too small to allow a good bony consolidation of the fracture.

Fracture treatment with extraoral pins *(Converse* and *Waknitz* 1942, *Moule* 1968, *Schüle* 1957) is likewise a possibility, but, this method is only successful if the mandible is not extremely atrophic and if the fractured bone surfaces are wide enough to be adapted together for adequate fixation. According to our experience *(Obwegeser* 1968) repositioning of the fragments under direct vision through the oral surgical approach is necessary in addition to placing the pins, and if this is done, the fragments can be adapted with direct wires and then be stabilized with locking bars between the pins. Without the direct surgical approach, there is frequently the danger of poor fragment adaptation and of the possibility of interposing the soft tissue between the fragments. There are many other disadvantages with the extraoral pin fixation, such as injury to the marginal mandibular (VII) nerve, injury to the mandibular nerve, localized skin infection where the pins penetrate the skin with the possible complication of skin scarring. We have, for the most part, abandoned this method of fracture treatment for the fractured edentulous mandible.

Treating the fractured edentulous mandible with marrow-pin fixation is also an alternative *(Hyder* 1962, *Fries* 1966, a. o.). From our limited experience with this method, only one Kirschner pin is insufficient for adequate immobilization. The treatment of the extremely atrophic mandible with this method is absolutely unacceptable. The main problem, above all, in treating fractures of the severely atrophic mandible is that fragment surfaces to be adapted are so small that the basis for bony union is very unfavourable. Furthermore, the portions of the mandible adjacent to the fracture line are so thin that the above mentioned surgical methods of treatment do not offer enough fixation for adequate stabilization. To overcome these obstacles and at the same time to augment the atrophic mandible for future prosthodontic rehabilitation, we utilize a bone graft which is onlayed and overlayed around the fracture sites. This provides the necessary splinting of the fracture and at the same time enlarges the contacting bone surfaces of the graft plus the fragments which facilitates fracture healing. In our opinion the above method of treatment is also suited for the treatment of comminuted fractures or single transverse fractures of the atrophic edentulous mandible. With an edentulous mandible that is not atrophic, sufficient stabilization may be achieved with half of a bank rib graft wired through the buccal and lingual surfaces of bone.

The cases described are very instructive in many ways. From them, it is self-evident that defect-pseudoarthrosis (case 1) can only be safely treated with a bone graft. Furthermore, they show that when treating fractures without missing segments, the fragments are well immobilized in the desired anatomical position with the onlay and overlay of rib grafts without the use of additional splints and fracture healing is assured when the principle of circular onlay and overlay of bone is followed (case 2; case 5: 2nd operation). The use of autogenous rib graft does not ensure bony union of a fracture if the principle of splinting by onlaying and overlaying the rib is not followed, as was shown in case 3. Here, the autogenous rib graft was placed only slightly beyond the fracture site and just overlayed on the buccal surface of the distal fragment. The use of deep frozen bank rib grafts can also result in a good union if attention is paid to the principles shown, at least, as far as splinting and bone stabilization technique at the fracture site are concerned (case 4 and 5 – left fracture site). With regard to reconstruction of the atrophic mandible, the use of bank rib is not so well tolerated by the body as is autogenous rib, because as time passes, the bank rib will be resorbed.

Conclusion

The treatment of fractures of the extremely atrophic edentulous mandible is always a difficult problem. The various known methods of surgical bone adaptation have not always proven successful in our hands. For this reason, we have changed our surgical approach in treating this type of fracture. We now graft over the fracture

sites with a bone graft (iliac crest, autogenous rib, deep frozen bank rib) to help to immobilize the fracture and also to augment the alveolar ridge for later prosthetic rehabilitation.

The simplest surgical technique is with the use of ribs, where one whole rib is onlayed over the ridge of the mandible in a circular fashion. A second rib is split in its long axis with one half being placed over the buccal surface and the second half being placed over the lingual surface of the mandible. The graft is fixed to the mandible with 2 circum-mandibular wires for each fracture site – one mesial and one distal to each fracture. The use of autogenous ribs has proved to be beneficial both for fracture treatment and also ridge augmentation. On the other hand, the use of autogenous ribs does not give the desired result if they are not long enough to overlay the fragments sufficiently. The fragments therefore are not successfully immobilized. The use of bank ribs has been successful with regard to fracture healing when the principles of fracture-over-grafting and splinting are closely followed. However, bank rib will indeed be widely resorbed and can therefore not be used for the pre-prosthetic surgical augmentation of the alveolar crest.

Acknowledgement

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