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Acute Sinusitis and Implant Failure Following Novel Minimally Invasive Hydraulic Sinus Lift: A Case Report

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Abstract

The last decade has presented us with a variety of innovative minimally invasive methods for sinus lifting. One described method is the iRaise, a novel implant device based on hydraulic sinus membrane elevation. Till now, all reported cases involving this method have been successful, and no major complications were observed. The current article presents a case of a 45 year-old healthy woman, who developed acute sinusitis following an iRaise sinus lift. Conservative antibiotic treatment has failed, and the patient was treated under general anesthesia. The sinus was accessed by the conventional Caldewell-Luk approach, and designated implant and graft material were removed. To our knowledge, this is the first case report describing acute sinusitis following the iRaise method. This case report suggests strong association between the iRaise method and acute sinusitis, and reviews alternative techniques to the iRaise device.

Keywords: Acute Sinusitis; Caldwell-Luk Procedure; Implant Failure; Hydraulic Membrane Elevation; Minimally Invasive Sinus Lift

Introduction

Dental implant therapy in the posterior maxilla is a challenging procedure for both general dentists and maxillofacial surgeons. Posterior maxilla is characterized by "fine" trabecular bone; with either thin porous cortical bone or no cortical crestal bone with very light density. Additionally, loss of teeth in the posterior maxilla might lead to sinus pneumatization and reduction of available bone volume required for conventional implantation. These two factors of reduced bone quality and quantity might result in insufficient bone support of dental implants [1,2]. In order to overcome these anatomic limitations, sinus augmentation is usually required for vertical bone height reconstruction. The sinus lift enables satisfactory osseointegration and long term survival of longer and wider implants [3].

The sinus augmentation technique was first presented by Tatum [4]. Autogenous cancellous bone from the lateral iliac crest was used as graft material, adopting a modified Caldwell-Luc procedure to approach the maxillary sinus [5]. Tatum's traditional method of sinus augmentation is also called: "open sinus lift" procedure and has been widely used and investigated, and has been established as an accepted standard for treatment of edentulous maxilla.

Open sinus lift enables direct access and visualization of the whole sinus. However, this method suffers from many shortcomings. Anatomic considerations may limit the applicability. Patients usually suffer from periprocedural discomfort: swelling, discoloration, disability and pain, hematomas and nosebleed. Also, the procedure requires surgical expertise, has a demanding learning curve and is time and resource consuming. Various complications of open sinus lift were reported in the literature as follows: obstruction of antronasal foramen, bleeding, infection, infraorbital nerve laceration, acute maxillary sinusitis, wound dehiscence, and Schneider an membrane perforations, with consecutive scattering of the grafting material in the sinus cavity [6,7]. Though the open sinus lift method has proved its worth and effectiveness over the years, it is significantly invasive and traumatic to the patient, and has stirred up the need for other less invasive methods.

In 1994 Summers has described the osteotome sinus floor approach and ridge expansion through the alveolar ridge [8]. The sinus lift approach was modified to a less invasive technique, aiming to achieve higher success rate and fewer complications compared to those introduced by open sinus lift technique. It is also called: "closed sinus lift". The rational of this technique was the

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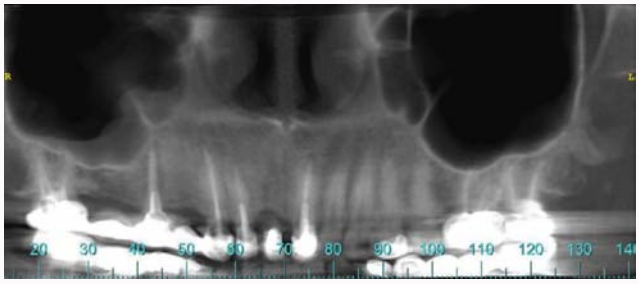

Figure 1: Preoperative cone beam computed tomography (CBCT) scan.

controlled compaction of soft maxillary bone by mallet, conservation of the residual osseous tissue in the alveolar bone and improvement of bone density around the implants. When bone compaction is not sufficient by itself, the osteotome technique enables the clinician to introduce bone graft material into the sinus through the osteotomy site, without the lateral window approach. However, this method was still traumatic to the patient and was limited by residual ridge height of 5 mm or more [3]. Moreover; it was limited in its ability to raise the sinus floor. Therefore, the closed sinus lift is a limited approach that does not necessarily meet with the achievements of the open approach.

Consequently, during the last decade sinus grafting by minimally invasive approach has evolved and has been used by a growing number of clinicians, as shown by an increasing body of scientific literature. Several modifications of the surgical techniques of closed sinus lift have been carried out in order to improve the predictability of clinical outcomes and, at the same time, reduce the amount of trauma to the patient. Various types of allografts, xenografts and alloplastic materials have been used as bone substitutes to simplify the grafting phase, enabling immediate implant placement and minimizing the patient's discomfort [9].

Hydraulic sinus condensation through osteotomy site was first described by Chen and Cha at 2005 [10]. Initially, pinhole access to the sinus is performed by a small round bars. Constant hydraulic pressure from the hand piece during osteotomy drilling inflates the Shneiderian membrane through the pinhole at the sinus floor. Once the membrane is loosened, a bone graft mixture is packed and pushed using a small sinus condenser. The osteotomy site is enlarged by an implant drill and the bone graft is condensed again by secondary lift. At the end of the sinus augmentation, the osteotomy site is ready for immediate implantation. This minimally invasive sinus lift procedure had favorable results in a single-center study, but has never been widely accepted [10,11].

At 2005 Soltan and Smiler suggested anthral membrane sinus elevation through the lateral window by open sinus lift access [12]. Kfir et al. [7] described a minimally invasive version for anthral membrane balloon elevation executed via the osteotomy site without the open access (MIAMBE). Bone grafting was also performed via the osteotomy site and implant fixation was performed at the same sitting. The procedure was executed in 24 patients. No major complications were reported. One patient had rupture of balloon and membrane, and implant rejection two weeks after procedure. Another patient had a minor nosebleed. 100% of implants exposed at 6-8 months were rehabilitated. The authors concluded that this method requires much abbreviated learning curve, carries excellent procedural success, has low complication rates and yields very satisfactory long-term results

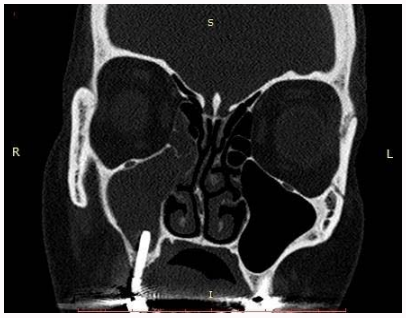

Figure 2: Five weeks postoperative medical computed tomography (MDCT) scan.
Figure 2(A): Coronal section through the iRaise implant device.

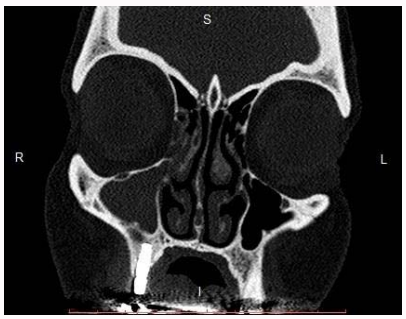

Figure 2(B): Coronal section through conventional implant anterior to the iRaise, showing good bone support of the conventional implant.

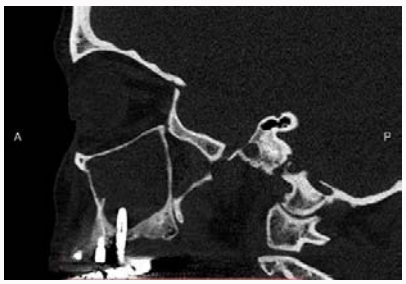

Figure 2(C): Sagittal section.

[7].

A later multicenter study [13] included 112 patients. Of 123 MIAMBE procedures, 119 were successful. Three procedures were aborted due to membrane tear and successfully retreated at second attempt. One patient had an infection and oroanthral fistula at 4 weeks after the sinus lift, which required implant removal. The authors did not specify which anatomic location the infection was present at, and whether or not the patient had developed signs of sinusitis. Another study [14] reviewed 34 cases of antral balloon elevation in 34 patients. Two patients developed acute maxillary sinusitis, which was defined by the authors as only a minor complication. One patient had a sinus membrane perforation, which was successfully managed intraoperatively. The authors did not note if the patient with membrane tear was the one who has developed the sinusitis. All bone grafts were stable and integrated well with the implants.

At 2014 Nahlieli introduced the dynamic implant valve approach (DIVA) [15]. The implant was developed with an internal port and a sealing screw, and might serve for end scoping direct observation

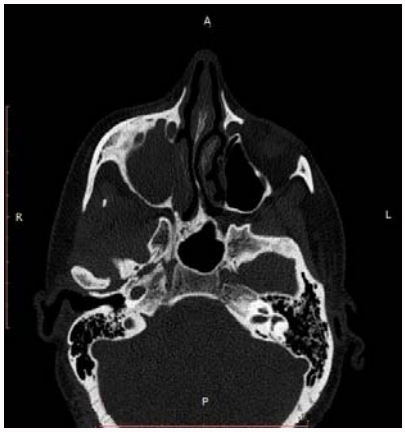

Figure 2(D): Axial section, bone window.

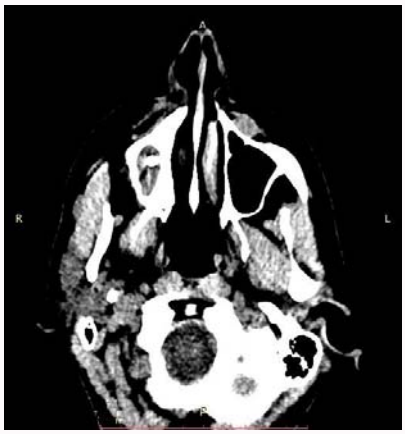

Figure 2(E): Axial section, soft tissue window. The iRaise implant is protruding into the infected sinus, no bone formation is demonstrated.

and as a drug delivery system via its corono-apical channel. After introducing the implant into the posterior maxilla at the osteotomy site, the internal screw is removed. Bleeding from inside the implant indicates fracture of the sinus floor, which is followed by saline irrigation via the internal port. The integrity of the Schneiderian membrane may be evaluated by an endoscope or by visual observation of the saline level movement at the coronal opening of the implant, according to the respiratory movement of the membrane. Careful saline irrigation and slow ratcheting of the implant separates the membrane by hydro dissection. A prospective observational uncontrolled study [16] assessed DIVA implant during follow up period of up to 60 months. In 94.5% of cases the implantation was totally successful from objective CBCT, clinical and subjective patients' viewpoints. No sinus complications or intraoperative membrane perforation were reported. The authors concluded that this minimally invasive sinus lift method simplifies the surgery and secures the optimal dental implant placement.

At 2014 Better et al. [17] has presented a novel procedure and device, designed as closed sinus lift, using dedicated dental implant – the iRaise. The implant contains an internal channel, which allows simultaneous hydraulic sinus membrane elevation and placement of flowable bone graft. The procedure is considered as minimally invasive and enables sinus bone augmentation and implant placement at the same time.

Sinusitis is considered to be one of the major complications and drawbacks of open sinus lift [18]. The reported incidence of sinus complications is as lower than 1% to as high as 3.9%. Increased incidence of complications has been especially observed when the history before surgery included factors that favored sinusitis [19]. As opposed to these reports; minimally invasive sinus lift appears to be a safer method with rare complications. The consequences of postoperative acute sinusitis are severe and might commonly cause implant and graft failures.

Case Presentation

A 45 year old healthy non-smoker female was referred to a private clinic in 2016 for rehabilitation of posterior atrophic maxilla using dental implants. The patient presented with a failing five units porcelain fused to metal bridge in the upper right quadrant. The bridge utilized three abutment teeth: canine, second premolar and the second molar. The first molar and the first premolar were the pontics. CT scan was obtained, and revealed a pneumotized right maxilla and a subanthral residual bone of 5 mm (Figure 1). Clinical and radiographic examination revealed no signs of sinusitis. No past history of sinus pathologies was present. Therefore, sinus lift was necessary to support dental implants. It was agreed to perform a minimally invasive hydraulic sinus floor elevation and bone augmentation, according to the iRaise technique, as described by Better et al. [17] (Maxillent, Israel). Risks, benefits, and alternatives of the proposed procedure were described to the patient, and the patient signed an informed consent.

Amoxicilline clavulanate 1,750 mg was administered prophylactically 1 hr preoperatively (Augmentin, SmithKline Beecham, Brentford, Middlesex, U.K). The patient performed a mouth wash for 1 minute with chlorhexidine gluconate 0.2% solution prior to surgery. A full thickness mucoperiosteal flap was reflected. The implantation site was calculated according to the preoperative CT scan of the area. The osteotomy site was marked with a small round bur and then was widened with the full drilling sequence, according to the company's drilling protocol (Maxillent, Israel). The hard cortical bone of the sinus cortex was identified and abraded, using a diamond-tipped cortex drill in order to avoid perforation of the membrane. A 4.2 mm-diameter iRaise implant was partially inserted at the site of maxillary right first molar. The tube connector was then assembled. A saline syringe was connected to the designated tubing port of the implant and sterile saline solution was injected into the sinus and aspirated. Saline slightly mixed with blood appeared in the syringe, indicating proper positioning of the sinus lift implant device and indicating no perforation of the Schniederian membrane. Two ml of synthetic bone graft were slowly injected into the sinus (MBCP gel, Biomatlante, France). The tube connector was removed and the implant was fully inserted. Implant length was 14.5 mm. An additional three conventional implants were placed at sites of the canine, first and second premolar. The surgical flaps were sutured and primary wound closure was obtained. There were no intraoperative incidents and the procedure was accomplished uneventful. Post-operative antibiotic coverage was prescribed with amoxicilline clavulanate 875 mg twice daily for 7 days.

One month post-operatively the patient visited the clinic complaining about pain, headache and discomfort at the right inner side of the mouth. Redness and swelling of the mucosa adjacent to the implantation site and purulent discharge were present. A copious irrigation was performed and amoxicilline clavulanate 875

mg was prescribed twice daily for 7 days. The patient showed no improvement in response to this treatment. CT scan showed total unilateral opacity of the right maxillary and ethmoidal sinuses, and diagnosis of acute maxillary sinusitis was confirmed (Figure 2). The infection was involving the whole maxillary and ethmoid sinuses, and was not limited to the bone graft. Under general anesthesia the right sinus was approached by Caldwell-Luc procedure. The iRaise implant device and the remnants of the graft material were removed from the sinus together with the infected mucosa. The other three conventional implants had good bone support and were stable, therefore they were left intact. Three months postoperatively the patient was free of symptoms. On clinical examination, normal sinus function and drainage were restored.

Discussion

Surgical complications after sinus lifts are rarely reported and their influences have been investigated to a lesser extent [20]. This article reports a case of acute sinusitis after minimally invasive sinus lift approach. The reported incidence of acute sinusitis after open sinus lift appears to be low. Exceptionally few case reports of acute maxillary sinusitis after open sinus lift were published [21-23]. In the case of closed sinus lift, only one report [24] presented an acute maxillary sinusitis following internal sinus lift using the osteotome technique. However, the patient in that report had a pre-existing chronic maxillary sinusitis. The authors concluded that maxillary sinusitis is an inevitable complication of maxillary sinus augmentation in patients with a history of maxillary sinus disease. Moreover, to our knowledge, case reports discussing about acute maxillary sinusitis after sinus lift, by any minimally invasive method, have not been reported in the literature to date.

When sinusitis does occur, the clinical management of this major complication is very traumatic for the patient. Except for per oral or intravenous antibiotic therapy, most often surgical intervention is inevitable in order to remove the offending source of the infection. The surgical management can range from debridement and drainage to removal of grafting material, the infected sinus mucosa and, in some cases, the removal of implants placed adjacent to the graft. Moreover, the infected sinus is accessed occasionally by the extensive Caldwell-Luc procedure under general anesthesia. All of these procedures may lead to significant pain and discomfort, prolonged overall treatment and require recurred appointments [3].

To date, there were three studies evaluating the use of the iRaise sinus lift system, that was published in the indexed literature [17,25-26]. The first study (2014) was a prospective preliminary study, evaluating 23 sinus lift procedures performed in 18 patients' cohort followed for up to 13.1 months [17]. The second study (2016) was a retrospective analysis of 64 procedures performed in 62 patients followed for up to 45 months [25]. The third study (2017) was a prospective case series study; evaluating clinical and radiological outcomes in a sample of 18 consecutive patients followed for up to 14 month [26]. All studies reported that all procedures were completed successfully. No intraoperative or postoperative adverse events were observed, such as membrane tears or sinusitis. Overall implant survival rate was 100% in both studies. In the retrospective study, which followed the patients for a longer period, a 100% of prosthetic cumulative survival rate was also reported [25].

Patients' perception of recovery after minimally invasive iRaise sinus lift was also evaluated in a prospective pilot study [27]. Patients were assessed by "health-related quality of life" (HRQOL) questionnaire. The questionnaire was designed to assess the patient's perception of recovery in four main areas: oral function, general activity, other symptoms and pain. The questionnaire was completed each day for consecutive 7 postoperative days by telephone visit. Patients reported very little discomfort to 'not at all'. Most of them returned to work on postoperative day 1. The study concluded that patients undergoing sinus augmentation using the iRaise device can expect to experience minimum discomfort and immediate return to everyday activity.

The sinus lift approach with the iRaise implant device harbors many possible advantages over other minimally invasive techniques. Closed Trans crestal hydraulic Schneiderian membrane elevation and simultaneous bone graft augmentation can be accomplished using a dedicated dental implant, which allows for reducing operative treatment time, risk of complications, and overall patient discomfort [25]. This approach mainly differs from previously described minimally invasive techniques as the Schneiderian membrane elevation and the bone graft are both performed through the implant fixture. In addition, the bone grafting is performed with a flowable material, which can be simply manipulated. The iRaise is a similar technique to the DIVA in that both of them utilize the implant as a delivery channel of the graft material. However, DIVA enables the clinician to visualize the terminal location of the implant apex by endoscope, securing the Shneiderian membrane from tearing. Moreover, in order to achieve access to the internal channel of the iRaise device, a tubing port should be connected to the lateral entry point of the implant. This need for exact spatial location might introduce complexity to this technically sensitive procedure.

The sinus membrane elevation requires delicate manipulation in order to avoid membrane perforation and tears. Intraoperatively, tearing or perforation of the Schneiderian membrane is the most common complication of open sinus lift. The reported incidence of sinus membrane perforation ranges from 7% to 56% of cases [28,29]. One prospective observational uncontrolled study reported the incidence of membrane perforation to be as high as 44%. [20] Several authors reported no correlation between Shniederian membrane perforation and development of maxillary sinusitis [6-30]. On the other hand, Nolan et al. [31] performed retrospective evaluation on 359 augmented sinuses and found that graft failure was statistically higher in sinuses in which the membrane was perforated during the surgery. Finally, Sakkas et al. (2016) concluded that tearing of the Schneiderian membrane does not affect the success rate of implants [32]. Despite the perforation, in most of those cases, the sinuses were repaired and the sinus augmentation completed without other complications [20].

There are various factors that can cause infection after maxillary sinus elevation. For example, there could be a loss of stability of the grafted bone, a pre-existing sinus condition, a membrane perforation, diabetes mellitus, poor early-infection management, smoking, and other factors [23]. The main concerns related to the iRaise approach are the absence of direct visualization of the sinus cavity and Schneiderian membrane, the limited amount of bone augmentation achieved, and the high risk of the Schneiderian membrane perforation due to irregular shape of the sinus floor and attachments caused by scars [33]. Under absence of direct visualization, the flowable graft material might be erroneously injected into the sinus. Floating bone graft materials are known to cause infection after maxillary sinus elevation

[34]. Even though membrane perforations are controversially related to sinusitis, possible membrane perforation might be the cause for acute sinusitis in our patient. Another possible cause for sinus graft failure and sinusitis is a pre-existing sinus infection from dental origin. The right second premolar presented with periapical pathology and concomitant sinus thickening as shown on preoperative panoramic cone beam CT scan. This reason is less likely because the patient was thoroughly examined preoperatively and sinus pathologies were excluded. The incidence of sinusitis may be reduced by adhering to clinical recommendations to reduce the incidence of postoperative complications [35].

Finally, our article presents a major complication after minimally invasive iraises sinus lift, which is becoming extensively used by general dentists. Therefore, it has relevance to global dental community. General practitioners and maxillofacial surgeons as well, should be familiar with possible unexpected occurrence of acute sinusitis after minimally invasive sinus lift. More evidence and reports are required in order to elucidate a more definitive association between the iRaise sinus lift and acute sinusitis. The current case demonstrates us that a clinician should be competent in addressing and managing major sinus complications that might arise after minimally invasive sinus lifts.

Conclusions

Minimally invasive sinus lift by the novel iRaise implant device has been reported as a safe and reliable technique. Acute sinusitis is a possible complication, which has to be managed immediately in order to reduce complications like parasinusitis, osteomyelitis of the maxillary bone, or the spreading of the infection to adjacent anatomical spaces. To minimize the risk, more evidence is required regarding the safety of this procedure. Moreover, clinical studies are needed to identify the potential factors involved in the occurrence of sinusitis after minimally invasive sinus lift.

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