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Sinus reactions to immediately loaded zygoma implants: a clinical and radiological study

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Key words *complications, maxillary sinus, sinusitis, zygomatic implant*

Aim: There are no published studies regarding sinus reactions to immediately loaded zygomatic implants. The aim of this study was to evaluate the maxillary sinus in a cohort of patients by means of clinical criteria and computerised tomography performed before surgery and after zygomatic implant placement (immediate function protocol).

Materials and methods: A total of 36 patients with 71 immediately loaded zygomatic implants were evaluated to find clinical criteria of maxillary sinus disturbance 13 to 42 months (average 21.9 months) after zygoma implant placement. A total of 44 implants had a machined surface and 27 had a porous titanium oxide surface. Twenty-six patients with 52 immediately loaded zygomatic implants were evaluated by means of a CT scan of the paranasal sinuses, 3 to 20 months (average 10.5 months) after zygomatic implant placement. All patients had no sinus symptoms before surgery and had a preoperative CT scan.

Results: No clinical signs or symptoms of sinusitis were found. Radiological opacity of the antrum was found in two sinuses (out of 52), and minimal thickening of the Schneiderian membrane was found in 12 patients (out of 26). In eight of them, this was present in the preoperative CT scan.

Conclusions: Sinuses penetrated by zygomatic implants seem to maintain a normal physiology. However, in approximately 15 to 20% of patients, early radiological findings without clinical symptoms were observed.

■ Introduction

The zygomatic implant has been described as a valid option for the rehabilitation of the atrophic maxilla using classical two-stage and immediate function protocols[1-6]. These implants are placed through the sinus, and are anchored in four cortical portions of bone from the maxillary alveolar process and the zygomatic bone[7,8]. The relationship between the zygomatic implant and the maxillary sinus structures remains controversial; some authors have reported a low rate of sinusitis as a complication related to machined

zygomatic implants placed with a two-stage protocol[1,3,9-13]. In most studies, sinusitis was treated with antibiotics and/or meatotomy, with no further consequences[1,3,12]. Furthermore, an oroantral fistula has been described by some authors, in a low percentage of patients, and it has been advocated as the main explanation for the low percentage of sinusitis associated with zygoma implants[9-11]. Although zygomatic implant placement violates the integrity of the antrum and perforates the Schneiderian membrane, sinoscopy has shown that zygomatic titanium implants were totally or partially covered with a normal-looking respiratory membrane[14]. There were no signs of infection or increased secretion around the implants. Furthermore, sinusitis has not been defined as a complication in other types of surgery that violate the integrity of the antrum and Schneiderian membrane, such as the Le Fort I osteotomy[15].

Recent studies on sinus reactions to implants penetrating the sinus cavity, without sinus augmentation, indicate that implant protrusion into the maxillary sinus cavity can cause sinus membrane thickening around the implants with no clinical signs of sinusitis[16,17].

The purpose of the present study was to evaluate sinus health, from a clinical and radiographic perspective, in a cohort of 36 consecutive patients treated with immediately loaded zygomatic implants.

■ Material and methods

A total of 36 patients with 71 immediately loaded zygomatic and 125 conventional dental implants were clinically evaluated to find clinical criteria of sinusitis 13 to 42 months after implant placement and loading.

A combination of zygoma and conventional implants was used to support fixed, screw-retained acrylic resin prostheses inserted 24 to 48 hours after surgery. Complete arch rehabilitations were accomplished in 33 patients. In 30 patients, two zygoma implants and six (two patients), five (three patients), four (16 patients), three (five patients), or two (four patients) conventional implants were used. In one case, one zygoma implant with five conventional ones was used. In two cases, four zygoma implants (two in each side) were used. Partial arch rehabilitation was accomplished in three patients, namely one zygoma implant in combination with two conventional implants.

In total, 44 zygomatic implants had a machined surface and 27 had a porous titanium oxide surface (TiUnite, Brånemark System; Nobel Biocare, Göteborg, Sweden). All the patients were clinically free of sinus-related symptoms before the surgery, and four of them smoked less than 10 cigarettes per day.

Clinical examinations were performed after 6 , 12, 24 and 36 months of function and signs of sinus disturbance symptoms were inspected and/or asked of the patients.

Ten patients refused post-operative computerised tomography. In total, 26 patients with 52 immediately loaded zygomatic implants and 85 conventional implants were evaluated by means of a paranasal computerised tomography (CT) scan, 3 to 20 months (average of 10.5 months) after zygomatic implant placement. Complete arch rehabilitation was accomplished in 23 patients and partial arch rehabilitation in three patients. A total of 32 zygomatic implants had a machined surface and 20 had a porous titanium oxide surface.

The selection criterion for using zygoma implants was that the patients required complete or partial rehabilitation of the edentulous maxilla. While conventional implants could be placed in the premaxilla, the posterior maxilla could not be treated without using sinus grafting, wide implants, or pterygoid implants[18-20]. Tilted posterior implants were used at the level of the second premolar to avoid excessive prosthetic cantilevers. In all other situations zygoma implants were used[21]. In two patients, there were no options for placement of implants in the anterior maxilla. In those cases, two zygoma implants were placed in each side. Most of the implants sites had type 2 bone quality and quantity of types B or C, according to the Leckholm and Zarb classification[22].

A multidetector CT scanner (MDCT) 64 x 0.65 was used (Philips Brilliance CT, Philips Medical System, The Netherlands) and multiple construction (2 mm thickness, 2 mm increment) was performed.

All patients had a preoperative CT scan (Tomoscan, Philips Medical System). Since ten of the patients were referred after the CT scan had been carried out by other radiologists, they were not performed up to the zygoma bone. In these patients, information about osteomeatal complex was not obtained, but Schneiderian mucosa status and opacity or clearness of the antrum were registered.

Figs 1a to 1c 'Sinus slot technique' to place zygomatic implants.

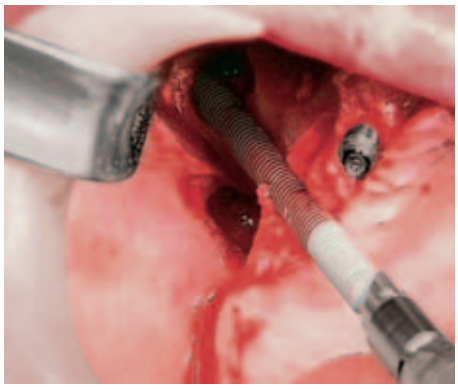

Fig 1a Placement of the implant through a previously designed maxillary groove.

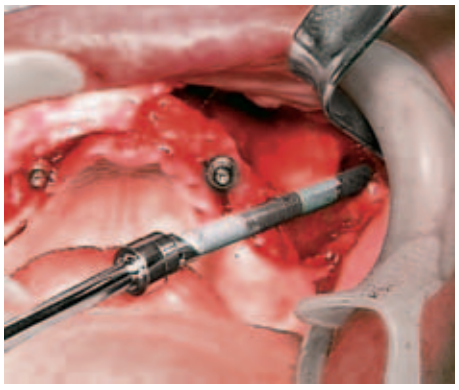

Fig 1b View of the left side.

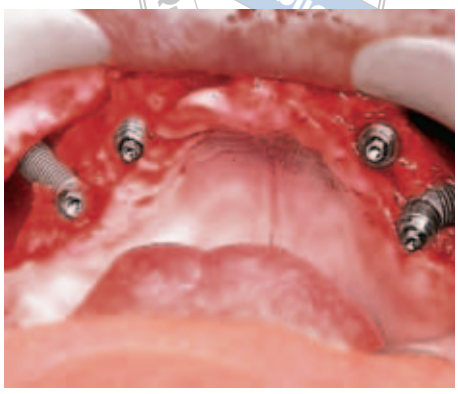

Fig 1c Crestal emergence of zygomatic implants.

Figs 2a to 2c Incision design for minimally invasive approach to place zygomatic implants.

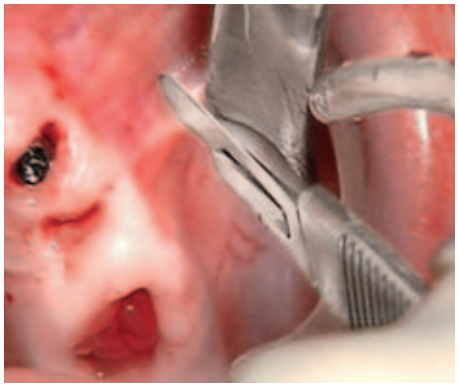

Fig 2a Incision at the level of the sulcus.

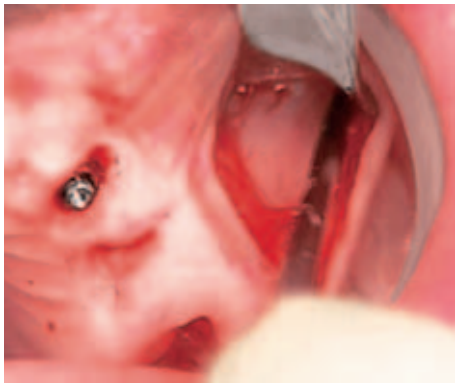

Fig 2b Degloving of the lateral wall of the maxilla up to the zygoma bone.

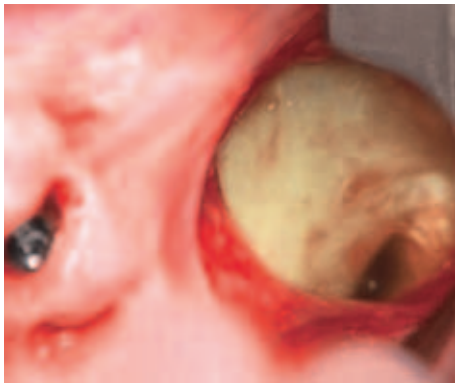

Fig 2c Operatory field just before starting the design of the window at the lateral wall of the maxilla.

Three items were examined by an independent radiologist in all the post-operative CT scans:

- radiological opacity or clearness of the antrum
- thickness of the Schneiderian mucosa, including the level of osteomeatal complex
- presence or absence of macroscopic oroantral communication.

For all patients, the surgical procedures were performed under general anaesthetic. If there were remnants of teeth present, these were extracted and, via an incision in the posterior maxilla, the entire anterolateral wall of the maxilla was degloved as far as the body of the zygomatic bone. To obtain visual control of the movement of the drills, a small lateral window was placed in the bone. In one patient, one intrasinusal cyst was removed through this window. All implants were directed towards the zygomatic bone, anchoring them at the level of the maxillary alveolar process and in the zygomatic bone itself, following the classic protocol for insertion[1-3,9]. For ten implants, the 'sinus slot' technique was performed, by making a groove in the lateral wall of the maxilla (Fig 1), to achieve a better crestal emergence[23].

In seven of the edentulous patients, the classic protocol was slightly modified, since palatal or crestal incision was avoided to respect oral mucosa integrity as much as possible. A soft tissue punch was used, and a small incision, recently described for zygoma computerised guided surgery, was designed at the sulcus at the level of the zygomatic buttress, large enough for good visualisation of the entire lateral wall of the maxilla and the zygomatic area after degloving (Fig 2)[4].

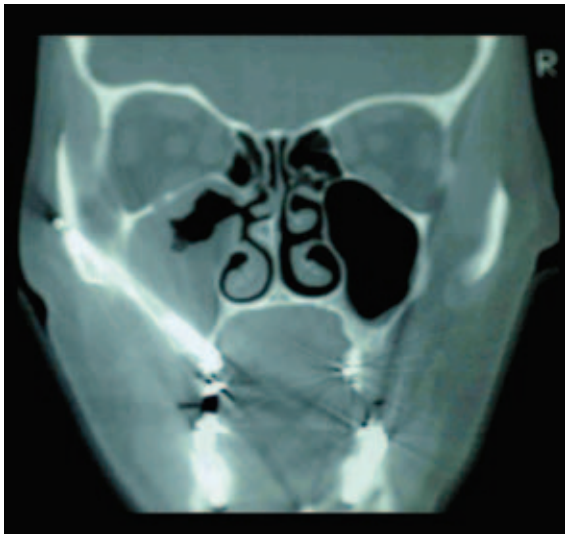

Fig 3 CT scan showing partially opaque right sinus.

As soon as the abutments (MultiUnit; Nobel Biocare) were connected and soft tissues sutured, standard impression copings were screwed on the abutments, and impressions were made.

Provisional prostheses, made of acrylic resin (Lucitone; Dentsply) and reinforced with metal wire (Remanium; Dentaurum, Ispringen, Germany), were placed between 24 and 48 hours after surgery.

Once the provisional prostheses were loaded, patients were recalled after 1 week, 1 month, 3 months and 6 months. At 6 months, a new impression was made and definitive fixed, screw-retained, acrylic resin prostheses were placed. Patients were recalled every 6 months for 2 years and once a year thereafter. The minimum follow-up was 13 months (two patients) and the maximum was 42 months (one patient), 21.9 months being the average length.

Results

In the preoperative CT scans, all maxillary sinuses were found to be radiologically clear, and 12 patients (20 sinuses) showed diffuse thickening of the Schneiderian mucosa, especially at the level of the floor of the sinus. A sinus cyst was found in one patient. No oroantral fistula was found.

All patients were clinically free of signs of sinus disturbance when examined after zygomatic implant placement (no nasal congestion, no nasal secretion, no headache, no oroantral fistula or sinusitis episodes). Some of the patients experienced surgery-related tenderness at the level of the zygomatic-maxillary buttress, which tended to disappear after 6 months.

Two sinuses were found to be radiologically opaque 3 and 6 months after implant placement (Fig 3). The first patient had thickening of the mucosa in the preoperative CT scan, and agreed to a sinoscopy. Nasal sinoscopy was performed by a specialist (FP-B) and no signs of maxillary sinusitis were found. Since an ear, nose and throat (ENT) specialist did not find the criteria required to perform functional endoscopic sinus surgery (FESS), the patient continued with follow-up only, with no further symptoms. The second patient did not consent to sinoscopy, and she remains under observation with no clinical symptoms of sinusitis after 2 years. Both implants had standard machined surfaces and were placed with the classic protocol. The contralateral sinus was normal in both cases.

No macroscopic oroantral fistula was found, and permeability of osteomeatal complex was found in all sinuses, with the exception of the two with a radiological opacity. Minimal diffuse thickening of the Schneiderian membrane was observed in 12 patients (20 sinuses) (Fig 4), but in eight of them (14 sinuses) this condition had been present in the preoperative CT scan. This thickening was limited to the floor of the sinuses and to the entrance of the implant in the zygoma bone, without affecting the osteomeatal complex. All other CT scans were normal.

Discussion

The purpose of the present study was to evaluate sinus health in patients treated with immediately loaded zygomatic implants after a period of at least 13 months after implant placement.

The relationship between the zygomatic implant and the maxillary sinus structures remains controversial, since some authors have communicated a low rate of sinusitis as a complication related to zygomatic implants placed with a two-stage protocol[1,3,9-13] (Table 1).

In these studies, there is a lack of information related to pre-existing sinus conditions from the clinical and radiological point of view. Therefore, it is difficult to elucidate a clear relationship between the implant and the infection of the antrum. In most studies, sinusitis was treated with antibiotics and/or meatotomy, with no further consequences[1,3]. Further-

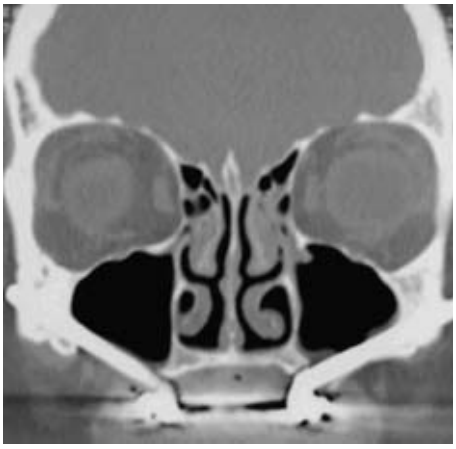

Fig 4a CT scan showing thickening of sinus mucosa.

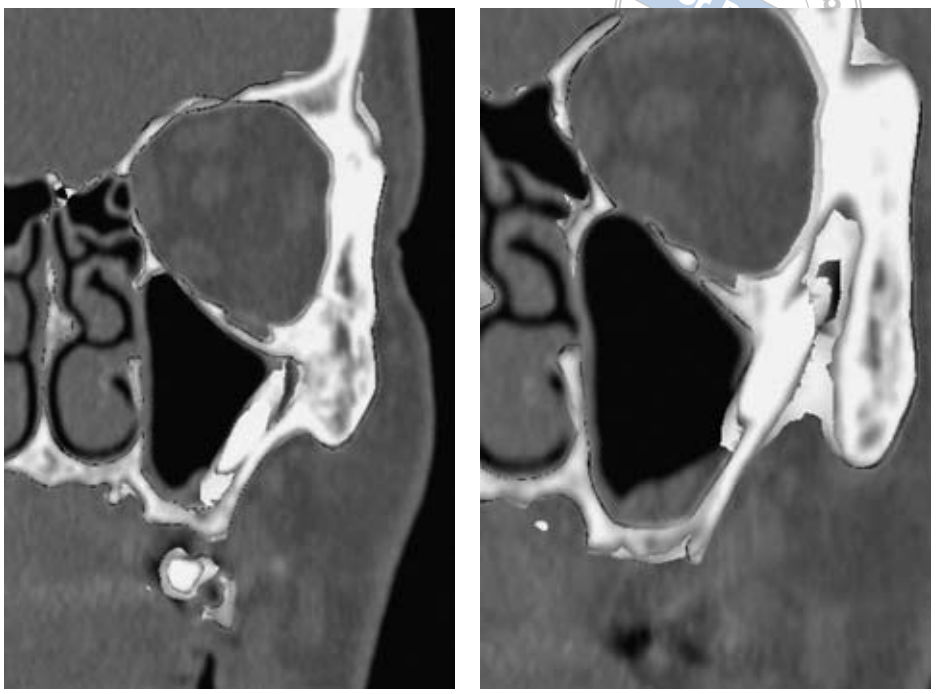

Fig 4b and 4c Thickening of mucosa at the floor of the sinus and slight thickening over the implant.

Table 1 Sinus complications reported in different studies with machine-surfaced zygomatic implants placed with the two-stage protocol

Study	Total number of patients	Follow-up period (months)	Survival rate of zygomatic implants	Reported patients with sinusitis episode
Bedrossian et al[2]	22	34	100%	0
Malevez et al[1]	55	6–48	100%	5 (9%)
Hirsch et al[12]	76	12	98%	3 (4%)
Brånemark et al[9]	28	72–108	94%	4 (14.3%)
Becktor et al[11]	16	9–69 (average 46)	90.3%	6 (26.6%)
Zwahlen et al[10]	18	6	94.4%	1 (5.5%)
Aparicio et al[3]	69	6–60	100%	3 (4.3%)
Peñarrocha et al[13]	21	12–60 (average 29)	100%	2 (9.5%)

more, it seems that sinusitis was not a factor to preclude osseointegration of the zygomatic implant, since this isolated complication (without oroantral fistula) has not been associated with loosening of the implant, in most of these studies[1,3,9,12,13].

Macroscopic oroantral fistula and sinusitis associated with the placement of zygomatic implants with a classic two-stage protocol has been reported, in a low percentage of patients[9-12]. In fact, oroantral communication has been advocated as the main explanation for the low percentage of sinusitis associated with zygoma implants[11]. Some authors have advocated the removal of the zygoma implant as the only way to deal with this complication[10,11]. Others have reported spontaneous closure of the fistula after treatment of the associated sinusitis by means of meatotomy[9].

Zygoma implant placement invades the sinus and violates anatomical integrity. This initially jeopardises the Schneiderian membrane, and fills the sinus with haematoma. Furthermore, a rigid trans-sinus titanium foreign-body is used to transmit occlusal loads up to the zygomatic bone[24]. For all these reasons, it could interfere with the clearance mechanisms of the sinus: permeability of osteomeatal complex and mucociliary cleaning system[25]. Since the present series of immediately loaded zygomatic implants showed no clinical signs of associated sinusitis, and some radiographical findings, it seems that sinus reactions after zygoma implant placement and loading tend to maintain a normalised sinus function.

It can be assumed that all operated sinuses fill up with blood and are radiologically opaque for some time after surgery, and a transient or persisting effect on the ciliated antral mucosa could be expected as a result of zygoma implant placement surgery[25]. Nevertheless, only two (6%) radiological sinus opacities were found in 36 patients. This implies there was no mechanical interference of the implant with the sinus clearance mechanisms. Furthermore, it suggests that the maxillary sinus membrane is capable of adapting adequately to the changes induced by surgery and that permeability of the osteomeatal complex remains intact[25]. Interestingly, other invasive surgeries of the sinuses, such as Le Fort I osteotomies, have not been related to sinus adverse reactions[15].

Zygoma implants could potentially act as an intrasinusal foreign body, causing an inflammatory reaction in the surrounding membrane. Chronic sinusitis associated with mobile intrasinusal foreign bodies has been demonstrated in different circumstances (odontogenic origin, sinus elevation with particulate graft)[14,26-28]. Sinoscopies performed in patients with zygomatic implants after at least 1 year of function showed that titanium implants were partially or totally covered with a normal respiratory membrane and there were no signs of infection around the implants, or increased secretion[9,14]. This has been confirmed in a recent animal study in which histological examinations were performed in conventional implants protruding from the maxillary sinus: the mucosa had no inflammation and was directly attached to the implants[16].

For these reasons, and based upon the results of the present clinical and radiological analysis, available sinoscopies and animal histological examinations, it seems that titanium implants do not act as a foreign body causing chronic sinusitis when they protrude or traverse the maxillary antrum[9,14,16,17]. The explanation could be the absence of mobility of these implants, which therefore does not cause irritation of the mucosa and/or obstruction of the meatal complex with consequent sinusitis[28].

In two patients, one sinus was found to be partially radiologically opaque, with no signs or symptoms of sinusitis. After 13 and 24 months of follow up, they had experienced no sinus infection. The ENT department did not consider it necessary to perform functional sinus surgery. There were several possible explanations for the findings, once infection was known not to be involved. At the instant of the CT scan, patients had variable levels of sinus clearance. A patient with a zygomatic implant might contract an upper respiratory tract infection, which could decrease permeability of the maxillary osteum[14]. It is also possible that some predisposed condition could lead to this finding, as for major grafting procedures[25]. Furthermore, since these CT scans were performed 3 and 6 months after surgery, it is possible that these two sinuses were in the process of healing.

In this series of patients, neither macroscopic oroantral fistula nor sinusitis was found. Nevertheless, a thickening of sinus mucosa around the implants, with no clinical consequences, was found in 12 (46%) out of 26 patients. This radiological finding was a non-adverse reaction of the sinus mucosa to conventional oral implants that penetrate the antrum[17]. Since this was also found in the preoperative CT scans of eight (31%) patients, it may not be caused by the implants. These changes could be the result of the physiological dynamic course of the maxillary sinus mucosal activity as a function of the airway tissue defence system in humans[25]. This is comparable to the diffuse mucosal reactions of the sinus mucosa, which can be observed in healthy humans who have not had surgery[25].

In their interesting study, Becktor et al[11] suggested that the internal thread abutment screw chamber of a zygomatic implant could create a communication from the oral cavity to the antrum, which may result in sinusitis. The implant they used had a small hole at the top of this chamber, occupied by the tip of the screw once the abutment was connected. This has been resolved with the new TiUnite implant design, which

Fig 5a Zygomatic implant with a hole for the abutment screw (machined surface). It has been suggested that the presence of this hole could lead to oral-sinus communication.

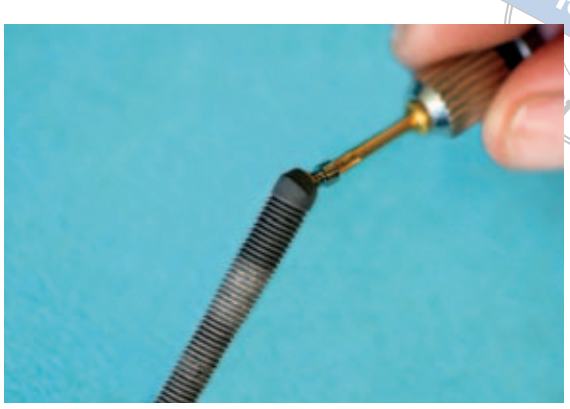

Fig 5b New implant design without the hole (titanium oxide surface, TiUnite).

Figs 5a to 5b Different designs of zygomatic implants.

has shorter abutment screws to avoid the need for this hole (Fig 5). This variation of the design may reduce the occurence of oroantral fistula and sinusitis.

In all the present patients, definitive abutments were connected at the time of surgery, with no further disconnection or reconnection. Since classic two-stage procedures employ more than one surgery, and various disconnections and reconnections of transepithelial components, it could be hypothesised that immediate function protocols, by means of avoiding these procedures, could allow improved establishment of the soft tissue barrier and a decreased risk of oroantral communication[1-3,29]. Further investigations are needed to evaluate this concept.

The limitations of this study include the small number of patients and relatively short follow-up period. Further prospective studies and randomised controlled clinical trials are needed to evaluate long-term sinus reactions to zygomatic implants, and to elucidate if immediate function protocols could decrease the associated risk of sinusitis[30].

Conclusions

Maxillary sinuses seem to maintain a normal physiology when penetrated by immediately loaded zygomatic implants. Nevertheless, in 15 to 20% of patients, early radiological findings without clinical relevance were observed.

Acknowledgements

This study was not financially supported by Nobel Biocare; however, the authors wish to thank Dr Franco Biondi, Clinical Research Manager of Nobel Biocare, for his efforts and support.

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