Case report

Magnetic resonance imaging assessment of a sinus lift operation using reoxidised cellulose (Surgicel®) as graft material

The sinus lift operation has been used since the early 1980s to gain vertical bone height in atrophic regions of the posterior maxilla, prior to the placement of dental implants [Boyne & James 1980]. In the basic surgical approach, a fenestration is made through the buccal bone, the Schneiderian membrane is freed from the maxilla and elevated, and a graft material is packed into the resulting void. Several refinements to the basic operation exist [Smiler 1997]. A variety of materials have been used for grafting, ranging from bone substitute materials [Smiler & Holmes 1987; Wagner 1991; Hürzeler et al. 1997] to autogenous bone, usually harvested from the iliac crest [Block & Kent 1997].

Surgicel® [Johnson and Johnson Ltd, Ascot, Berkshire, UK] is a material containing oxidised regenerated cellulose at a low pH (2.8). It is used in a variety of clinical situations, notably to assist blood clot formation as an adjunct to wound healing [Miller et al. 1961]. The material is resorbed, with in-growth of normal tissue. Skoog (1967) first used Surgicel® to assist bone formation in the repair of palatal clefts, but the literature is inconclusive on the success of Surgicel® in this role. In this study, we report a case of Surgicel® being used as a graft material in the sinus lift procedure.

Material and methods

The subject was a 50-year-old man, who had lost #25, 26 and had a #24 of hopeless prognosis. He had requested dental implant surgery. Initial clinical and radiographic examination showed that there was insufficient vertical bone height in the left maxilla for the placement of dental implants [Fig. 1]. #24 was extracted and, after a healing interval, it was de-
decided that he should undergo a sinus lift procedure.

The sinus lift was performed under a general anaesthetic, via a vestibular incision, and the buccal surface of the maxillary sinus was exposed. A 1.5 cm fenestration was made in the buccal bone, and the bone plate was dissected off the underlying intact Schneiderian membrane. The elevation of the sinus mucoperiosteum was performed using a ball end burnisher. Surgicel® was packed into the space between the elevated Schneiderian membrane and the bony wall of the maxilla. Primary closure of the wound was made. Antibiotic cover was prescribed for the procedure, and continued for five days.

At 3 months post operation, a low-field MRI scan (Fig. 2, 3) was performed, using a 0.2 T “Open Viva” magnetic resonance imaging (MRI) scanner (Siemens AG, Erlangen, Germany). T1-weighted imaging protocols were used, as described in our previous low-field implant assessment study (Gray et al. 1998), and high resolution images were obtained in the axial plane and at parallel (quasi-sagittal) and right angles (quasi-coronal) to the sinus lift region (Gray et al. 1996). Before imaging, the patient received an intravenous injection of Magnevist, 0.2 ml per kg body weight (Schering AG Berlin, Germany). The paramagnetic gadolinium ions in Magnevist are used to help delineate boundaries, as they strongly enhance visibility of tissues such as mucosa and mucoperiosteum in T1-weighted MR images. From the quasi-sagittal scan parallel to the arch, we selected the central buccopalatal slice. The vertical bone height (from the oral cortical plate to the sinus surface) was measured at three points delineated along the edentulous portion of the arch. As the interface between new and old bone could be clearly delineated, the pre-surgical vertical bone height (height from the lower edge of the “ghost”)
cortical plate to the antral surface] was measured at the same three points along the arch. Measurements of vertical bone height from the pre-surgical panoramic radiograph were also made at the same horizontal spacing used in the MRI scans.

At seven months post sinus lift, a flap was raised and three dental implants (Nobel Biocare AB, Göteborg, Sweden) were placed. The locations of the implants were confirmed by a further panoramic radiograph [Fig. 4].

Results

The preoperative assessment of the case by panoramic radiograph indicated a vertical bone height of between 10 and 15 mm at the potential implant site. Using the post-sinus lift MRI scan, the quasi-sagittal views at right angles to the maxilla [Fig. 2] showed that a material of similar MRI appearance to bone was present in the area where the Surgicel® had been placed, below the nasal mucoperiosteum. This material behaved as normal cancellous bone on final implant placement.

The outline of the previous upper cortical plate [the limit of bone before the sinus lift] could be clearly seen. This vertical measurement of the preoperative bone height on the MRI scan was related to the preoperative vertical measurements from the panoramic radiograph (Table 1). The MRI scan apparently shows a new layer of cortical bone forming below the antral mucoperiosteum.

The implant lengths used confirmed the vertical bone height viewed on the right-angled MRI scans of the implant area.

Discussion

A plethora of materials have been used as bone grafts for the sinus lift operation, with many operators preferring to use autogenous bone from the iliac crest. As the use of autogenous bone requires a second operation to harvest the graft, the procedure leads to increased morbidity and healing time.

Surgicel® has been successfully used to assist bone remodelling in cleft palate cases [Skoog 1967; Thilander & Stenstrom 1974] and in guided tissue regeneration [Galgot 1990a, 1990b, 1996]. The literature on the success of Surgicel® is, however, inconclusive. Some operators claim that Surgicel® does not induce bone formation [Matthew et al. 1995] and may even be detrimental [Nappi & Lehman 1980]. Ibarrola et al. (1985) noted that Surgicel® left in situ exhibited a slower rate of bone repair than controls. They thought that the acid pH of Surgicel® may delay the ‘alkaline tide’ essential to the function of alkaline phosphatase.

The novel use of Surgicel® here poses interesting questions as to the physiological mechanisms at play in the conversion of blood clot within the Surgicel® into bone. The possible pathway may be that found in calcification of subperiosteal haematoma in long bones such as the tibia [Kullman & Wouters 1972].

Engdahl (1972) observed that serum and blood within a cavity bounded by mucoperiosteum led to rapid bone growth within the cavity. In this series, Surgicel® onlay grafts appeared to slow down the rate of new bone growth. In the sinus lift situation, however, our hypothesis is that the main purpose of the Surgicel® is to act as a loose matrix with the blood clot, and to hold the elevated antral mucoperiosteum up against the collapse that would otherwise happen. The Surgicel® within the sinus graft is certainly not homogeneous in nature, and will contain tissue fluids, blood and air within the matrix. It is to be expected that such a matrix will show a reduction in volume during the healing phase, as in an autogenous bone graft, where tissue fluid can be seen to transform into bone when viewed on sequential MRI scans (Gray et al. 2000). It is agreed by most authorities that a periosteal layer is necessary for bone growth of this sort [Skoog 1965; Engdahl 1972; Rintala et al. 1974].

The growth of bone within the graft is likely to be from the influence of the antral mucoperiosteum causing differentiation of fibroblasts within the clot to form osteoblasts and hence bone matrix. Care should be taken to avoid placement of Surgicel® into an infected site, as Surgicel® has been shown to significantly enhance the proliferation of bacteria in wound sites [Scher & Coil 1982]. It is imperative that the Schneiderian membrane is elevated without tearing, as damage would lead to infection of the graft and failure.

The use of MRI to investigate the re-

![Fig. 4. A post-implant placement panoramic radiograph showing the final position of implants within the augmented bone.](image-url)
sult of the sinus lift operation [Gray et al. 1999] allows examinations to be made of the patient without the exposure to ionising radiation [NRPB 1991]. Cortical bone yields no MR signal and is seen as a dark region, while cancellous bone exhibits a strong MR signal. Implant alignment can be manipulated to allow maximum use of vertical bone [Gray et al. 1996, 1998]. Although not performed on this case, further investigation into the nature of the graft material could be made using T2 weighted and fat suppression MR sequences. It should be noted that as this examination was performed using a low-field 0.2 T open scanner, fat suppression would be impractical. Ideally, a pre-sinus lift MRI scan would have been useful, but the “ghost” outline of the original cortical plate has in this instance permitted us to view pre- and postoperative limits on the postoperative scan. The dimensional inaccuracy in the use of panoramic radiographs is well documented [Reddy et al. 1994; Bolin et al. 1996]. Assuming that the MRI measurements are accurate, it is of interest to note that the magnification factor from the panoramic machine is not constant at different horizontal positions along the dental arch.

The use of X-ray computed tomography (CT) for similar investigations is difficult to justify due to the substantial dose of ionising radiation incurred [NRPB 1992]. CT and MRI have been shown to have strong correlation in dimensional accuracy [Nasel et al. 1999], allowing confidence in measurements made using MRI scans. In CT examinations of healing sites where Surgicel® has been used, artefacts resembling developing abscesses have been noted, leading to confusion of the healing status of the site [Young et al. 1994]. A similar artefact is found when examined by ultrasound [Melamed et al. 1993].

The literature is contradictory in both outcome and mechanism for Surgicel® as a graft material, and we feel that further study of the use of Surgicel® in the sinus lift operation is warranted. If results were reproducible, the use of an agent such as Surgicel® could be recommended as a possible bone graft substitute, avoiding unnecessary bone harvesting or introduction of non-autogenous particulate bone substitutes. The use of MRI in the examination of healing graft sites allows us to gain significant information without the use of ionising radiation, and allows full tomographic examination of the sinus lift region.

Résumé

Différents matériaux ont été utilisés pour les greffes osseuses lors d’opérations d’épaississement du sinus afin d’augmenter la hauteur osseuse verticale dans le maxillaire avant le placement d’implants dentaires dans des maxillaires atrophiés. Dans le cas présent, le Surgicel® (cellulose régénérée oxydiée) a été utilisé comme matériel de greffe chez un patient, permettant ainsi l’insertion différée d’un implant tant dans l’os existant que le nouveau. La région du sinus a été examinée trois mois après ce processus de greffage avec le Surgicel® en utilisant l’imagerie par résonance magnétique (MRI). Le MRI a montré qu’un matériel avec un signal MR semblable à celui de l’os s’était formé dans le greffon. MRI permettait d’obtenir des informations tomographiques dans cette région sans exposition aux radiations ionisantes. La formation d’os dans la matrice du Surgicel® a été confirmée lors du placement de l’implant. Ce fait nous amène à nous poser plus de questions en ce qui concerne la physiologie de la formation osseuse à l’intérieur de matériaux de greffe sans particule et à procéder à davantage de recherche dans ce domaine.

Zusammenfassung


References


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