International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Clinical Observation of Xenogeneic Acellular Collagen Matrix Repair of Odontogenic Maxillary Sinus Perforation

Ying Zhang[1], Lixin Xu[2]

[1]Beijing Yourui Stomatology Department. Associate Chief Physician

[2]Beijing Zhongke Stomatology Department. Associate Chief Physician
Corresponding Author Email: *2818341465[at]qq.com*

Abstract: ***Objective: This case study investigates the clinical use of xenogeneic acellular collagen matrix in the treatment of odontogenic maxillary sinus perforation. Methods: Eight patients underwent repair procedures using this matrix, and outcomes were tracked over 6 to 24 months. Results: All cases showed successful healing of both sinus mucosa and bone, with no adverse systemic or local reactions. Conclusion: The use of the collagen matrix provided a stable platform for eventual dental implant placement, offering a viable alternative to traditional autologous grafts.***

Keywords: Odontogenic sinus perforation, Collagen matrix, Maxillary sinus repair, Dental implants, Oral surgery

1. Introduction

Because the anatomical location of the maxillary sinus is closely related to the oral cavity, and sometimes it is only mucosally separated from the maxillary posterior teeth, the inflammation of the maxillary posterior teeth can easily ascend to the sinus cavity. In addition, oro - antral fistula (OAF) due to tooth extraction or implant surgery can cause inflammation of the maxillary sinus mucosa, which is called odontogenic maxillary sinusitis (OMS) [1]. Cure odontogenic maxillary sinusitis requires not only endodontic therapy, antibiotic use, and, more often, surgery [2 - 3]. Previous surgeries have included apical excision of the affected tooth and oral - maxillary sinus fistula repair, as well as traditional or modified Caldwell - Luc procedures, nasal endoscopy and other surgeries involving the maxillary sinus cavity [4 - 5]. In this paper, xenograft collagen matrix was used to repair odontogenic maxillary sinus fistula, which provided a simpler surgical operation and a more stable restoration effect for the repair of odontogenic maxillary sinus fistula.

2. Information and Methodology

2.1 General information

From March 2020 to June 2023, 8 patients with perforation of maxillary sinus and odontogenic sinusitis in the maxillary posterior tooth area due to odontogenic disease occurred in the continuous visit to Beijing Zhongke Dental Clinic, including 6 males and 2 females, with an age range of 45~70 years and an average age of (58.2±7.48) years.

2.2 Inclusion Criteria and Exclusion Criteria

Inclusion Criteria

1) All patients had perforation of maxillary sinus due to odontogenic disease accompanied by odontogenic maxillary sinusitis.
2) Preoperative CBCT showed maxillary sinus perforation accompanied by chronic inflammation in the maxillary sinus, as shown in Figure1 - 8.
3) Systemic diseases without contraindications to tooth extraction surgery.
4) The whole mouth has good periodontal and hygiene, or after the completion of basic treatment of periodontal disease. Patient understands and signs the consent form.

Exclusion Criteria

1) Cases with incomplete or missing clinical data and follow - up data.
2) Those who have cognitive impairment and are unable to conduct subjective satisfaction evaluation.

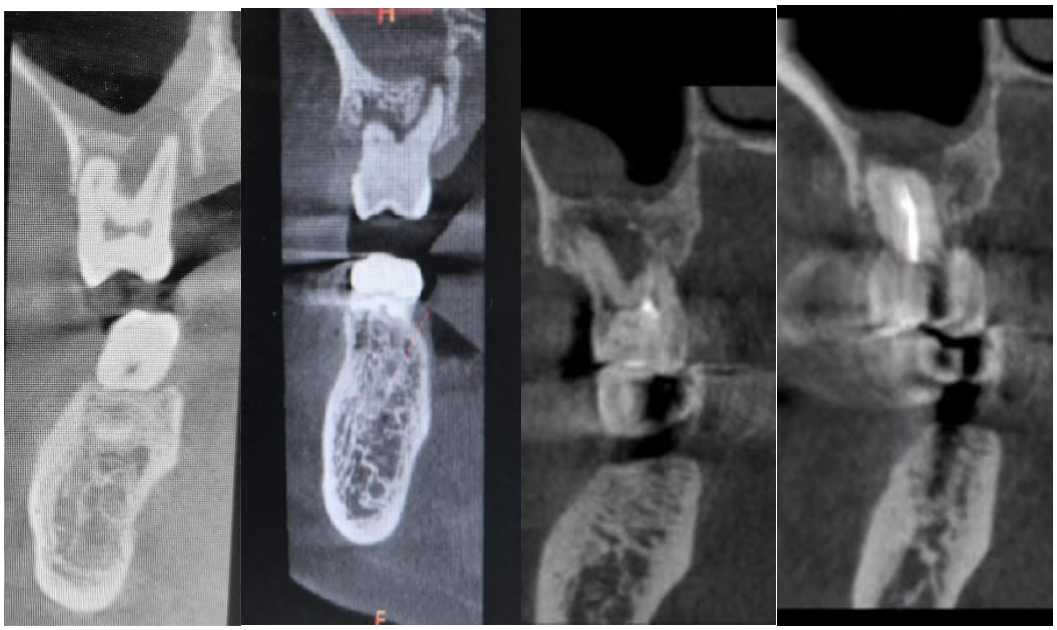

Figure 1 **Figure 2** **Figure 3** **Figure 4**

Figure 5 **Figure 6** **Figure 7** **Figure 8**

Figure 1 - 8: Three - dimensional imaging shows that a large area of bone defect around the apex caused by severe periodontal disease or failed root canal treatment penetrates the base wall of the maxillary sinus, causing thickening of the maxillary sinus mucosa and chronic inflammation.

2.3 Surgical methods

All 8 patients were thoroughly scraped to remove inflammatory granulation tissue after extraction of the affected teeth, and the alveolar fossa was irrigated with gentamicin saline mixture after maxillary sinus perforation, and then implanted into the Chenggukuai® oral collagen matrix (Figs.9 - 10) independently developed and produced by Xiling (Zhenjiang) Medical Technology Co., Ltd., the Chenggukuai® oral collagen membrane (Figs.11 - 12) was covered on the collagen matrix, and the wound was sutured with non - absorbable threads (Figs.13 - 17), and attention should be paid to the protection of upper respiratory tract infection during the healing period. The gingiva at the tooth extraction site will completely heal in about 4 weeks. After 6 months, take an X - ray to observe the repair situation of the bone wall at the floor of the maxillary sinus. The perforated floors of the maxillary sinuses of 8 patients have all been repaired. However, the remaining bone height at the floor of the maxillary sinus is insufficient for implant placement, so a sinus floor elevation procedure needs to be carried out simultaneously during the second - stage implantation surgery to increase the bone quantity. During the second - stage implantation, the Chenggukuai® oral collagen matrix and the Chenggukuai® oral collagen membrane need to be implanted again at the same time, and then the wound should be tightly sutured. The upper restorations of all 8 patients were completed 6 months after the implant placement.


Figure 9

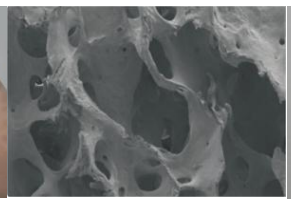
Figure 10


Figure 11

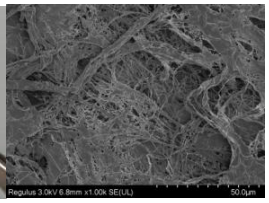
Figure 12


Figure 13


Figure 14


Figure 15


Figure 16


Figure 17


Figure 18

Figure 13 - 18: (Figure 13) Extract the diseased tooth, thoroughly clean the inflammatory granulation tissue within the tooth extraction socket. (Figure 14) Then implant the Chenggukuai® oral collagen matrix into the tooth extraction socket. (Figure 15) reposition and suture the gingiva at the tooth extraction site. (Figure 16) The gingiva at the tooth extraction site will completely heal in about 4 weeks. (Figure 17) During the second - stage implantation, the Chenggukuai® oral collagen matrix and the Chenggukuai® oral collagen membrane need to be implanted again at the same time, and then the wound should be tightly sutured. (Figure 18) The upper restoration was initiated 6 months after implant placement.

2.4 Postoperative treatment

After the surgical wound is sutured, apply the antibacterial gel. Intermittently apply ice compress to the facial area on the surgical side for 48 hours. Take oral antibiotics for 3 to 7 days. Do not chew food on the surgical side. Instruct the patient not to swim, engage in strenuous exercise, puff out their cheeks, etc. Pay attention to oral hygiene and rinse the mouth with Regoral® mouthwash of Xiling for one week after the surgery. Remove the stitches two weeks later.

2.5 Postoperative follow - up and repair:

X - ray examination of maxillary sinus bone repair at 3 months, 6 months, 12 months, and 24 months after surgery. The implants were implanted 6 months after the operation, and the implants were well stabilized, and the implants had good osseointegration 6 months after the implantation, and the upper porcelain tooth restoration was completed. (Figure 19 - 26)

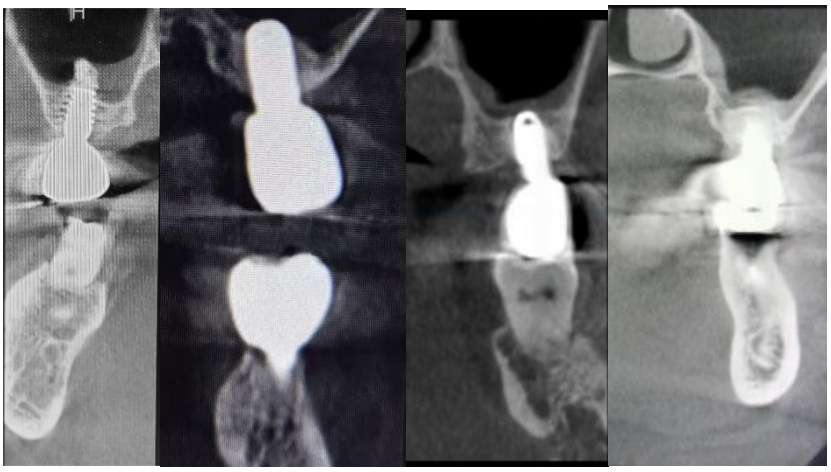

Figure 19 Figure 20 Figure 21 Figure 22

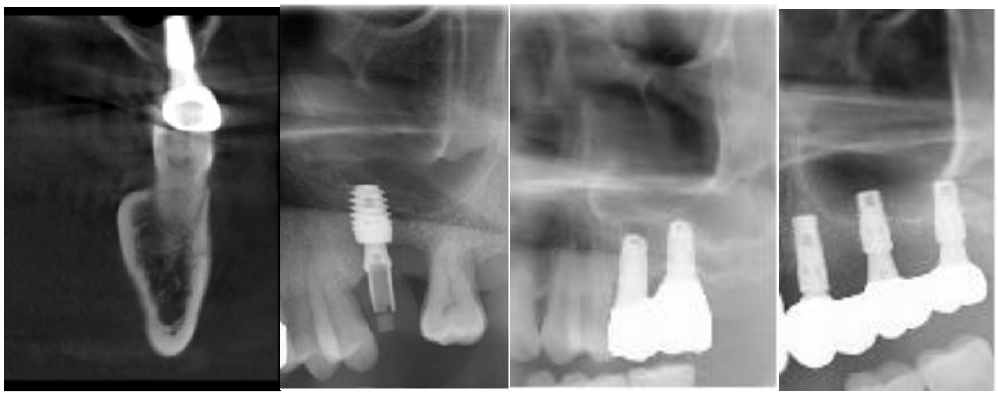

Figure 23 Figure 24 Figure 25 Figure 26

2.6 Postoperative evaluation Standard evaluation

No movement in the clinical examination of the independent implant, and no translucent area around the implant in radiological examination. One year after implant placement, the alveolar bone around the implant was resorbed < 0.2mm on average per year, and there was no pain, infection and nerve damage, which was considered satisfactory from both functional and aesthetic perspectives.

3. Results

a) Among the 8 patients included in the study, 7 patients were re - examined 2 weeks after the tooth extraction was implanted with Chenggukuai® oral collagen matrix, and the wound healed well, showing no signs of redness, swelling, or pain, and no symptoms of oronasal fistula. One patient had poor wound healing at the time of suture removal.

b) The observation group waited for 6 months of bone healing before implantation, and the implants were implanted 6 months after the operation, and the implants were all well stabilized, and the implants had good osseointegration 6 months after implantation, and the upper porcelain tooth restoration was completed.

4. Conclusion

Clinically, the investigators observed that chronic adult periodontitis, periodontal pulp lesions and chronic apical periodontitis in the posterior maxillary region may cause odontogenic maxillary sinusitis (OMS) and even maxillary sinus perforation. Among them, the bone destruction and thickening of the mucosa of the sinus cavity were relatively limited in patients with periapical disease as the pathogenic factor. Patients with severe periodontitis and periodontal pulp combined lesions have a wider range of bone destruction, and are more likely to develop oral sinus fistula, and the degree of maxillary sinus lesions is more severe; Patients with combined periodontal endodontic lesions have a higher chance of developing OMS in the presence of poor root canal filling. It has been reported that the source tooth of OMS is the largest maxillary first molar, accounting for 35.33% [6]. In this study, it was found that among the 8 cases of odontogenic maxillary sinusitis and maxillary sinus perforation, 6 cases were maxillary first molars and 2 cases were maxillary second molars. In patients with periapical lesions or moderate to severe periodontal bone loss, the probability of maxillary sinus mucosa thickening was significantly increased [7 - 10]. In this study, the predominant source of OMS caused by chronic adult periodontitis was severe periodontitis (90%).

At present, after maxillary sinus perforation, there are different treatment methods depending on the size of the perforation site, the local soft and hard tissues, and whether there is maxillary sinus inflammation. Literature [11] suggests that the treatment of maxillary sinus perforation usually

depends on the size of the perforation diameter: when the perforation diameter is less than 2 mm, the gingiva on both sides is pulled together and sutured to form a high - quality blood clot in the alveolar fossa, and the perforation heals naturally after its organization; When the diameter of the perforation is 2 mm~6 mm, the iodoform gauze can be fixed on the surface of the alveolar fossa to close the wound, so as to protect the blood clot in the alveolar fossa and wait for it to heal naturally. Perforations larger than 7 mm in diameter usually require surgical repair. Common clinical repair procedures include: buccal and palatal mucoperiosteal flap gliding, buccal fat pad grafting, autologous/non - autologous bone grafting, absorbable biologics tamponade and biofilm dissection technology, among which buccal mucoperiosteal flap gliding is easy to cause significant shallowness of the buccal vestibular sulcus after surgery, and secondary vestibular sulcus deepening is also required for those elderly patients with low alveolar ridge and need denture restoration [12]. The requirements for the surgeon are relatively high, otherwise it is easy to cause the destruction of the buccal fat pad capsule and cause avascular necrosis or damage to adjacent tissues and cause other complications [13 - 14], and if the perfusion of the surrounding tissues is poor and the amount of surrounding soft tissue is insufficient during autologous/non - autologous bone grafting operation, it is difficult to completely close the wound, which can cause infection and resorption of the grafted bone. These studies focused on repairing oronasal fistulas, and it has not been reported whether the bone wall at the floor of the maxillary sinus is truly osteogenic. The above studies also do not mention the relationship between the size of the perforation in the maxillary sinus and the height of the remaining alveolar ridge and future mandibular sinus basement bone restoration. Due to the rapid development of implant restoration technology, the choice of implant restoration is also the preferred option for patients after tooth loss. Therefore, patients with odontogenic maxillary sinusitis and maxillary sinus perforation are faced with the problem of implant restoration after the tooth is extracted. There are relatively few reports on this and it deserves in - depth study.

The main component of the Chenggukuai® oral collagen matrix and the Chenggukuai® oral collagen membrane used in this study is collagen egg white, in which the collagen membrane retains the collagen barrier membrane after preparation, and the collagen matrix undergoes a series of processes such as decellularization, deantigenization, and virus inactivation to obtain a blocky collagen matrix with strong supporting effect, which has a natural three - dimensional structure that is highly similar to human bone, and has good histocompatibility and hydrophilicity.

The collagen matrix for Chenggukuai® oral cavity is conducive to host cell growth and rapid vascularization, and the key to the success or failure of maxillary sinus perforation repair lies in the abundant blood supply of the vascular bed and sufficient area of graft filling. Maxillary sinus perforation repair involves a layered approach, addressing both soft tissue and bone regeneration, it is a composite tissue repair process, first of all, repair the perforated maxillary sinus mucosa with chronic inflammation. In general, the growth rate of soft tissue is faster, and the lumpy Chenggukuai® bone collagen matrix is filled in the maxillary sinus perforation (choose the appropriate specification according to the size of the perforation), so that it can play the role of a bridge, so that the maxillary sinus mucosa can crawl along the collagen matrix to complete the repair of the maxillary sinus mucosal perforation.

Some studies [15 - 16] have found that the sinus floor mucosa has osteogenic function, which can form bone adhesion, osteocontin, osteopontin, alkaline phosphatase and osteogenic protein, and induce the formation of surrounding new bone.

In the process of applying xenoacellular bone matrix to repair maxillary sinus perforation, the author has experienced: (1) a transplant bed with good blood supply is the basis for the survival of repair materials, which can better play the role of repair materials; (2) The loose and porous three - dimensional structure can be used in combination with gentamicin and other antibiotics to control local chronic inflammation and facilitate wound healing; (3) The decellularized matrix biomaterial has good biocompatibility: the decellularized matrix has been specially treated to remove the immunogen components, but still retains the natural bioactive components, so it can be well compatible with human tissues. At the same time, it has a strong endogenous tissue induction ability, which can induce cell adhesion and growth, and regulate and accelerate the tissue repair process [17 - 20]. (4) Decellularized matrix materials have a wide range of indications: they can be used to fill the gaps of tissue loss, induce tissue regeneration, repair damaged tissues, and complete the integration of peripheral tissues. (5) The operation is simple and time - saving, which is conducive to improving the quality of life of patients. The case observations support the use of xenogeneic acellular collagen matrix as a reliable and practical alternative for repairing odontogenic maxillary sinus perforations. The successful bone regeneration and mucosal healing observed, coupled with favorable long - term implant outcomes, suggest this method has strong clinical potential in dental regenerative practices.

References

[1] Psillas G, Papaioannou D, Petsali S, et al. Odontogenic maxillary sinusitis: a comprehensive review [J]. J Dent Sci, 2021, 16 (1): 474 - 481.
[2] Yingkai Hu, Guangzhou Xu, Chi Yang. Advances in the Treatment of Odontogenic Maxillary Sinusitis Chinese Journal of Oral and Maxillofacial Surgery, Volume 12, Issue 6, November 2014.
[3] Wang KL, Nichols BG, Poetker DM, et al. Odontogenic sinusitis: a case series studying diagnosis and management [J]. Int Forum Allergy Rhinol, 2015, 5 (7): 597 - 601.
[4] Zhuohui Fu, Xue Tan, Dingming Huang. Diagnosis and treatment strategies for odontogenic maxillary sinusitis. International Journal of Stomatology.2021 - 05, 48 (3): 367 - 372.

[5] Zheng B. The relationship between chronic apical sinus [D]. Chengdu: Sichuan University, 2019: 1 - 68.
[6] Xu Tao, Lu Baoquan, Liao Shengkai. Prevention of oral sinus fistula by intraoperative extraction of maxillary cyst filling with buccal fat pad [J]. Journal of Bengbu Medical College, 2007, 32 (5): 531 - 532.
[7] Abrahams JJ, Glassberg RM. Dental disease: a frequently unrecognized cause of maxillary sinus abnormalities? AJR Am J Roentgenol.1996; 166: 1219–23.
[8] Sakir M, Ercalik Yalcinkaya S. Associations between periapical health of maxillary molars and mucosal thickening of maxillary sinuses in cone - beam computed tomographic images: a retrospective study [J]. J Endod, 2020, 46 (3): 397 - 403.
[9] Zhang B, Wei Y, Cao J, et al. Association between the dimensions of the maxillary sinus membrane and molar periodontal status: a retrospective CBCT study [J]. J Periodontol, 2020, 91 (11): 1429 - 1435.
[10] LA de Souza - Nunes, FS Verner, LPL Rosado, et al. Periapical and endodontic status scale for endodontically treated teeth and their association with maxillary sinus abnormalities: a cone - beam computed tomographic study [J]. J Endod, 2019, 45 (12): 1479 - 1488.
[11] Yankang Shi, Lihua Hu, Xiaohui Han, et al. Application of concentrated growth factor in maxillary sinus perforation repair [J]. Shandong Medicine, 2017, 57 (7): 95 - 97.
[12] Xiang Yan, Shaofu Du. Application of buccal mucosal flap of alveolar bone in the repair of oral maxillary sinus fistula [J]. Journal of Stomatology, 2000, 16 (3): 229.
[13] Xiufa Tang, Zhiqi He, Chengge Hua, et al. Application of buccal fat pad flap in the repair of oral defects [J]. Chinese Journal of Reparative and Reconstructive Surgery, 2006, 20 (9): 893 - 895.
[14] Jung Y S, Chung S W, Nam W, et al. Park. Spontaneous bone formation on the maxillary sinus floor in association with an extraction socket [J]. Int J Oral Maxillofac Surg, 2007, 36 (7): 656 - 657.
[15] S. Srouji, D. Ben - David, R. Lotan, M. Riminucci, et al. The innate osteogenic potential of the m axillary sinus (Schneiderian) m em brane: an ectopic tissue transplant model simulating si- nus lifting [J]. Int J Oral Maxillofac Surg, 2010, 39 (8): 793 - 801.
[16] JP Bonardi, R dos Santos Pereira, FBDJB Lima, et al. Prospective and random ized evaluation of chronos and Bio - Oss in hum an maxillary sinuses: histom orphom etric and im m unohisto- chem ical assignm ent for runx 2, vascular endothelial growth factor, and osteocalcin [J]. J Oral Maxillofac Surg, 2018, 76 (2): 325 - 335.
[17] Deepak Choudhury, Marcus Yee, Zach Lee Jia Sheng, et al. Decellularization systems and devices: State–of–the–art. Acta Biomater 2020; 115: 51–59.
[18] Shagufta Parveen, Shishu Pal Singh, M. M. Panicker, et al. Amniotic membrane as novel scaffold for human iPSC–derived cardiomyogenesis. In Vitro Cell Dev Biol Anim 2019; 55 (4): 272–284.
[19] Doris A. Taylor, Luiz C. Sampaio, Zannatul Ferdous, et al. Decellularized matrices in regenerative medicine. Acta Biomater 2018; 74: 74–89.
[20] Yuguo Zhao, Mingming Li. Preparation Method of Acellular Matrix Materials and Their Application in the Repair of Bone, Joint and Cartilage Injuries China Organization Engineering 2016 20 (34): 5051 - 5056.