Journal of Cranio-Maxillo-Facial Surgery 40 (2012) 485–493

Contents lists available at SciVerse ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Jaw cysts – Filling or no filling after enucleation? A review☆

Tobias Ettl[a,*], Martin Gosau[a], Robert Sader[b], Torsten E. Reichert[a]

[a] Department of Oral and Maxillofacial Surgery (Chair: Prof. T.E. Reichert, MD, DMD, PhD), University of Regensburg, Germany
[b] Department of Oral and Maxillofacial Surgery (Chair: Prof. R. Sader, MD, DMD, PhD), University of Frankfurt, Germany

ARTICLE INFO

Article history:
Paper received 24 March 2011
Accepted 23 July 2011

Keywords:
Jaw cysts
Enucleation
Defect filling
Bone grafts
Ossification
Complications

ABSTRACT

Introduction: Jaw cysts are common lesions in the oral and maxillofacial region. Enucleation of the lesions and primary closure of the defects, the so-called "cystectomy", has evolved as the treatment of choice. In order to reduce infections and to accelerate bone regeneration, different types of bone grafts are increasingly investigated for defect filling.
Material and methods: The present review reflects the most recent studies using autogenous, allogenic, xenogenic and alloplastic bone grafts and compares the results to current investigations about conservative cyst enucleation without using any filling materials. Relevant studies with significant patient sample sizes were electronically searched in PubMed and Medline.
Results: Simple cyst enucleation and blood clot healing show low complication rates and sufficient bone regeneration even in large defects. Prospective randomized trials comparing the additional use of filling materials to the "cystectomy" are rare. Currently available data do not indicate the superiority of additional bone grafts.
Conclusion: Enucleation of jaw cysts and primary closure without bone substitutes remains "state of the art" in most cases.

1. Introduction

Human bone is characterized by the unique ability to regenerate its original structure after defects or fractures through a programmed sequence of maturation steps closely resembling the pattern of bone development and bone growth (Schenk et al., 1994; Buser et al., 1998). Reliable bone healing depends on an adequate blood supply, a solid basis for bone deposition and immobilization. During the first 4 weeks angiogenic and osteogenic cells originating from the adjacent bone walls and the periosteum turn a blood clot into granulation tissue and woven bone towards the centre of the defect. This procedure is stimulated by various cytokines, growth factors (e.g. PDGFs, IGFs, FGFs, TGF-β, BMPs) and stem cells (Schenk et al., 1994; Buser et al., 1998; Schliephake, 2002; Ogunlewe et al., 2006; Rodeo et al., 2010). Over the following 4 months desmoplastic bone is replaced by parallel-fibred bone resembling the original Haversian bone structure (Lemperle et al., 1998).

Odontogenic jaw cysts are common lesions in the maxillofacial area. The preferred treatment of these lesions consists of enucleation of the cysts and watertight primary closure, which has been described by Partsch as "Cystectomy" (Partsch II) in 1910 (Partsch, 1910). Especially cysts located in the mandible present an ideal bone defect after enucleation as in most cases these defects are completely surrounded by solid bone walls apart from the site of approach. This facilitates a stable blood clot leading to a regular and safe healing process. The enucleation of jaw cysts of different sizes with safe closure of the wound has been the standard procedure to the present day (van Doorn, 1972; Chiapasco et al., 2000; Bolouri et al., 2001; Ihan Hren and Miljavec, 2008; Iatrou et al., 2009; Yim and Lee, 2009; Kreusch et al., 2010).

Partsch was convinced that the cystectomy was restricted to smaller cavities up to 2 cm and that this method, when applied to larger cysts, would lead to infections and complications. In the 1960's Schulte stated that with increasing size of the cyst, the risk of wound infection rises due to retraction of the blood clot from the cyst wall (Schulte, 1960; Dickmeiss et al., 1985). For this reason he inserted a gelatine sponge in combination with thrombin to stabilize the blood clot (Schulte, 1965).

In the last decades there have been numerous investigations into the treatment of jaw lesions using autogenous grafts, allogenous grafts, xenografts or alloplastic and synthetic grafts as filling

☆ Presented at the 59th Annual Meeting of the Academy of Oral and Maxillofacial Surgery ("Arbeitsgemeinschaft für Kieferchirurgie"), Bad Homburg, Germany, 13.05.2010–14.05.2010.

* Corresponding author. Klinik und Poliklinik für Mund-, Kiefer- und Gesichtschirurgie, Klinikum der Universität Regensburg, Franz-Josef-Strauß-Allee 11, 93053 Regensburg, Germany. Tel.: +49 941 9446361; fax: +49 941 9446302.
E-mail address: tobias.ettl@klinik.uni-regensburg.de (T. Ettl).

1010-5182/$ – see front matter © 2011 European Association for Cranio-Maxillo-Facial Surgery.
doi:10.1016/j.jcms.2011.07.023

materials. Besides reduction of infections and healing disturbances these materials have been applied for reasons such as accelerated bone regeneration, prevention of soft tissue collapse into the defect and improved bone strength.

This review reflects the results for cyst enucleation and simple closure in comparison to those using bone substitutes. Data of complications and bone regeneration are particularly emphasized.

2. Materials and methods

Relevant studies were identified and retrieved by electronic searches in PubMed and Medline up to January 15, 2010. The search was supported by a senior librarian who specialized in health sciences. Free text words were used for search with following terms: "jaw, mandible, maxilla, cysts, lesion, defect, critical size, treatment, enucleation, cystectomy, blood clot, filling material, bone graft, autologous, iliac spongiose, allogenous, alloplastic, synthetic, tricalcium phosphate, hydroxyapatite, xenogenic, collagen, bone regeneration, ossification, complication, infection, fracture, histology, radiographic, periosteum, bone wall, localisation" Reference lists of all articles retrieved from PubMed search were selected for further relevant studies. Clinical and preclinical studies with a sample size of $N \geq 5$ were evaluated and included in this review. The main focus was on data regarding complication rates and bone regeneration. The most recent studies are shown in Table 1 and Table 2.

3. Results

3.1. Enucleation and primary closure – cystectomy – without any additional bone substitutes

Up to date, several studies have reported safe and regular bone healing after enucleation and simple closure of jaw cysts without using bone grafts even in cases of large defects (van Doorn, 1972; Mitchell, 1992; Chiapasco et al., 2000; Bolouri et al., 2001; Ihan Hren and Miljavec, 2008; Iatrou et al., 2009; Yim and Lee, 2009; Kreusch et al., 2010) (see Table 1).

The complication rate for cyst enucleation, primary closure and perioperative antibiotic treatment seems to be less than 5%, even in defects measuring far more than 3 cm (van Doorn, 1972; Chiapasco et al., 2000; Ihan Hren and Miljavec, 2008; Iatrou et al., 2009; Kreusch et al., 2010). Infection going along with suppuration and wound dehiscence presents the main complication. However, the presence of suppuration at the moment of surgery does not inevitably lead to healing disturbances (van Doorn, 1972). An optimal access incision – e.g. marginal incision – ensures a safe defect closure on solid bone, which is mandatory for undisturbed organization of the blood clot (van Doorn, 1972; Chiapasco et al., 2000; Kreusch et al., 2010).

Fractures after enucleation of mandibular cysts are extremely rare (Chiapasco et al., 2000; Kreusch et al., 2010). The highest risk exists for lesions affecting the angle of the mandible. Bolouri et al. (2001) reported a fracture-rate of 3.1% in a study on 160 patients presenting with follicular cysts of the mandibular angle with a mean size of 31.5 mm.

With regard to bone regeneration after cystectomy extensive ossification of defects up to 3–4 cm in diameter can be expected after 12 months. Ihan Hren and Miljavec evaluated spontaneous bone healing of large mandible bone defects in 33 patients by computer-analyzed radiographs. Analysis revealed a mean gain of bone density of 7%, 27% and 46% after 2, 6 and 12 months respectively. In smaller defects measuring 2–3 cm in diameter a final bone density of 97% in relation to normal surrounding bone was observed after 12 months (Ihan Hren and Miljavec, 2008). Similar results were reported by Yim and Lee on 74 patients after enucleation of jaw cysts. In this study panoramic radiograph analysis showed a recovery of radiopacity of more than 97% in defects smaller than 3×4 cm after 12 months. It has to be mentioned that only patients without wound dehiscence were selected (Yim and Lee, 2009). In mandibular defects exceeding 3 cm in size Ihan Hren and Miljavec (2008) found a bone density of 84% of normal surrounding bone after 12 months. In another study by Chiapasco et al. evaluating spontaneous bone regeneration after enucleation of 27 cysts larger than 4 cm computed analysis of panoramic radiographs showed a mean reduction in size of 12.3%, 43.5% and 81.3% after 6, 12 and 24 months respectively. The increase of bone density was 37.0%, 48.2% and 91.0% after 6, 12 and 24 months. This investigation demonstrated almost complete bone healing of defects exceeding 4 cm in diameter after 24 months (Chiapasco et al., 2000).

Young patients show better bone healing compared to older patients, and monocortical defects result in higher ossification rates than bicortical defects (Ihan Hren and Miljavec, 2008; Yim and Lee, 2009). Furthermore, the shape of the bone defect seems to be more important for healing than the volume. Ihan Hren and Miljavec (2008) observed that the minimal diameter of the lesion is the crucial parameter, for which reason elliptic defects show a better bone healing as circular defects of the same volume. The same group described a superior bony regeneration for mandibular defects of the angle and the symphysis compared to defects of the body region. In a former publication examining radiographs of 38 patients by Laffers and Zimmer, bone healing after cystectomy was most favourable in the anterior region of the mandible and least favourable in the anterior region of the maxilla (Laffers and Zimmer, 1977). The poor bone regeneration of the anterior maxilla has also been described (Hemprich et al., 1989). Other studies again report no difference in bone regeneration of maxillary and mandibular defects (van Doorn, 1972; Yim and Lee, 2009).

Special attention should be paid to the preservation of the periosteum, which has a large capacity for spontaneous ossification and bone repair. Ma et al. (2009) determined a critical size defect of 6 cm for minipig mandibular segmental defects when the periosteum was preserved and a critical size defect of only 2 cm when the periosteum was removed. Similar results were observed in canine mandibles where defects greater than 15 mm failed to heal when the periosteum was removed in contrast to spontaneous bone healing in defects up to 50 mm when the periosteum was preserved (Huh et al., 2005). One report showed spontaneous osteogenesis in mandibular segmental defects even when the whole mandible was resected with preservation of the periosteum (Ogunlewe et al., 2006). The periosteum seems to have a higher osteogenic potential than the adjacent bone edges (Lemperle et al., 1998; Huh et al., 2005). Guided bone regeneration with the use of resorbable or non-resorbable membranes did not show any advantage over primary periosteal wound closure in human mandibular monocortical defects (Santamaria et al., 1998). Even the additional application of iliac cancellous bone grafts did not enhance bone regeneration in mandibular segmental defects of mongrel dogs with intact periosteum leading to the authors' conclusion that absorption and replacement of the bone grafts delayed the healing process (Lemperle et al., 1998). However, if the periosteum is absent spontaneous bone regeneration might benefit from osteoconductive and osteogenic cancellous autografts protected by macroporous meshs against the adjacent soft tissue prolaps (Lemperle et al., 1998; Ma et al., 2009).

3.2. Additional bone substitutes

As mentioned above there have been many investigations into the treatment of cystic jaw lesions using additional bone