Fibrin Sealant in Maxillofacial Surgery (Literature Review)

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Abstract

The use of fibrin in oral and maxillofacial surgery is becoming increasingly relevant. Fibrin glue, also known as Fibrin sealant, demonstrates adhesive and haemostatic opportunities that are vital in surgery. Fibrin sealant has numerous applications in the field of maxillofacial surgery. It is a safe, cost-effective, and clinically proven method of providing haemostasis, securing or gluing hard and soft tissue, as well as sealing of difficult-to-reach tissues. However, some scientists disagree on fibrin sealants clinical efficacy.

The aim of this study is to summarise and analyse the most recent literature about fibrin sealant clinical usage in oral and maxillofacial surgery, as well as to ascertain the efficacy of fibrin sealants by reviewing several clinical studies.

A literature search was conducted electronically in databases PubMed and EBSCO. The search was limited to articles published in the English language between 1990 and 2015.

In all, 75 articles were found, 37 of which met the aforementioned requirements and thus were included and analysed in the study. 38 scientific papers could not be included in the literature review due to having been written prior to 1990. This article comprises and analyses materials about fibrin sealant application in oral and maxillofacial surgery.

The fibrin sealant has many applications in oral and maxillofacial surgery: for maxillary sinus floor augmentation, in bone surgery when mixed with bioceramic granules, in treatment of peri-implant defects, in facelift surgery to avoid the formation of hematomas or seromas, as well as for inducing wound healing. Furthermore, fibrin sealant is used to control bleeding in complicated situations such as difficult tooth extractions and treating patients with haemophilia.

Keywords: fibrin sealant, fibrin glue, bone surgery, facelift surgery, bleeding disorders.

Introduction

Fibronectin Sealing System was first used in 1909 by Bergel in the medical field for haemostatic purposes (Arnaud, 2000). However, the Food and Drug Administration (FDA) banned fibrin glue in 1978 due to reported cases of transmission of hepatitis. It was approved by the FDA again in 1998 after implementation of rigorous virus elimination methods (Fattahi, 2004).

Fibrin sealants are non-cytotoxic, fully resorbable biological matrices that contain fibrinogen, factor XIII, thrombin, and aprotinin. The components are extracted from human plasma, except for antifibrinolytic agent and calcium chloride. Mixing fibrinogen and thrombin simulates the last stages

of the natural coagulation cascade to form a structured fibrin clot similar to a physiological clot. This clot is naturally degraded by proteolytic enzymes from the fibrinolytic system such as plasmin (Reiss, 1996).

Traditionally, fibrin sealant is used as tissue adhesive and as a haemostatic agent, as well as in new and creative ways, such as for cellular growth stimulation in tissue engineering (Yücel, 2003).

Surgeons have long sought a material that could act as both a tissue adhesive and a haemostatic agent. Presently, fibrin sealant demonstrates the best equilibrium between both properties (Choukroun, 2006).

Fibrin sealant has numerous applications in the field of maxillofacial surgery. It is a safe, cost-effective, and clinically proven method of providing haemostasis, securing or gluing hard and soft tissue, as well as sealing or difficult-to-reach tissues (Diaz, 1994).

Aim

The aim of this study is to summarise and analyse the most recent literature about fibrin sealant clinical usage in oral and maxillofacial surgery, as well as to ascertain the efficacy of fibrin sealants by reviewing several clinical studies.

Material and Methods

A literature search was conducted electronically in databases PubMed and EBSCO (http://www.ncbi.nlm.nih.gov/pubmed/) using keywords “fibrin glue”, “fibrin sealants” and “maxillofacial surgery”. The search was limited to articles published in the English language between 1990 and 2015. After selection of the literature 37 articles were used: 21 controlled studies and 16 literature reviews.

Results

In all, 75 articles were found, 37 of which met the aforementioned requirements and thus were included and analysed in the study. 38 scientific papers could not be included in the literature review due to having been written prior to 1990 and contained outdated information and descriptions of obsolete methods.

Analysis of the literature made it clear that the usage of fibrin sealants in maxillofacial surgery is very extensive. This article summarises the most popular and available application methods of fibrin sealant in modern maxillofacial clinical practice.

Bone surgery

Considering their adhesive and haemostatic properties, fibrin sealants have been widely used in bone surgery. However, the role of fibrin sealants in bone healing or bone tissue response is controversial. Le Guéhennec (2004) has reported that fibrin sealant has a negative effect on bone healing. In another study, however, the fibrin sealant has a positive effect on bone healing (Le Nihouannen, 2007).

Currently, bone surgeons have several different possibilities when it comes to replacing bone. There are bone substitutes available that can overcome limitations of autologous bone due to their osteoconductive properties and biocompatibility (Bauer, 2000). The most frequently used alloplastic materials are based on calcium phosphate bioceramics such as hydroxyapatite and/or β-tricalcium phosphate (Suzuki, 2006).

Micro-macroporous biphasic calcium phosphate (MBCP) is a bioactive bone substitute material approved for bone filling. The porosity of the scaffold plays an important role to permit adequate tissue ingrowth. Microporosity enlarges the scaffold surface and enables osteoblasts, as well as precursor cells to adherence (Habibovic, 2005).

The combination of MBCP and fibrin sealant has shown stimulating properties in bone formation in maxillofacial surgery. The osseointegration results of the substitute material was reported as successful, and the newly formed bone was characterised by a mature, solid structure (Bagot d’Arc, 2003).

Fibrin scaffold has a double function in tissue engineering. Firstly, it is used as scaffold for incorporation of cells, proteins and other biological and pharmaceutical agents; and secondly as immobilizer of different substances in other biomaterials to provide long-term retention in site of clinical necessity and controlled release.

The biological properties may be enhanced due to fibrin which plays a positive role in vascularisation and blood vessel growth in bone defects. Fibrin mediates platelet and endothelial cell spreading, fibroblast proliferation and capillary tube formation (Mosesson, 2005).

Maxillary sinus floor augmentation

Maxillary sinus floor augmentation is a standard surgical procedure to increase bone height in the atrophic posterior maxilla for dental implant placement (Kaufman, 2003).

Micro-macroporous biphasic calcium phosphate bioceramic, combined with fibrin sealant, has been investigated in maxillofacial bone filling, including sinus floor augmentation, and it has proven to be biocompatible and osteoconductive in animal models as well as in clinical studies (Le Nihouannen, 2007).

Treatment of peri-implant bone defects with Platelet-Rich Fibrin (PRF)

Considering the high survival rate and the predictability of the procedure/practice, replacing missing teeth with dental implants has become a popular procedure among patients and clinicians (Weber, 2009). Long-term follow-up studies confirm that peri-implant complications are common and that implant survival does not necessarily indicate a successful implantation (Misch Ce, 2001).

Peri-implant defect treatment with Platelet Rich Fibrin (PRF) is clinically more effective than access flap surgery alone. It has been clinically proven in a study that took place in Oral and Maxillofacial Surgery and Periodontology of the Baskent University School of Dentistry in Ankara (Hamzacebi, 2015).

Treatment protocol: access to the implant surface and the inflammatory tissue removing, decontamination (citric acid for three minutes or tetracycline hydrochloride solution), infrabony defect filling with the PRF membranes.

PRF promoted probing depth reduction and lower distance between the restoration margin and peri-implant mucosal margin (Esposito, 2012).

Facelift surgery

Fibrin sealant is probably the most popular autologous blood product in plastic surgery practice. Fibrin sealants based on clot table plasma proteins have several potential advantages in improving the outcome of facelift surgery (Hamilton, 2001). The use of fibrin sealants strongly hinders the formation of hematomas and seromas, providing a faster recovery and return to daily activities, thus ensuring higher satisfactory rates among postoperative patients (Matarasso, 2005). The fibrin network is proven to reduce the amount of postoperative bleeding by sealing capillary vessels and making raw surfaces adhere to one another, thus closing the dead space (Zoumalan, 2008).

A prospective study was conducted in 20 patients (14 women and 6 men) undergoing a facelift surgery from June to October, 2010. The mean age of the patients was 56 (range 43–72) years. Comparisons were made considering hematoma and seroma rates, degree of induration, oedema, and ecchymosis, pain levels, as well as patient satisfaction.

Twenty four hours after surgery, no hematomas had occurred in 19 patients. The only exception was a significant hematoma on the right side in one patient. The bleeding was most probably due to a sudden rise in blood pressure during the immediate postoperative period (Botti, 2007).

Aerosolised fibrin sealant offers several potential advantages in improving the outcome of facelift surgery (Fezza, 2002). A number of studies have investigated the effectiveness of fibrin sealants in reducing formation of hematoma, seroma and ecchymosis. In addition, fibrin sealants reduce postoperative wound drainage which is important as it greatly influences patient comfort and reduces recovery time (Marchac, 2005).

Preoperative administration of autologous fibrin can be useful for enhancing the viability of skin flaps. Facelift certainly is a procedure that requires a proper preoperative planning, appropriate knowledge of the anatomy and correct surgical execution. It is also clear that fibrin glue application may not prevent possible complications such as skin necrosis. This may be practical for patients who have major risks for flap survival and are not willing to have additional delay surgery (Eppley, 2006).

Bleeding control

Patients with bleeding disorders who undergo a dental extraction are at risk of prolonged or excessive bleeding. Fibrin sealant has been used as an effective operative sealant in surgery for more than 10 years. It has also been used to control bleeding in difficult situations, such as dental extraction or surgery in patients with haemophilia or other coagulopathies, without the use of blood replacement (Rakocz, 1993).

After a tooth extraction with minimal trauma to the surrounding bone and soft tissue, the socket should be curetted and covered with fibrin gel which is based on fibrin sealant (Suwannuraks, 1993). Local homeostasis at the extraction site was achieved with a fabricated fibrin sealant. After the fibrin gel had formed, the soft tissue at the margin of the socket was sutured with non-absorbable silk, and the fibrin sealant was reapplied on top of the socket (Martinowitz, 1995).

After application at the extraction site, thrombin converts fibrinogen into an unstable fibrin clot, factor XIII stabilises the fibrin clot and aprotinin prevents clot degradation. This combined method is a safe, cost-effective procedure for dental extraction without replacement therapy in patients with bleeding disorders (Sigaud-Eiks, 2002).

Wound healing

Normal wound healing involves activation of blood clotting, fibrinolysis, kinin and complement cascades, followed by inflammation, granulation tissue deposition and remodelling (Baum, 2005). Activation of biological cascades leads to an influx of inflammatory cells into the wound and fibrin deposition. Inflammatory cells release cytokines that are involved in removal of dead tissues and deposition of macromolecules associated with the repair response (Kamolz, 2014). The inflammatory phase is followed by proliferation of capillaries and fibroblasts that lay down granulation tissue (Hosgood, 2006). During remodelling the delicate collagen fibrils deposited during granulation are replaced by larger diameter fibres that form the basis of scar tissue. Fibrin is an essential component of the wound healing process. It is the product of blood coagulation cascade (Jabs, 1992).

Fibrin is reported to stimulate the formation of granulation tissue, including increased deposition of collagen. Fibrin has also been used in skin-grafting for patients with malignant melanoma and is useful in areas where skin is stretched, such as the deltoid region (Kamolz, 2014). The wounds treated with fibrin sealant demonstrated neither oedema nor bleeding, whereas wounds that were not treated with fibrin glue exhibited oedema and bleeding as well as perivascular cell infiltration under the graft (Lundquist, 2008).

Fibrin sealant has been used to eliminate “dead space” beneath skin-grafts and to promote healing as it increases the probability that the graft will be vascularised. It is also useful in decreasing the number of sutures required in cosmetic and reconstructive surgery, thereby limiting the possibility of scarring (Silver, 1995).

Conclusions

The fibrin sealant has many applications in oral and maxillofacial surgery – for maxillary sinus floor augmentation, in bone surgery mixing with bioceramic granules, in treatment of peri-implant defects, in facelift surgery to avoid the formation of hematomas and seromas, as well as for inducing wound healing. Furthermore, fibrin sealant is used to control bleeding in complicated situations such as difficult tooth extractions and treating patients with haemophilia. Origin of fibrin is an important issue – to use allogenic commercial materials as fibrin sealant or autologous fibrin derived from the patient blood.

It is proven that fibrin sealant has many positive features, and therefore it is increasingly used in oral and maxillofacial surgery and clinical practices. However, not all results can be trusted. Fibrin sealant usage in treatment of peri-implantitis is questionable considering the lack of clinical studies dedicated to this subject and the insufficient number of proving results. A number of clinical studies are yet to be conducted in order to verify the efficacy of this method.

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