

POLYAMIDE VS SILK SUTURES IN THE HEALING OF POSTEXTRACTION SOCKETS: A SPLIT MOUTH STUDY

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SUMMARY

Objective. The aim of the present work is to compare polyamide sutures with traditional silk sutures after tooth extraction.

Methods. The investigators implemented a split-mouth study, in 50 healthy patients undergoing dental extractions. Follow-up included one post-extraction checkup at 7 days for the suture removal. The outcome variables were the Healing Index, the socket area, postsurgical complications and outcome of a patient questionnaire. Pairs of correlated continuous variables were analyzed with the Wilcoxon test, independent continuous variables with the Mann-Whitney test, and categorical variables with the χ^2 test or Fisher test.

Results. From September 2015 to September 2016, 50 patients underwent contemporary bilateral extractions of homologous teeth. The treatment-*versus*-control postoperative comparison showed that polyamide sutures resulted in significantly smaller residual socket areas and better Healing Indices at day 7. The patients' questionnaire outcomes were unanimously in favor of polyamide sutures.

Conclusions. The primary goals of this study were to measure socket reduction and the Healing Index (HI) at a 7 day post-extraction checkup and to assess patients' satisfaction based on answers to a questionnaire. Based on the results here reported, the polyamide sutures performed better than the silk sutures.

Key words: silk sutures, polyamide sutures, sutures, postextraction sockets.

Introduction

Depending on the structure, sutures are classified as monofil or polyfil, while they are absorbable or nonabsorbable owing to their chemical composition. Among the absorbable materials polydioxanone, polyglycolic acid and poly-L-lactide, poly- ϵ -caprolactone and polyglactin are used. Natural products as silk (polyfil) belong to the group of non-absorbable materials. Synthetic non-absorbable suture products consist, for instance, of polyamides, polypropylene and poly-

ester. Polyamides are available as monofil, polyfil and pseudopolyfil (polyamide fibers endowed with a polyamidic coat) threads.

Suture materials are prone to the adhesion of bacteria, which represent potential risk factors for wound healing. Indeed, the adhered bacteria, especially the anaerobic ones, can act as a focus of odontogenic infections. Fusobacteria, peptostreptococci, prevotella, porphyromonas, *Streptococcus intermedius*, *S. anginosus*, and bacteroides species are usually identified in odontogenic infections (1). Recent studies have shown that bacteremia can result from the re-

removal of sutures (2, 3). Among the others, Otten et al. (4) investigated the bacterial colonization of a resorbable copolymer of glycolide and epsilon-caprolactone and non-resorbable polyamide monofilament sutures used in intraoral dentoalveolar surgery. The *in vivo* findings suggested that, in comparison with the resorbable sutures, more pathogens were present on non-resorbable sutures. Based on the *in vitro* study the colonization rate of *Streptococcus intermedius* on both sutures was similar, whilst *Prevotella intermedia* grew much better on polyamid than on monocryl.

Mechanical properties of these materials vary by the composition. The tensile and knot security properties of several resorbable and non-resorbable sutures was studied by Kim et al. (5) leading to the knowledge that no single suture material possesses all of the requirements depending on the type and caliber.

Sutures are applied in many medical areas, but, in dentistry, a few papers deal with these materials. For instance, polyamide suture was compared with polyglactin suture (6) in oral implant surgery. No difference could be found between the two suture groups, although a higher incidence of complications was found in the absorbable suture group. Polyamide sutures have been successfully used for periodontal surgery (7, 8).

To the Authors' knowledge, this study is the first comparing silk and polyamide sutures and focusing on the quality of the wound healing in a large number of patients who received dental extractions.

Materials and methods

Research design and management

To address the research purpose, a split-mouth study was designed and implemented. Post-extractive sockets were sutured either with polyamide sutures (Polimid, Swden & Martina Due Carrare (PD), Italy; investigation site), or

with silk suture (Silkam, Silkam Non Absorbable Aesculap Aesculap, Inc. Center Valley, PA; control site). The choice of the socket was randomized recurring to a software.

The study population consisted entirely of patients referred to the Department of Surgery at the Dental School of the University of Turin from September 2012 to September 2013. The inclusion criteria were: good general health conditions, attendance of the preoperative professional hygiene program; need for bilateral extractions of homologous teeth; compliance to the study protocol. The exclusion criteria were platelet dysfunction, thrombocytopenia or treatment with corticosteroids.

Fifty patients satisfying all the inclusion and exclusion criteria were enrolled in the study. The study was planned and performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Dental School (Ref. Numb. CIR141113).

Surgical protocol

At enrolment, the patients were registered in a computerized clinical file and attended a program of professional dental hygiene. After a thorough clinical and radiologic evaluation, a digital case history for each patient was filed containing information on age, gender, smoking habits, alcohol consumption, systemic pathologies, the use of any drugs, oral and dental parameters such as periodontal screening and recording code. The possible presence of infections, carious processes, or periodontal affection were also noted as the difficulty of extraction (based on crown integrity, root morphology, space, and patient compliance).

Depending on the dental arch, alveolar nerve block infiltration was administered with either local or regional anesthesia, using 2% mepivacaine, which does not cause restriction of the blood supply, owing to the absence of epinephrine. To prevent interference with the healing process, no intraligamentous or intrapapillary infiltrations were performed. Non-traumatic bilateral extractions were accomplished without ele-

vation of full-thickness flaps to preserve the bone ridges and soft tissue at the 2 sites. Surgery was performed on the treatment and control sides at the same time.

After removed granulation tissue, a millimeter probe was used to measure the socket diameters (maximum mesiodistal [MD] and buccolingual extensions [BL]). Accurate postoperative recommendations were provided to the patients. No pharmacologic therapy was prescribed, and recourse to antibiotics was deemed a negative outcome as a sign of postoperative complications from infection.

After the extractions, each patient was recalled at day 7. Measurements of the 2 variables – MD, BL – was conducted to determine the socket area (SA). The residual socket area (RSA) i.e., the fraction of the postextraction original cavity still open at the follow-up session ($t = 7$), was computed as the ratio of $(MD \times BL)_t$ to the value $(MD \times BL)_{t=0}$, measured after extraction (perfect closure corresponds to $RSV = 0.00$).

The maturation and quality of regenerating tissues were evaluated using a modified version of the HI of Masse et al. (9-11), originally developed to evaluate healing with primary closure after periodontal surgery as previously reported by Mozzati et al. in 2013 (12). The modified HI, adapted to estimate socket healing without primary closure, involved 3 scoring levels for each of the 4 parameters considered: tissue color (1 = 100% of gingiva pink; 2 = <50% of gingiva red, hyperemic, movable; 3 = >50% of gingiva red, hyperemic, movable), color and consistency of the healing tissue (1 = close grained, pink; 2 = soft, red; 3 = fragile, greenish or grayish), supuration (1 = absent; 2 = absent but pronounced amount of plaque around socket walls; 3 = pronounced), and bleeding (1 = absent; 2 = induced by palpation; 3 = spontaneous). Thus, the scoring scale ranged from 4, corresponding to excellent healing, to 12, indicating severely impaired healing.

Pain was evaluated by the patients using a VAS, which distinguished the study and control sockets, for 7 consecutive days, with day 0 considered the day of extraction, after resolution of the effects of the anesthesia.

The patients' general satisfaction was evaluated with a questionnaire administered after extraction. Patients were asked to state any differences noticed in bleeding or pain between the 2 sites and to state which technique they would choose for a future extraction.

Study variables

The primary predictor variable in the trial was treatment group status (study or control socket). The primary outcome variables were socket area, HI, and postsurgical complications (mainly the need for late follow-up and reoperations). The secondary outcome variable was the patient satisfaction. A third category of variables described the anamnesis of the sample (age, gender, smoking habits) and the dental characteristics (tooth vitality, caries, periodontal diseases, granuloma, and pain).

Statistical methods

The results included continuous and categorical variables. The former are reported as mean and standard deviation. Non parametric tests were used: the Wilcoxon signed-rank test for comparisons of 2 correlated samples involving matched pairs and the Mann-Whitney test for comparisons of 2 independent distributions.

Categorical variables, reported as count and percentage, were arranged in cross-correlation tables and compared using the χ^2 test with the Yates correction when all expected values were higher than 5 or the Fisher test. Statistical significance corresponded to a probability less than .05 that differences could be ascribed to chance.

Results

The patients enrolled in the study were 50 (36% female) with a mean age of 52 years ($SD = 14$). The complete absence of any complications

Table 1 - Socket Areas and Residual Socket Area (RSA).

	Days from extraction			
	Socket Areas		RSA	
	Day 0	Day 7	Day 7	Day 7
Polyamide suture	32.5±27.8	5.2±12.3		0.09±0.1
Silk suture	28.9±20.6	10.1±15.1		0.29±0.3
t-test value	0.234	0.041		328* 10 ⁻⁶

from surgery, such as infection, excessive bleeding, or alveolar osteitis, was a noteworthy result, which held true for both the study and control sides. Data concerning the healing of the sockets as for their progressive decreases in areas are presented in Table 1, while the values of HI are showed in Figure 1. Comparisons between values relative to the study and control sides showed better healing and faster socket closure for the wounds sutured with polyamide at day 7. Figure 2 shows the HI distribution. The patients' questionnaire outcomes were unanimously in favor of polyamide sutures.

Discussion

In the mouth more than in other districts, sutures should avoid or limit bacterial adhesion and proliferation. The present study was designed to clinically test the validity of polyamide sutures against silk ones: a split-mouth design was chosen to monitor outcomes and possible discriminant factors. Here the synthetic material resulted more suited than silk as a suture as for the healing index and the patients' satisfaction. This may not seem completely in accordance with Banche et al. who compared silk to polyamide, polyester and monocryl sutures finding silk as the least affine material to bacteria (13-33). It is to be underscored that nonresorbable sutures tend to accumulate more micro-organisms than the resorbable ones. On the other hand, a consistent outcome was described by Balamurugan et al. (34). These Authors tested silk suture and ab-

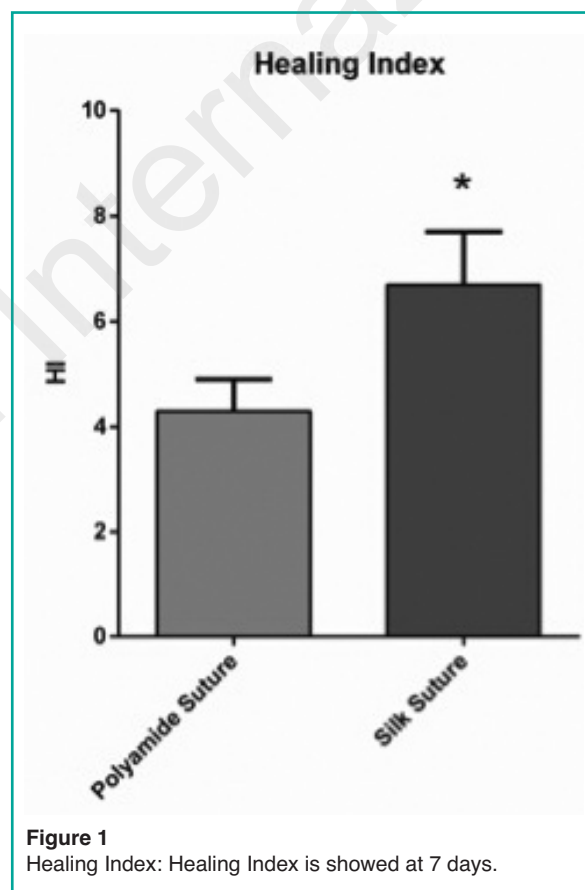


Figure 1
Healing Index: Healing Index is showed at 7 days.

sorbable polyglycolic acid suture clinically and histologically in 50 patients, after 7 days. They concluded that polyglycolic acid suture was superior, as “it had less tissue reaction, better handling characteristics and knotting capacity”. When polyamide suture was compared with polyglactin suture (6) in oral implant surgery, no difference could be found between the two suture materials.

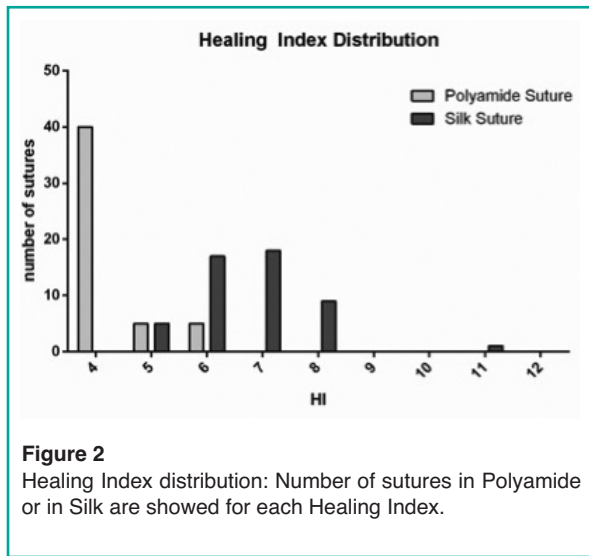


Figure 2
Healing Index distribution: Number of sutures in Polyamide or in Silk are showed for each Healing Index.

The present paper adds a clinical point of view to a previous *in vitro* report (35). Although there may not be only one ideal suture material the main factors to be taken into consideration are the surgery type and the tissue quality.

References

- Otten JE, Pelz K, Christmann G. Anaerobic bacteremia following tooth extraction and removal of osteosynthesis plates. *J Oral Maxillofac Surg.* 1987;45:477-80.
- King RC, Crawford JJ, Small EW. Bacteremia following intraoral suture removal. *Oral Surgery, Oral Med Oral Pathol.* 1988;65:23-8.
- Brown AR, Papiasian CJ, Shultz P, Theisen FC, Shultz RE. Bacteremia and intraoral suture removal: can an antimicrobial rinse help? *J Am Dent Assoc.* 1998;129:1455-61.
- Otten JE, Wiedmann-Al-Ahmad M, Jahnke H, Pelz K. Bacterial colonization on different suture materials - A potential risk for intraoral dentoalveolar surgery. *J Biomed Mater Res - Part B Appl Biomater.* 2005;74:627-35.
- Kim JC, Lee YK, Lim BS, Rhee SH, Yang HC. Comparison of tensile and knot security properties of surgical sutures. *J Mater Sci Mater Med.* 2007;18:2363-9.
- Ivanoff CJ, Widmark G. Nonresorbable versus resorbable sutures in oral implant surgery: a prospective clinical study. *Clin Implant Dent Relat Res.* 2001;3:57-60.
- Velvart P, Ebner-Zimmermann U, Ebner JP. Comparison of long-term papilla healing following sulcular full thickness flap and papilla base flap in endodontic surgery. *Int Endod J.* 2004;37:687-93.
- Di Comite M, Crincoli V, Fatone L, Ballini A, Mori G, Rapone B, Boccaccio A, Pappalettere C, Grassi FR, Favia A. Quantitative analysis of defects at the dentin-post space in endodontically treated teeth. *Materials.* 2015;8:3268-3283. Published online 2015 Jun 4. doi: 10.3390/ma8063268.
- Masse JF, Landry RG, Rochette C, Dufour L, Morency R, D'Aoust P. Effectiveness of soft laser treatment in periodontal surgery. *Int Dent J.* 1993;43:121-7.
- Kalemaj Z, Scarano A, Valbonetti L, Rapone B, Grassi FR. Bone response to four dental implants with different surface topography: a histologic and histometric study in minipigs. *Int J Periodontics Restorative Dent.* 2016 Sep-Oct; 36(5):745-54. doi: 10.11607/prd.2719.
- Grassi FR, Rapone B, Scarano Catanzaro F, Corsalini M, Kalemaj Z. Effectiveness of computer-assisted anesthetic delivery system (STA™) in dental implant surgery: a prospective study. *Oral Implantology.* 2017;10(4):381-389. ISSN: 1974-5648. doi: 10.11138/orl/2017.10.4.381.
- Mozzati M, Gallesio G, Di Romana S, Bergamasco L, Pol R. Efficacy of plasma-rich growth factor in the healing of postextraction sockets in patients affected by insulin-dependent diabetes mellitus. *J Oral Maxillofac Surg.* 2014;72:456-62.
- Banche G, Roana J, Mandras N, Amasio M, Gallesio C, Allizond V, et al. Microbial Adherence on Various Intraoral Suture Materials in Patients Undergoing Dental Surgery. *J Oral Maxillofac Surg.* 2007;65:1503-7.
- Rapone B, Nardi GM, Di Venere D, Pettini F, Grassi FR, Corsalini M. Oral hygiene in patients with oral cancer undergoing chemotherapy and/or radiotherapy after prosthesis rehabilitation: protocol proposal. *Oral Implantol (Rome).* 2016 Dic;9(01 suppl):90-97. doi : 10.11138/orl/2016.9.1S.090.
- Corsalini M, Rapone B, Grassi FR, Di Venere D. A study on oral rehabilitation in stroke patients: analysis of a group of 33 patients. *Gerodontology.* 2010 Sep;27(3):178-82. doi: 10.1111/j.1741-2358.2009.00322.x.
- Corsalini M, Carella M, Boccaccio A, Lamberti L, Pappalettere C, Catapano S, Carossa S. An alternative approach to the polishing technique for acrylic resin surfaces. *Int J Prosthodont.* 2008 Sep-Oct;21(5):409-12.
- Corsalini M, Genovese K, Lamberti L, Pappalettere C, Carella M, Carossa S. A laboratory comparison of individual Targis/Vectris posts with standard fiberglass posts. *Int J Prosthodont.* 2007 Mar-Apr;20(2):190-2.
- De Tommaso M, Lavolpe V, Di Venere D, Corsalini M, Vecchio E, Favia G, Sardaro M, Livrea P, Nolano M. A case of unilateral burning mouth syndrome of neuropathic origin. *Headache.* 2011 Mar;51(3):441-443. doi: 10.1111/j.1526-4610.2010.01754.x. Epub 2010 Aug 27.

19. Vallée A, Faga MG, Mussano F, Catalano F, Tolosano E, Carossa S, Altruda F, Martra G. Alumina-zirconia composites functionalized with laminin-1 and laminin-5 for dentistry: effect of protein adsorption on cellular response. *Colloids Surf B Biointerfaces*. 2014 Feb 1;114:284-93. doi: 10.1016/j.colsurfb.2013.09.053. Epub 2013 Oct 17.
20. Mussano F, Rovasio S, Schierano G, Baldi I, Carossa S. The effect of glycine-powder airflow and hand instrumentation on peri-implant soft tissues: a split-mouth pilot study. *Int J Prosthodont*. 2013 Jan-Feb;26(1):42-4.
21. Mori G, Ballini A, Carbone C, Oranger A, Brunetti G, Di Benedetto A, Rapone B, Cantore S, Di Comite M, Colucci S, Grano M, Grassi FR. Osteogenic differentiation of dental follicle stem cells. *International Journal of Medical Sciences*. 2012;9(6):480-7. Published online 2012 Aug 13. doi: 10.7150/ijms.4583.
22. Ballini A, Cantore S, Fatone L, Montenegro V, De Vito D, Pettini F, Crincoli V, Antelmi A, Romita P, Rapone B, Miniello G, Perillo L, Grassi FR, Foti C. Transmission of non-viral sexually transmitted infections and oral sex. *Journal of Sexual Medicine*. 2012 Feb;9(2):372-84. doi: 10.1111/j.1743-6109.2011.02515.x. Epub 2011 Oct 24.
23. Di Venere D, Nardi GM, Lacarbonara V, Laforgia A, Stefanachi G, Corsalini M, Grassi FR, Rapone B, Pettini F. Early mandibular canine-lateral incisor transposition: Case Report. *Oral Implantology*. 2017 April;10(2):181-189. doi: 10.11138/orl/2017.10.2.181.
24. Di Venere D, Corsalini M, Nardi GM, Laforgia A, Grassi FR, Rapone B, Pettini F. Obstructive site localization in patients with Obstructive Sleep Apnea Syndrome: a comparison between otolaryngologic data and cephalometric values. *Oral Implantology*. 2017 Jul-Sep;10(3):295-310. Published online 2017 Nov 30. doi: 10.11138/orl/2017.10.3.295.
25. Notaro V, Rapone B, Cagnetta G, Sportelli P, Nardi GM, Corsalini M. Resonance frequency evaluation on immediate loading implants with angled abutments: case series. *Annali di Stomatologia*. 2018 May-August;9(2):91-96. doi: 10.11138/ads/2018.9.2.091.
26. Di Venere D, Pettini F, Nardi GM, Laforgia A, Stefanachi G, Notaro V, Rapone B, Grassi FR, Corsalini M. Correlation between parodontal indexes and orthodontic retainers: prospective study in a group of 16 patients. *Oral Implantology*. 2017 Apr 10;10(1):78-86. doi: 10.11138/orl/2017.10.1.078. eCollection 2017 Jan-Mar.
27. Corsalini M, Di Venere D, Rapone B, Stefanachi G, Laforgia A, Pettini F. Evidence of signs and symptoms of Craniomandibular Disorders in Fibromyalgia patients. *The Open Dent Journal*. 2017;11:91-98. Published online 2017 Feb 14. doi: 10.2174/1874210601711010091.
28. Grassi FR, Pappalettere C, Di Comite M, Corsalini M, Mori G, Ballini A, Crincoli V, Pettini F, Rapone B, Boccaccio A. Effect of different irrigating solutions and endodontic sealers on bond strength of the dentin-post interface with and without defects. *Int J Med Sci*. 2012;9(8):642-54. Published online 2012 Sep 24. doi: 10.7150/ijms.4998.
29. Autieri G, Mussano F, Petrucci M, Carossa M, Genova T, Corsalini M, Carossa S. Proanthocyanidin may improve the shear bond strength at the composites/dentine interface. *J Biol Regul Homeost Agents*. 2018 Jul-Aug;32(4):1021-1025.
30. Pettini F, Savino M, Corsalini M, Cantore S, Ballini A. Cytogenetic genotoxic investigation in peripheral blood lymphocytes of subjects with dental composite restorative filling materials. *J Biol Regul Homeost Agents*. 2015 Jan-Mar;29(1):229-33.
31. Di Venere D, Corsalini M, Stefanachi G, Tafuri S, De Tommaso M, Cervinara F, Re A, Pettini F. Quality of life in fibromyalgia patients with craniomandibular disorders. *Open Dent J*. 2015 Jan 30;9:9-14. doi: 10.2174/1874210601509010009.
32. Solarino B, Coppola F, Di Vella G, Corsalini M, Quaranta N. Vestibular evoked myogenic potentials (VEMPs) in whiplash injury: a prospective study. *Acta Otolaryngol*. 2009 Sep;129(9):976-81. doi: 10.1080/00016480802527552.
33. Laforgia A, Corsalini M, Stefanachi G, Pettini F, Di Venere D. Assessment of Psychopathologic Traits in a Group of Patients with Adult Chronic Periodontitis: Study on 108 Cases and Analysis of Compliance during and after Periodontal Treatment. *Int J Med Sci*. 2015 Oct 4;12(10):832-9. doi: 10.7150/ijms.12317.
34. Balamurugan R, Mohamed Prof. M, Pandey V, Katikani HKR, Kumar Prof. KA. Clinical and histological comparison of polyglycolic acid suture with black silk suture after minor oral surgical procedure. *J Contemp Dent Pract*. 2012 Jul;13:521-7.
35. Selvi F, Cakarar S, Can T, Kirli Topcu Sİ, Palancioglu A, Keskin B, et al. Effects of different suture materials on tissue healing. *J Istanbul Univ Fac Dent. Istanbul University Faculty of Dentistry*; 2016;50:35-42.

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