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COMPARATIVE ANALYSIS OF MICROBIAL ACCUMULATION ON DIFFERENT TYPES OF SUTURE MATERIALS IN PERIODONTAL SURGERY AND IMPLANTOLOGY

КОМПАРАТИВНА АНАЛИЗА НА МИКРОБИОЛОШКА АКУМУЛАЦИЈА НА РАЗЛИЧНИ ТИПОВИ МАТЕРИЈАЛИ ЗА СУТУРИРАЊЕ ВО ПАРОДОНТАЛНА ХИРУРГИЈА И ИМПЛАНТОЛОГИЈА

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Abstract

Introduction: The suture material is an artificial material used for intimate approximation of the wound edges until they can naturally adhere through collagen fibers. The accumulation of microbes varies depending on the quality and macrostructure of different suture materials. The ideal suture material should induce minimal tissue injury, resist bacterial contamination, and provide adequate tissue support. **Aim of the study:** The goal of this study is the evaluation of microbiological findings and the healing of the tissue by using 4 types of suture materials in various periodontal and implant surgical interventions. To achieve this objective, a comparative analysis of clinical and microbiological findings was conducted. **Material and methods:** The examination involved 20 participants divided into four groups. Each group received a different type of suture material: silk, polyamide, polyglycolic acid and poliglecaprone 25. The examinations were conducted 10 days after the surgery and comprised two parts: clinical and microbiological evaluations. **Results:** The highest number of colony-forming units (CFUs/ml) was observed with silk suture materials, followed by a decline in the subsequent groups: polyglycolic acid, poliglecaprone 25 and polyamide. The soft tissue healing index showed the best results with polyamide and poliglecaprone 25, while the worst results were associated with polyglycolic acid and silk. **Conclusions:** Monofilament suturing materials demonstrated lower bacterial accumulation and superior clinical characteristics compared to multifilament materials. **Key words:** Suturing materials, inflammation, bacterial accumulation, periodontal surgery, implantology.

Апстракт

Вовед: Материјалот за сутура претставува синтетички материјал кој се користи со цел интимно прилепување на рабовите на раната се додека истите не бидат оспособени за самостојно прилепување со природни колагени влакна. Микробиолошката акумулација се разликува кај различни видови материјали за сутура во зависност од квалитетот и макроструктурата на материјалот. Идеалниот материјал за сутура треба да врши минимална тквивна повреда, да има резистенција кон бактериска контаминација и да подржува соодветна тквивнапотпора. **Цел:** Цел на оваа студија е евалуација на микробиолошкиот наод и мекотквивното заздравување при користење на 4 типови на материјали за сутура кај различни пародонтално хирушки и имплантолошки интервенции.За реализација на целта е спроведена компаративна анализа на клиничкиот и микробилошкиот наод. **Материјал и метод:** Испитувањето беше изведено на 20 испитаници поделени во 4 групи. Во секоја група беше користен различен тип материјал за сутура: свила, полиамид, полигликолна киселина и полиглекапрон 25. Испитувањата се изведуваа 10 дена постоперативно, а истите беа реализирани во 2 дела: клинички и микробиолошки. **Резултати:** Бројот на колонии(CFUs/ml) беше најголем кај свилените сутурни материјали, последователно опаѓајќи кај следните групи: полигликолна киселина, полиглекапрон 25 и полиамид. Индексот на мекотквивно заздравување покажа најдобри резултати кај материјалите од полиамид и полиглекапрон 25, додека најлоши разултати беа добиени при употреба на материјалите од полигликолна киселина и свила. **Заклучоци:** Монофиламентните материјали за сутурирање покажаа помала бактериска акумулација и супериорни клинички карактеристики во споредба со мултифиламентнитематеријали. **Клучни зборови:** материјали за сутурирање, инфламација, бактерискаакумулација, пародонталнахирургија, имплантологија.

Introduction

Suturing represents the final stage of a surgical intervention, serving a purpose of closely approximating wound edges, controlling bleeding and facilitating primary wound healing[1]. The delayed healing of surgical wounds is a significant concern for both patients and healthcare professionals, often leading to complications such as wound infections and dehiscence, there by prolonging the wound healing period and increasing treatment costs[2].

The ideal suture material should possess qualities such as high strength, knot stability, flexibility, ease of manipulation, minimal tissue reactivity and resistance to infections[3]. Commercially available suture materials are classified according to different criteria, including three-dimensional structure (monofilament, multifilament), tissue stability (resorbable, non-resorbable) and origin of the material (natural, synthetic)[4]. The selection of suture material for a surgical intervention depends on several factors, including the duration of wound healing tension during the healing process, and the temporary or the permanent need for suture in order to provide mechanical support[5].

Suturing materials pose a potential risk factor for occurrence of wound infections in periodontal surgery, and their success depends on the achievement of primary wound healing and the absence of bacteria at the healing site[6,7]. Generally, monofilament materials are more acceptable due to the latter's propensity to facilitate bacterial colonization in the spaces between the filaments. Natural suture materials differ from the synthetic ones in that they degrade (if resorbable, as catgut) through proteolysis, whereas synthetic materials degrade through hydrolysis. Proteolysis triggers a more pronounced inflammatory response than hydrolysis, leading to greater inflammation when natural sutures are used[8].

Varma et al.[9] demonstrated that a certain quantity of microorganisms is necessary to initiate an infection in a surgical wound. The bacterial accumulation alters and creates a hypoxic environment within and around the wound, there by inhibiting the activity of fibroblasts and causing delayed healing[10]. Experimental and clinical data indicate that tissue reactions primarily occur around the suture material within the wound. Furthermore, the rate of infection in contaminated tissue containing sutures is significantly higher then in contaminated tissue from needle puncture alone, without the presence of suture material[11]. Although suture materials provide strength during wound healing, they also serve as a gateway for bacteria, and increasing the host's susceptibility to infection by up to 10,000 times[12]. Allergic reactions and reactions to the chemical structure of suture materials that can hinder proper healing, have been reported[11]. Singh[13], emphasizes the importance of minimizing bacterial accumulation around the suture materials in order to prevent soft tissue dehiscence and exfoliation of the membrane in periodontal surgery. This reduction of postoperative bacterial accumulation is especially important when performing mucogingival surgery, because the greater the bacterial accumulation, the greater the postoperative gingival recession is, which leads to aesthetically unacceptable results.

Aim of the study

The aim of this study is to evaluate the microbiological finding and soft tissue healing using 4 different types of suture materials in different periodontal and implant surgical interventions. For the realization of this aim, a comparative analysis of the clinical and the microbiological findings was conducted.

Material and method

Our study involved 20 participants who were divided into four groups as follows:

1 group - sutures with non-absorbable SILK - silk suture materials (Medipac, Gr);

2 group - sutures with non-absorbable POLYAMID - nylon suture materials (Medipac, Gr);

3 group - sutures with absorbable P.G.A - polyglycolic acid suture materials (Medipac, Gr);

4 group - sutures with absorbable MONOFAST-poliglecaprone 25, polyglycolic acid copolymer with polycaprolactone suture materials (Medipac, Gr).

Each group consisted of five participants.

Inclusion criteria:

The study included patients who underwent periodontal surgery and implant interventions.

Patients aged 18 and above who provided consent to participate in the study by signing a consent form.

Exclusion criteria

Patients with systemic diseases (diabetes, immune compromise and cardiovascular disease),

Pregnant women and nursing mothers.

Standard surgical protocols, evaluated within the periodontal surgery and implantology were used. All suture materials had an equal thickness of 4.0. The sutures were removed 10 days postoperatively. The results were segmented into two aspects: clinical and microbiological.

Clinical evaluation:

For clinical evaluation, the soft tissue healing index was used, according to Landry et al.[14] For evaluation of the healing the following parameters were used: the color of the tissue, the bleeding upon palpation, the presence of granulation tissue, the features of incision margin, and the presence of suppuration. According to this index, the healing was graded on a scale from 1 (very poor healing) to 5 (excellent healing).

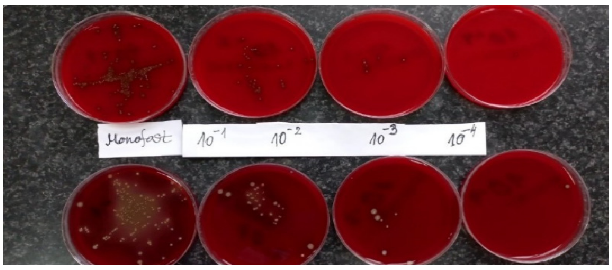
Microbiological evaluation:

During the process of suture removal, 1 mm suture segments of the suture were transferred into sterile containers (Ependorf tubes) containing 1 ml of sterile glucose bouillon. The test tubes were then transported to the Institute of Microbiology and Parasitology at the Medical Faculty in Skopje.

Prior to planting, the specimens were vortexed for 10 seconds to ensure proper mixing. In the meantime, four test tubes containing 90 µl of sterile saline solution were prepared for serial dilution,in which the bouillon with the sample was serially diluted. In the first test tube, 10 µl of the sample were diluted, resulting in a 10 dilution.10^{-1}. From the obtained dilution, another 10µl were transferred into the second test tube, and this process was repeated until a dilution of 10^{-4}µl was obtained. 10µl of each tube were planted onto aerobic plates (Columbia agar) for the cultivation of Gram-positive and Gram-negative aerobic bacteria) and anaerobic plates (Schaedler agar) for cultivation of Gram-positive and Gram-negative anaerobic and facultative anaerobic bacteria. These plates were obtained from the company Oxoid, a manufacturer based in Great Britain.

Columbia agar plates were then incubated in a thermostat at 37° C for a duration of 24 hours. Schaedler agar plates were placed in a separate pot containing AnaeroGen A (Oxoid UK) in order to create anaerobic conditions and were incubated for 48 hours.

At the completion of the incubation period, the number of colonies (CFU - colony forming units) was calculated from the bacteria that was diffused into the boullon by vortexing of the suture materials.



Picture 1. *Overview of the plates displaying the bacterial colonies formed on aerobic plates (top) and anaerobic plates (bottom), after the completion of the incubation period.*

The number of colonies in the sample (CFU/ml) was calculated according to the following formula:

$$\text{CFU/ml}= \frac{\text{No. of colonies x total dilution factor}}{\textit{volume of culture plated in ml}}$$

Results and discussion

Tables 1 and 2 present the results obtained after the completion of the microbiological evaluation of the different types of suture materials. Table 1 displays the number of bacteria following the calculation of grown colonies (CFUs/ml) on Columbia agar plates. Table 2 shows the number of bacteria (CFUs/ml) on Schaedler agar plates.

Table 1. Number of colonies, grown on Columbia agar (CFUs/ml)

	Silk	Polyamide	Polyglycolic acid (P.G.A)	Poliglecaprone25 (Monofast)
1	$8x10^6$ CFU/ml	$5.5x10^5$ CFU/ml	$8.3x10^6$ CFU/ml	$3.9x10^6$ CFU/ml
2	$4.5x10^6$ CFU/ml	$9.7x10^5$ CFU/ml	$4.2x10^6$ CFU/ml	$4.5x10^5$ CFU/ml
3	$9x10^6$ CFU/ml	$4.3x10^5$ CFU/ml	$4x10^6$ CFU/ml	$7x10^5$ CFU/ml
4	$7.7x10^6$ CFU/ml	$4.8x10^5$ CFU/ml	$2.8x10^6$ CFU/ml	$4.8x10^5$ CFU/ml
5	$10.2x10^6$ CFU/ml	$6.8 x 10^5$ CFU/ml	$5.5x10^6$ CFU/ml	$4.3x10^6$ CFU/ml

Table 2. Number of colonies, grown on Schaedleragar (CFUs/ml)

	Silk	Polyamide	Polyglycolic acid (P.G.A)	Poliglecaprone 25 (Monofast)
1	$9x10^6$ CFU/ml	$3.2x10^5$ CFU/ml	$4x10^6$ CFU/ml	$3.8x10^6$ CFU/ml
2	$6x10^6$ CFU/ml	6 $x10^5$ CFU/ml	$6.5x10^6$ CFU/ml	$3.7x10^5$ CFU/ml
3	$8x10^6$ CFU/ml	Poor growth 10^{-1}	$5.5x10^6$ CFU/ml	$3x10^6$ CFU/ml
4	$11.5x10^6$ CFU/ml	$5x10^5$ CFU/ml	$3.3x10^6$ CFU/ml	$4.8x10^5$ CFU/ml
5	$9x10^6$ CFU/ml	$6.2x10^5$ CFU/ml	$3.5x10^6$ CFU/ml	$3.3x10^6$ CFU/ml

All suture materials used in this study exhibited accumulated bacteria in every patient. In general, silk materials showed a higher number of colonies (CFUs/ml) compared to other materials. We assume that the obtained results are likely attributed to the quality of the materials and macro structure of the materials The number of formed colonies (CFUs/ml) subsequently decreased in the following groups of materials: polyglycolic acid, poliglecaprone 25 and polyamide. Our in vivo results indicate that polyamide adheres the lowest number of bacteria and this is in correlation with previous studies on this matter.

Numerous authors have examined the bacterial accumulation around the suture materials in their studies. Asher et al.[15] found out that the microbiological accumulation varied among different types of suture materials, depending on their quality and macrostructure. Similar results to ours were obtained in the study conducted by Yaltirik et al.[16], which examined the colonization of various microorganisms on natural materials and noted that it was more significant in silk. Silk is a non-absorbable, multifilament and most commonly used natural suture material within the last 100 years[17]. Polyamide is the first synthetic suturing material and is characterized by minimal induction of cellular response and prolonged retention of suture hardness. Several studies have shown that polyamide suture gives the best biological results and the least inflammatory response[18,19]. In today's market, a large number of synthetic resorbable suture materials with different designs are available to meet the requirements of modern surgery. Polyglycolic acid is a synthetic, resorbable, multifilament material. Some studies suggest that they are characterized by greater wound inflammation than resorbable monofilament materials[20]. Poliglecaprone 25 is a monofilament suture and causes only a mild tissue reaction during absorption[21].

Table 3 presents the results of the clinical evaluation of the soft tissue healing, using the soft tissue healing index according to Landry et al.[14]

Table 3. Evaluation of soft tissue healing

	Silk	Polyamide	Polyglycolic acid (P.G.A)	Poliglecaprone 25 (Monofast)
1	2	5	3	4
2	2	3	2	4
3	1	5	3	3
4	1	4	3	4
5	2	5	2	5

From the table we can see that the weakest healing occurs when silk is utilized as a suture material. On the other hand, significantly better results are observed with the use of polyglycolic acid, while the best results are achieved when employing poliglecaprone 25 and polyamide. These findings support previous studies that have demonstrated that silk causes a more intense inflammatory response and delayed healing compared to other healing materials. In contrast, tissue reactions are minimal when using polyamide and poliglecaprone 25 suture materials[22,23].

Conclusion

In conclusion, the results indicate that monofilament suture materials exhibit lower bacterial accumulation and promote better healing of the soft tissue compared to multifilament materials. Among the examined materials, the most favorable results were obtained with polyamide, while the most unfavorable results were obtained with silk as a suturing material.

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