https://doi.org/10.36377/ET-0081

Evaluation of antibacterial properties of medical adhesives in soft tissue plastic surgery in the oral cavity

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Abstract

INTRODUCTION. Soft tissue plastic surgery is usually accompanied by the harvesting of a gingival graft from the hard palate. The exposed donor wound surface may cause pain and the possibility of wound infection cannot be ruled out. Medical adhesives have recently been increasingly used as wound coverings on the donor area.

AIM. Comparison of antibacterial activity of medical adhesives from different manufacturers.

MATERIALS AND METHODS. The tests used medical adhesives Sulfacrylate (NTO MedIn), Histoacryl (B. Braun), Hemocompact (MTPO Inter-Vita). Chlorhexidine (0.05% solution) was used as a control antiseptic. The antimicrobial activity of various adhesives was tested on Staphylococcus aureus and isolates of Streptococcus salivarius, Streptococcus sobrinus and Candida albicans.

RESULTS. All the presented preparations have antibacterial activity, but it is most pronounced in the domestic manufacturer's glue based on ethyl cyanoacrylic acid.

CONCLUSIONS. The antibacterial activity declared by the manufacturer of medical adhesives against opportunistic strains of microorganisms that are permanent inhabitants of the oral cavity was experimentally confirmed.

Keywords: medical glue, soft tissue plastic surgery, sulfacrylate, histoacryl, hemocompact

Article info: received – 27.01.2025; revised – 11.03.2025; accepted – 16.03.2025

Conflict of interest: The authors report no conflict of interest.

Acknowledgements: There are no funding and individual acknowledgments to declare.

For citation: Bakaev Yu.A., Khabadze Z.S., Magomedov O.I., Kudzheva A.T., Kakabadze E.M., Umarov A.Y., Wehbe A. Evaluation of antibacterial properties of medical adhesives in soft tissue plastic surgery in the oral cavity. *Endodontics Today.* 2025;23(2):318–325. https://doi.org/10.36377/ET-0081

Оценка антибактериальных свойств медицинских адгезивов в пластической хирургии мягких тканей полости рта

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Резюме

ВВЕДЕНИЕ. Пластическая хирургия мягких тканей, как правило, сопровождается забором десневого трансплантата с твердых тканей нёба. Открытая раневая поверхность в донорской зоне может вызывать болевые ощущения, а также сохраняется риск инфицирования раны. В последнее время для покрытия ран в донорской области все чаще применяются медицинские клеи.

ЦЕЛЬ ИССЛЕДОВАНИЯ. Сравнение антибактериальной активности медицинских клеев различных производителей.

МАТЕРИАЛЫ И МЕТОДЫ. В ходе исследования были использованы медицинские клеи: Сульфакрилат (НТО «МедИн»), Гистоакрил (B.Braun), Гемокомпакт (МТПО «Интер-Вита»). В качестве контрольного антисептика применялся раствор хлоргексидина (0,05%). Антимикробная активность различных клеевых составов была протестирована на Staphylococcus aureus и изолятах Streptococcus salivarius, Streptococcus sobrinus и Candida albicans.

РЕЗУЛЬТАТЫ. Все представленные препараты продемонстрировали антибактериальную активность, однако наиболее выраженный эффект наблюдался у клея отечественного производителя на основе этилцианоакриловой кислоты.

ВЫВОДЫ. Экспериментально подтверждена заявленная производителем антибактериальная активность медицинских клеев в отношении условно-патогенных штаммов микроорганизмов, являющихся постоянными обитателями полости рта.

Ключевые слова: медицинский клей, пластическая хирургия мягких тканей, сульфакрилат, гистоакрил, гемокомпакт

Информация о статье: поступила – 27.01.2025; исправлена – 11.03.2025; принята – 16.03.2025

Конфликт интересов: авторы сообщают об отсутствии конфликта интересов.

Благодарности: финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Бакаев Ю.А., Хабадзе З.С., Магомедов О.И., Куджева А.Т., Какабадзе Э.М., Умаров А.Ю., Вехби А. Оценка антибактериальных свойств медицинских адгезивов в пластической хирургии мягких тканей полости рта. *Эндодонтия Today.* 2025;23(2):318–325. https://doi.org/10.36377/ET-0081

INTRODUCTION

Soft tissue grafting is a popular procedure in surgical dentistry. Often, this type of surgery is accompanied by the harvesting of soft tissue autograft. The mucous membrane of the hard palate is the area from which the graft is most often harvested [1]. The wound surface after harvesting the graft from the palate should be closed to minimize postoperative pain. Medical glue is the material of choice for such purposes. Recently, medical tissue adhesives have been studied as a good alternative to conventional suture materials, although the following properties had to be taken into account, among others: good adhesive strength, reliable polymerization in a moist environment, biocompatibility, stability and good working time [2; 3]. Considering this, cyanoacrylate adhesives seem to be a good option for use in dentistry [4]. Cyanoacrylates come in several different forms depending on the length and complexity of their chains; These include methyl, ethyl, n-butyl, isoamyl, isohexyl and octyl cyanoacrylates [5; 6].

AIM

The aim of this study was to compare the manifestation of antibacterial properties of medical adhesives from different manufacturers and its duration in the donor area on the palate during plastic surgery of soft tissues in the oral cavity.

MATERIALS AND METHODS

Test compounds and sample preparation

The materials for the study were divided into 4 groups:

1. The first group included samples using domestically produced medical adhesive based on feracryl

2. The second group with samples of domestically produced adhesive based on ethyl cyanoacrylate

3. Samples of group 3 using imported adhesive based on n-butyl-2-cyanoacrylate

4. The control group included samples using an antiseptic based on Chlorhexidine 0.05%. 10 µl of the substances were applied to sterile Whatman ® 3MM discs (6 mm in diameter) and allowed to dry.

Sulfacrylate (LLC NTO MedIn), Histoacryl (B.Braun), and Hemocompact (LLC MTPO Inter-Vita) were used in the tests (Table 1).

Bacterial strains and growth conditions

The antimicrobial activity of various adhesives was tested on normal oral flora residents that may cause secondary infection: Staphylococcus aureus and previously obtained isolates of Streptococcus salivarius, Streptococcus sobrinus and Candida albicans. S. aureus was cultured in LB medium. LB medium supplemented with FBS (fetal bovine serum) (5%) and glucose (2%) was used to maintain and grow Streptococcus isolates. Sabouraud medium (dry enzymatic peptone; glucose; microbiological agar) was used to cultivate Candida albicans fungi.

Disc Diffusion Test

1 ml of bacterial (1-5 x 106 CFU/ml) or yeast cell suspension (1-5 x 104 CFU/ml) was spread on the surface of the corresponding solid medium in Petri dishes and dried for 15 min. Then the prepared discs with samples of all 4 groups were placed on the surface of agar plates and incubated for 24 h at 37°C. The zone of growth inhibition was then measured in four directions and averaged.

To assess how long the test compound retains antimicrobial activity, filter papers with samples of all 4 groups were incubated on clean LB plates for one, two and three days to allow the substance to diffuse from the disc, and then the residual activity was tested as described above.

Table 1. Characteristics of the medical adhesives studied

Таблица 1. Характеристика исследуемых медицинских адгезивов

Glue	Manufacturer	Compound	Group
Hemocompact	LLC MTPO Inter-Vita, Moscow	– aqueous solution of feracryl 1%; – sodium alginate; – acetic acid, chemically pure for pharmacology, content not less than 99.85%; – distilled water for pharmacology	Feracryl
Sulfacrylate	LLC NTO MedIn	– ethyl ester of α-cyanoacrylic acid; – butyl ester of acrylic acid; – methacrylate-3-oxysulfalanes	Cyanoacrylate
Histoacryl	B.Braun, Germany	n-butyl-2-cyanoacrylate monomer	Cyanoacrylate

RESULTS

The results of the study on the 1st day are presented in Tables 2–5.

Table 2. Diameter of growth inhibition zones of S. Aureus (1st day)

Таблица 2. Диаметр зон подавления роста S. Aureus (1-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	12	10	8	10	6	5	6	6	7.75
Group 2	20	22	16	18	20	18	14	16	18.00
Group 3	16	18	14	14	14	14	12	12	14.25
Group 4	12	16	12	12	10	10	10	10	11.50

Table 3. Diameter of growth inhibition zones of C. albicans (1st day)

Таблица 3. Диаметр зон подавления роста C. albicans (в первый день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	9	8	8	9	16	14	8	8	10.0
Group 2	24	28	30	22	22	22	18	26	24.0
Group 3	20	22	20	18	14	16	14	16	17.5
Group 4	10	8	6	6	12	12	16	10	10.0

Table 4. Diameter of growth inhibition zones of S. Sobrinus (1st day)

Таблица 4. Диаметр зон подавления роста S. Sobrinus (в первый день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	14	12	16	14	20	22	18	18	16.750
Group 2	40	36	37	46	30	34	30	34	35.875
Group 3	26	24	26	28	22	22	22	20	23.750
Group 4	14	14	14	16	14	14	12	12	14.000

Table 5. Diameter of growth inhibition zones of S. Salivarius (1st day)

Таблица 5. Диаметр зон подавления роста S. Salivarius (1-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	16	14	18	20	10	12	12	10	14.000
Group 2	45	50	46	46	30	30	28	30	38.125
Group 3	26	24	28	22	16	16	20	22	21.750
Group 4	12	12	12	12	12	14	22	14	13.750

The presented results of sample control on the first day allow us to verify that the medical glue based on ethyl cyanoacrylate showed the best result (**Fig. 1**).

Comparatively low antibacterial activity on the first day was shown by samples of group 1 using medical glue based on feracryl.

The results of the study on the 2nd day are presented in Tables 6–9.

Table 6. Diameter of growth inhibition zones of S. Aureus (2nd day)

Таблица 6. Диаметр зон ингибирования роста S. Aureus (2-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	8	8	6	6	8	10	10	8	8.000
Group 3	5	5	5	5	–	–	–	–	5.000
Group 4	8	6	6	8	5	5	6	5	6.125

Table 7. Diameter of growth inhibition zones of C. albicans (2nd day)

Таблица 7. Диаметр зон ингибирования роста C. albicans (2-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	10	10	6	6	6	8	5	6	7.125
Group 3	4	3	4	3	3	3	5	4	3.625
Group 4	6	6	6	6	–	–	–	–	6.000

Table 8. Diameter of growth inhibition zones of S. Sobrinus (2nd day)

Таблица 8. Диаметр зон подавления роста S. Sobrinus (на 2-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	12	14	12	10	10	8	10	10	10.75
Group 3	–	–	–	–	–	–	–	–	–
Group 4	6	6	6	6	8	8	6	6	6.50

Table 9. Diameter of growth inhibition zones of S. Salivarius (2nd day)

Таблица 9. Диаметр зон подавления роста S. Salivarius (на 2-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	12	10	10	10	8	10	10	8	9.75
Group 3	–	–	–	–	–	–	–	–	–
Group 4	6	6	6	6	8	8	8	6	6.75

When assessing the antibacterial activity of medical adhesives on the 2nd day, we obtain a sharp decrease in the antibacterial activity of all samples (**Fig. 2**). However, the sample of group 2, which showed the best results on the first day, still had the largest halo of antibacterial activity compared to other samples.

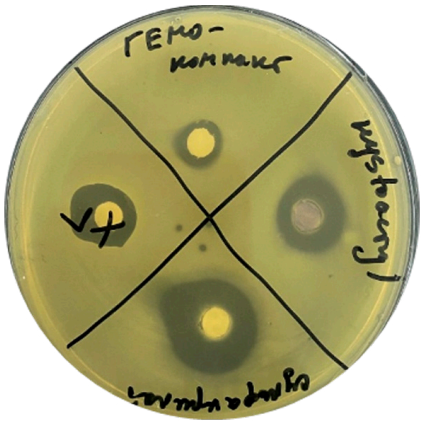
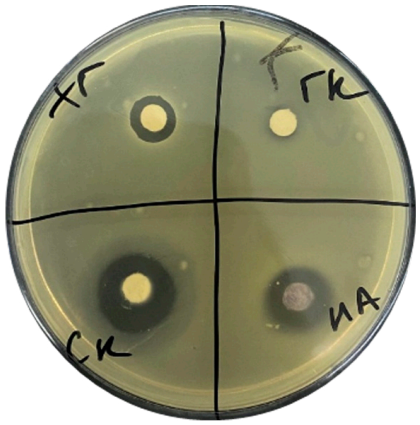
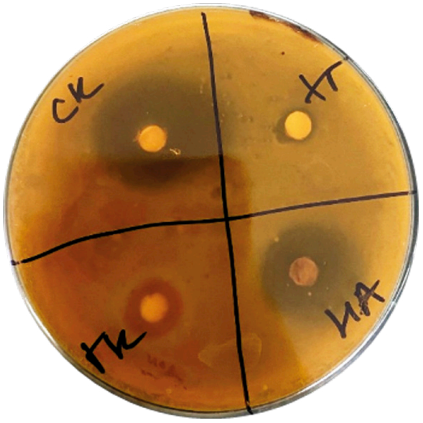
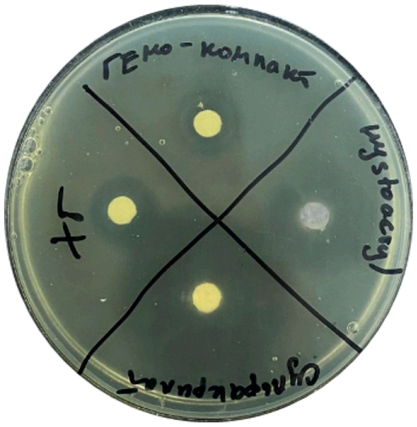
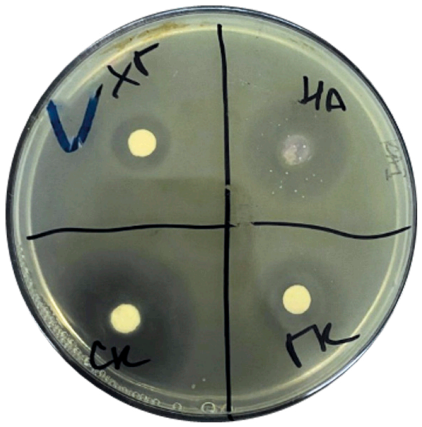
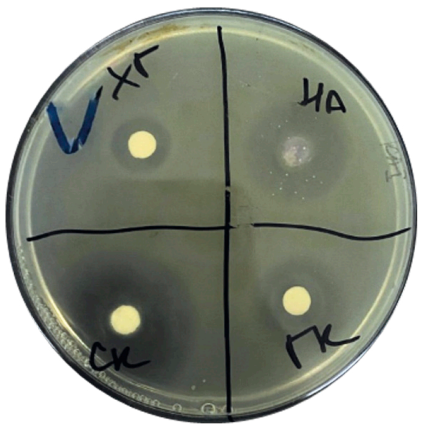
Microorganism	Repeat 1	Repeat 2
S. aureus		
C. albicans		
S. sobrinus		
S. salivarius		

Fig. 1 Study of antibacterial activity of medical adhesives on the first day

Рис.1 Исследование антибактериальной активности медицинских клеев в первые сутки

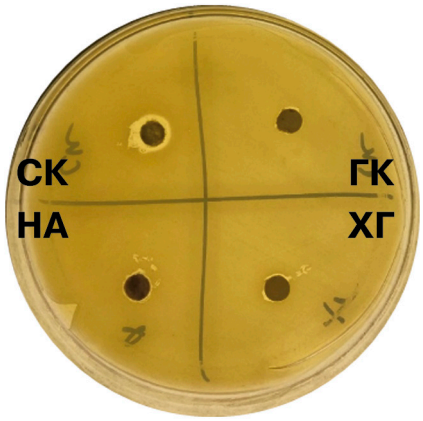
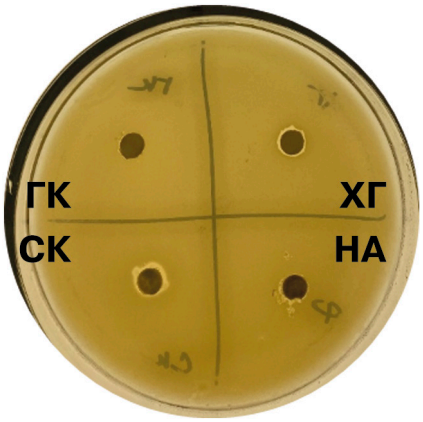
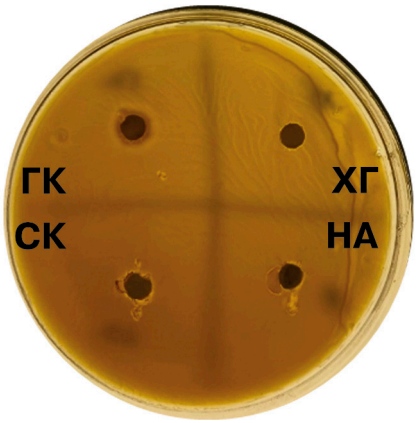
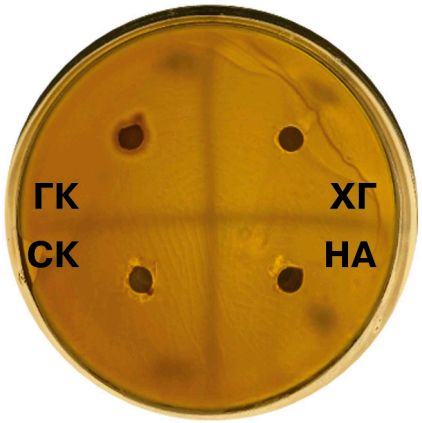
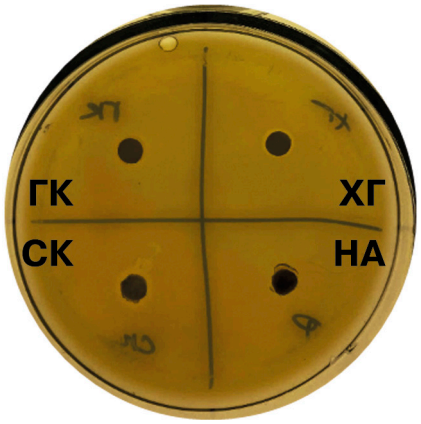
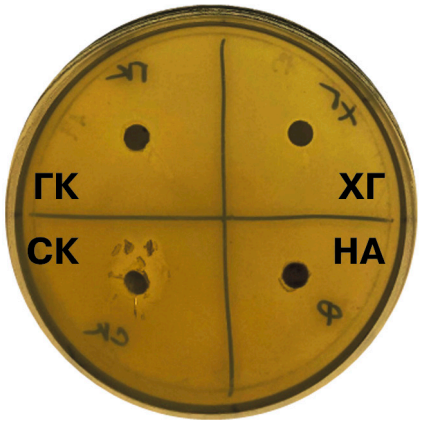
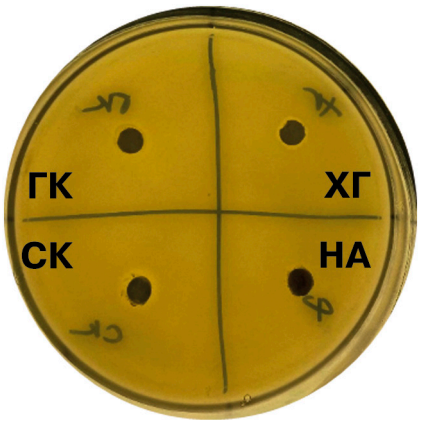
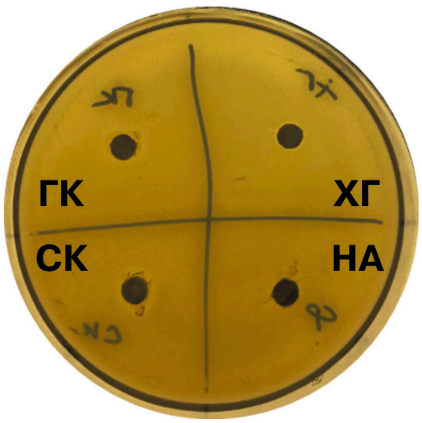
Microorganism	Repeat 1	Repeat 2
S. aureus		
C. albicans		
S. sobrinus		
S. salivarius		

Fig. 2. Study of antibacterial activity of medical adhesives on the second day

Рис. 2. Исследование антибактериальной активности медицинских клеев на вторые сутки

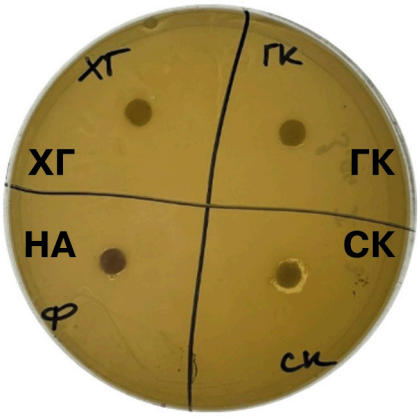
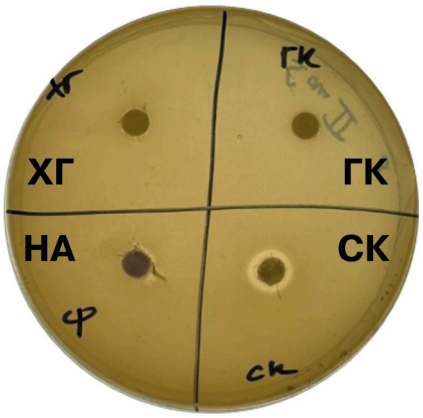
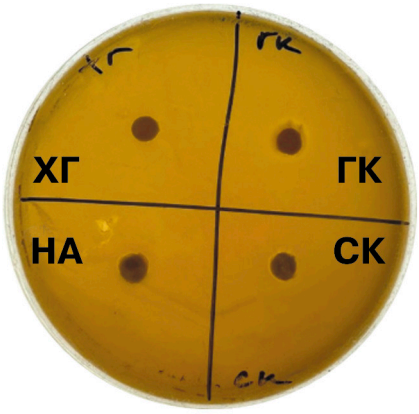
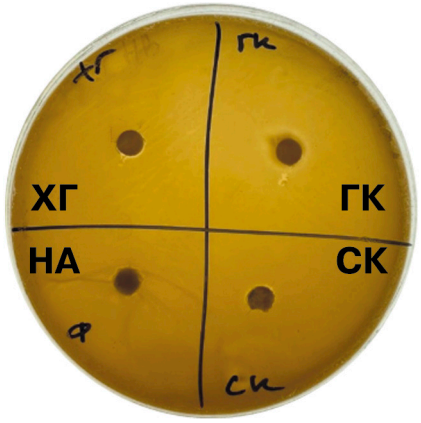
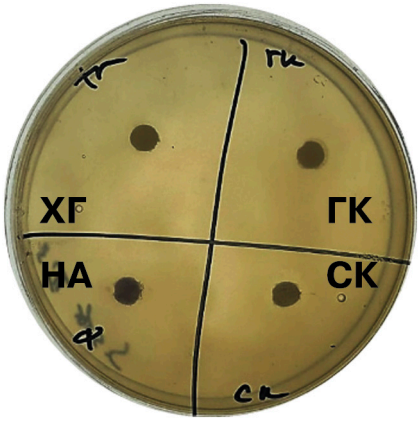
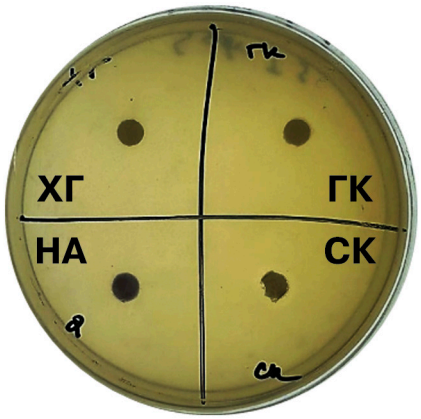
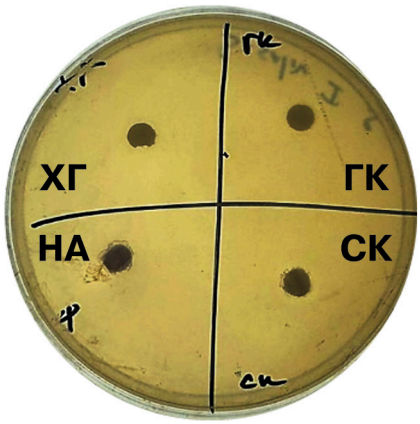
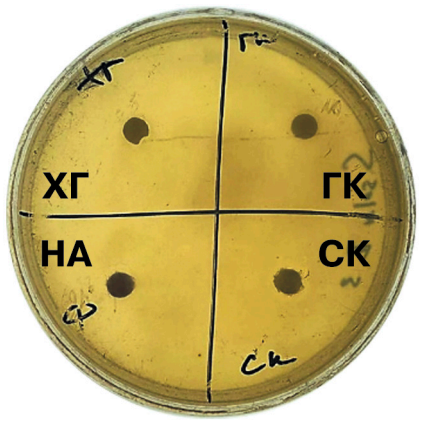
Microorganism	Repeat 1	Repeat 2
S. aureus		
C. albicans		
S. sobrinus		
S. salivarius		

Fig. 3 Study of antibacterial activity of medical adhesives on the third day

Рис. 3. Исследование антибактериальной активности медицинских клеев на третьи сутки

The results of the study on the 3rd day are presented in Tables 10–13.

Table 10. Diameter of growth inhibition zones of S. Aureus (3rd day)

Таблица 10. Диаметр зон ингибирования роста S. Aureus (3-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	8	8	6	6	8	10	8	8	7.750
Group 3	6	10	6	6	4	3	3	3	5.125
Group 4	–	–	–	–	–	–	–	–	–

Table 11. Diameter of growth inhibition zones of C. albicans (3rd day)

Таблица 11. Диаметр зон торможения роста C. albicans (3-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	4	3	3	3	4	3	3	3	3.25
Group 3	4	3	3	3	4	3	3	3	3.25
Group 4	4	3	3	3	4	3	3	3	3.25

Table 12. Diameter of growth inhibition zones of S. Sobrinus (3rd day)

Таблица 12. Диаметр зон подавления роста S. Sobrinus (на 3-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	10	10	8	6	10	8	8	8	8.5
Group 3	–	–	–	–	–	–	–	–	–
Group 4	–	–	–	–	–	–	–	–	–

Table 13. Diameter of growth inhibition zones of S. Salivarius (3rd day)

Таблица 13. Диаметр зон подавления роста S. Salivarius (на 3-й день)

Substance under study	Diameter of zones								
	Initial data								Average
Group 1	–	–	–	–	–	–	–	–	–
Group 2	8	10	8	10	8	8	8	10	8.75
Group 3	4	3	3	3	4	3	3	3	3.25
Group 4	4	3	3	3	4	3	3	3	3.25

On the 3rd day, it is noted that antibacterial activity is completely absent in all representatives of medical glue, with the exception of samples of Group 2, which retained a slight halo of antibacterial activity against Staphylococcus aureus (Fig. 3).

DISCUSSION

During the study, a significant difference was noted between the medical adhesives of the cyanoacrylic group and the feracryl group. The adhesive based on cyanoacrylic acid was more effective in relation to the studied strains. Such differences indicate that when performing surgical manipulations in the oral cavity using medical glue, preference should be given to the first group of adhesives.

Ethyl cyanoacrylate glue has proven itself as a glue capable of exerting pronounced local antibacterial activity on opportunistic strains of microorganisms. Such activity of the glue helps to reduce the likelihood of infection of the wound surface of the donor area on the palate and to ensure rapid and painless wound healing.

CONCLUSION

The study showed that all tested preparations have an antibacterial effect. However, the highest and longest antibacterial activity against all studied strains and in comparison, with the control group was demonstrated by the glue based on ethyl cyanoacrylate.

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AUTHOR'S CONTRIBUTION

All the authors made equal contributions to the publication preparation in terms of the idea and design of the article; data collection; critical revision of the article in terms of significant intellectual content and final approval of the version of the article for publication.

ВКЛАД АВТОРОВ

Все авторы внесли равноценный вклад в подготовку публикации в части замысла и дизайна исследования; сбора данных; критического пересмотра статьи в части значимого интеллектуального содержания и окончательного одобрения варианта статьи для опубликования.