

Efficiency of wound dressing made of powder cotton cellulose

S.S. Ksembaev^{1*}, O.V. Nesterov², L.N. Khafizova¹

¹Kazan State Medical University, Kazan, Russia;

²Kazan State Medical Academy — Branch of the Russian Medical Academy of Postgraduate Education, Kazan, Russia

Abstract

Aim. To study the effectiveness of a wound dressing made of powdered cotton cellulose for open surgical wounds in the oral cavity.

Methods. The effectiveness of a wound dressing made of powdered cotton cellulose during vestibuloplasty was assessed based on clinical indicators. The study included 197 children aged 8–12 years (boys — 91, girls — 106), divided into 2 groups — the main group (100 children treated with powdered cotton cellulose wound dressing) and the comparison group (97 children, treated with a surgical gauze dressing). The number of children in clinical groups was determined by the “copy-pair” method. The dynamics of the postoperative period was assessed according to traditional clinical indicators (the presence of pain, inflammatory edema, hematomas, healing time, etc.). The severity of general and local clinical signs was determined by using the system of its assessment in points developed by us. Differences were considered significant at $p < 0.05$.

Results. In the postoperative period, the patients of the main group had no complications — in contrast to the patients of the comparison group, who had pronounced edema and hematomas of the soft tissues of the chin, edema and hyperemia of the displaced flap. Changes in clinical signs severity in points also prevailed in the comparison group ($p < 0.001$). The surgical wound showed complete epithelialization after 11.4 ± 0.7 days in the main group and after 13.5 ± 0.9 days in the comparison group. The reduction in the duration of treatment was 2.1 ± 0.8 days.

Conclusion. When using a wound dressing made of powdered cotton cellulose, the wound is protected from the aggressive environment of the mouth, including microflora, food debris, etc., which excludes the possibility of its secondary infection; there is no pain, postoperative inflammatory edema and hematomas; the surgical wound healing time is reduced; there are no contraindications, no side and allergic reactions.

Keywords: wound dressings, powdered cotton cellulose, operations in the oral cavity.

For citation: Ksembaev S.S., Nesterov O.V., Khafizova L.N. Efficiency of wound dressing made of powder cotton cellulose. *Kazan Medical Journal*. 2021; 102 (1): 12–18. DOI: 10.17816/KMJ2021-12.

Background. The postoperative period is an important and complicated stage of any surgical intervention and largely influences the final result of treatment [1–3]. The management of postoperative open wounds in the oral cavity in children is of particular difficulty because of the significance of painless manipulations in children due to their pain sensitivity and the probability of psychological trauma [4].

The results of surgical intervention in the oral vestibule are not always satisfactory. First, in both adults and children, this concerns the impossibility of closing a sufficiently extensive wound surface with topical tissues due to their deficiency, which leads to healing of the surgical wound by secondary adhesion. In addition, the concomitant pain syn-

drome causes mastication dysfunction, which requires the consumption of strained food that leads to contamination of wound dressings and, with impairment of the self-cleaning process of the mouth, to a significant decrease in the level of individual oral hygiene, which creates favorable conditions for the growth of various microorganisms that cause wound infection contamination. Ultimately, this results in the formation of deforming scar tissues [5–8].

A large number of dressings are being used in clinical practice and contain multiple antibiotics, cleaning agents, and irrigators. However, no ideal remedy has been found that would meet all the criteria for wound dressings or coverings [9–11]. For most surgeons, modern dressings used to treat wounds should meet the following criteria [1, 3]:

- remove detritus, microbial particles, and excess exudate;
- provide adequate gas exchange between the wound and atmosphere;
- stimulate reparative processes in the wound;
- protect the wound from mechanical stress, chemical irritation, and secondary infection;
- prevent disruption of blood circulation and oxygenation of wound edges;
- be stored for a long time;
- promote patient comfort.

Recently, there has been a revision of many concepts about the means of topical treatment of wounds: they should not only be selected based on the type and characteristics of the wound but also be easy to use without reducing the patient's quality of life [1,2].

The surgical wound after vestibuloplasty is closed with gauze dressings with various antibacterial properties, keratoplastic ointments, collagen films, preserved cattle peritoneum, and tissue membranes of directed regeneration. Their common disadvantages include difficulties in fixing the dressing, postoperative pain, soreness in bandaging, and inflammatory complications.

In addition, for the closure of such postoperative wounds, it is proposed to use biological materials (autogenous, allogeneic, and xenogenic), based on their biointegration. For these purposes, vascularized mucous grafts from the buccal areas are used [6]—freely transplanted mucosal autografts [8]. Each technique has significant drawbacks. Thus, the use of allogeneic materials (e.g., the dura mater) is hindered by ethical and technological problems, and the problem of antigenic compatibility has not been solved [10].

Until now, in our opinion, many developed wound dressings for oral cavity surgeries have not eliminated their main drawback, including the impossibility of relieving pain as the absence of which is important for managing postoperative period, especially in children. This corresponds to one of the main principles of modern medicine, which consists of not only treating but also preventing the reduction of the patient's quality of life, especially for children. Therefore, it is necessary to develop a wound dressing that meets the current surgical requirements [1].

A Russian plant powder sorbent made of cotton cellulose that has been developed by Kazan scientists recently [10] was used for sorption-application therapy in the complex treatment of dental patients. In particular, several studies have established the clinical efficacy of topical application of a sorbent made of powdered cotton cellulose (PCC) in patients with alveolitis (complications after tooth



Fig. 1. Powdered cotton cellulose

extraction), odontogenic phlegmons, and chronic generalized periodontitis [3,12].

In addition, the technical capability of using PCC for sorption-application therapy in vestibuloplasty was substantiated because of its pronounced adhesive, vapor-permeable, and draining properties [4].

Aim. This study aimed to analyze the efficiency of PCC wound dressing for open surgical wounds in the oral cavity.

Materials and methods of the study. The studies were conducted in 2017–2020 in the dental clinics of the “City Dentistry” and the “Center for Maxillofacial Surgery and Periodontology” companies (Kazan).

PCC was developed jointly by employees of the Kazan National Research Technological University and Kazan State Medical University. This substance is white, has powdery soft consistency (Fig. 1), hygroscopic, with a fiber size of 20–50 μm , and was mechanically crushed by the elastic-deformation method based on cotton fiber, and it does not contain any foreign inclusions [4,10].

The clinical study included 197 patients with a small lower vestibule of the mouth at the age of 8–12 years (91 boys and 106 girls). The work was approved by the ethical committee of the Kazan State Medical University (Protocol No.5 of May 30, 2017).

All patients underwent surgery for vestibuloplasty according to Edlan-Meicher. We selected vestibuloplasty among all oral cavity surgeries as the most indicative in terms of assessing wound dressing efficacy.

All patients were distributed into two groups as follows:

1) the main group (MG) included 100 pediatric patients who were identical in age and gender and used PCC as wound dressings;

2) the comparison group (CG) comprised 97 pediatric patients who were identical in age and gender and used a surgical gauze bandage to close the wound surface, which we chose after considering the fact that, like PCC, it is made from the same raw material—cotton cellulose.

The number of pediatric patients in the clinical study was determined according to the table of Ot-delnova [13]. Patients were grouped according to the “copy-pair” method (based on the selection of a “copy-pair” for each follow-up unit of the group under study according to one or several characteristics).

The postoperative period dynamics were assessed according to traditional clinical indicators (pain syndrome, inflammatory edema, hematomas, healing time, etc.), and the severity of general and local clinical signs was determined using our point assessment system (Table 1).

Sterile PCC powder was applied to postoperative wounds of MG patients, after which the sorbent was soaked in blood, and a wound dressing was formed (Fig. 2).

In CG patients, a tampon cut to the size of the wound from sterile surgical gauze was sutured to the wound. Nutritional care oral baths with 0.1% chlorhexidine solution were prescribed to all patients. Control examinations with corresponding points were performed after 1, 3, 5, 7, 10, 14, and 30 days. To determine the reconstructed depth level of the vestibule of the mouth, the final examination was performed 6 months after the surgery.

In addition, the developed wound dressing was tested in 25 pediatric patients (19 girls and 6 boys) aged 7–12 years after frenuloplasty for a short frenum of the upper lip. At the same time, the exposed area of the bone tissue of the alveolar process, formed after frenuloplasty, was closed with PCC wound dressings.

Mathematical processing of the research results was performed through variation statistics. The arithmetic mean values were taken for assessment, and based on them, the mean error of the arithmetic mean value and mean-square deviation were calculated. The obtained digital data were analyzed to determine the significance of the mean values according to Student's test.

Results. During the postoperative period, the comparative dynamics of clinical indicators was recorded, as presented in Table 2.

In the postoperative period, we did not register any complications in MG patients. The next day after surgery, all patients had no complaints of surgical wound pain. The survey of parents revealed that painkillers were not required in any case. In addition, there was no pronounced postoperative edema or hematoma of the chin area after vestibuloplasty. Upon examination of the mouth, there were no pronounced inflammatory signs in the area of the surgical wound isolated by the wound dressing.

In CG patients, 47 (54.1%) pediatric patients required painkillers within 1 day after surgery. During external examination, edema of the chin

Table 1. Scoring system for the severity of clinical signs in the postoperative period

Signs		Points
General condition	Poor	1
	Satisfactory	0
Body temperature	Subfebrile (37–38°C)	1
	Within normal limits	0
Appetite	Inappetency	2
	Impaired	1
	Unimpaired	0
Sleep	Insomnia	2
	Impaired	1
	Unimpaired	0
Edema of the soft tissues of the chin	Yes	1
	No	0
Chin hematoma	Yes	1
	No	0
Regional lymph nodes	Enlarged	1
	Not enlarged	0
Mouth opening limitation	Yes	1
	No	0
Graft hyperemia	Severe diffuse	2
	Mild	1
	No	0
Perifocal inflammatory edema in the surgical wound area	Severe	2
	Moderate	1
	No	0
Pain in the surgical wound area	Severe	3
	Moderate	2
	Mild	1
	No	0
Stomatodysodia	Severe	2
	Mild	1
	No	0
Feeling of “contracture”	Yes	1
	No	0
Maximum possible score		20

soft tissues was recorded (on average, up to 4 days) in all CG patients, and hematomas of the chin area in nine pediatric patients. Edema and graft hyperemia were registered (persisted for 9.4 ± 0.9 days). The wound on the lip was covered with a fibrin film, and healing occurred because of gradual epithelium overlaying from the wound edges. The pediatric patients noted the feeling of “contracture”

Table 2. Comparative dynamics of clinical indicators of the effectiveness of wound dressings

Clinical indicators	Main group, <i>n</i> = 100 (1)	Comparison group, <i>n</i> = 97 (2)	Significance of differences
Pain syndrome (the next day after surgery)	No	Stopped after 2.3 ± 0.6 days	$p_1-p_2 < 0.01$
Postoperative edema of the chin area	No	Stopped after 4.2 ± 0.6 days	$p_1-p_2 < 0.01$
Hematoma of the chin area	No	Registered in 9 of 87 children	—
Edema and hyperemia of the graft transplanted	No	Retained for up to 9.4 ± 0.9 days	$p_1-p_2 < 0.01$
Feeling of “contracture” in the surgical wound area	No	Retained for up to 28.3 ± 2.9 days	$p_1-p_2 < 0.01$
Complete epithelialization of the wound	11.4 ± 0.7 days	13.5 ± 0.9 days	$p_1-p_2 < 0.01$
Treatment time	12.9 ± 0.6 days	15.0 ± 0.9 days	$p_1-p_2 < 0.05$

and awkwardness, which gradually decreased and then completely disappeared, on average, by month 1 after the surgery.

Differences during the postoperative period were noted in MG and CG patients in the dynamics of the severity of general (disorders of the general condition, sleep, appetite, etc.) and local (edema, hematoma, etc.) clinical signs (Fig. 3).

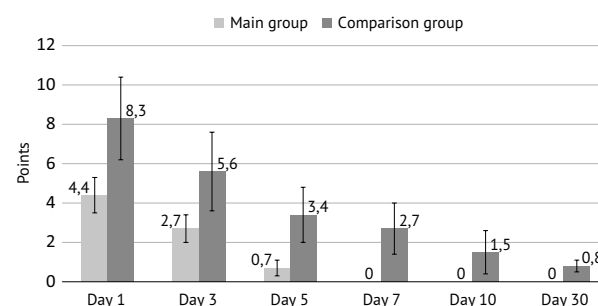
Figure 3 reveals significantly more pronounced clinical sign deteriorations in CG patients on day 1 compared with MG indicators ($p > 0.001$).

On day 3, the values of these indicators decreased, which were more pronounced in MG patients and less pronounced in CG patients, although not significant in both cases ($p > 0.05$). However, the difference between the values of these indicators was significant ($p < 0.001$).

On day 5 of the follow-up, the decrease in the values of these indicators continued, and it was statistically significant ($p < 0.05$) in MG patients and insignificant in CG patients ($p > 0.05$). The difference in the values of these indicators was significant ($p < 0.01$). At the same time, the decrease in the values of indicators (compared with day 3 of the follow-up period) was not statistically significant in both MG and CG patients ($p > 0.05$), whereas the difference in the values of MG and CG indicators was significant ($p < 0.001$).

On day 7, a significant decrease in indicators continued in MG pediatric patients ($p < 0.05$), and the difference in the values of MG and CG indicators at this stage of follow-up also remained statistically significant ($p < 0.01$).

On days 7 and 8 after surgery, the wound dressings were removed, which easily separated from the epithelizing wound. Complete epithelialization of the surgical wound was noted on days 11 and 12 in MG patients (on average, day 11.4 ± 0.7) and days

**Fig. 2.** Type of wound dressing made of powdered cotton cellulose**Fig. 3.** Changes in the severity of general and local clinical signs in the postoperative period in vestibuloplasty (points)

12 and 14 in CG patients (day 13.5 ± 0.9). The reduction in the treatment duration was 2.1 ± 0.8 days.

On day 30, the difference in scores remained in MG and CG patients, mainly due to the feeling of “contracture” in the latter ($p < 0.05$).

In all MG pediatric patients, abnormalities of soft tissue attachment were eliminated because of surgical intervention, and the depth of the mouth vestibule increased to 9.2 ± 0.8 mm because of the formed soft cicatricial joints with retention of the mucous membrane (Fig. 4).



Fig. 4. Lower vestibule of the mouth 1 month after the surgery (main group)

Case follow-up of patients was performed for 6 months. All pediatric patients achieved deepening of the mouth vestibule by the planned amount.

Discussion. The methodology of our work was based on the creation of a universal, technological, simple, and sufficiently effective wound dressing made of PCC for oral cavity surgeries with predictable results.

The work was started by testing PCC wound dressings for oral cavity surgeries, namely, frenuloplasty (correction of the short frenum of the upper lip) and epulis excision. These surgeries always leave an exposed bone tissue area of the alveolar process, which cannot be closed using local tissue grafting. However, then, vestibuloplasty (a surgery to deepen the shallow vestibule of the mouth) was chosen as indicative in terms of assessing wound dressing efficiency, after which a more extensive wound surface remains (Fig. 2).

Significant disadvantages of the dressing method include adhesion of the gauze dressing to the wound surface, painful separation during removal, and trauma of the wound surface. In case of an open surgical wound in the oral cavity, on the contrary, a high degree of adhesion of the application coating to the wound surface is required, which ensures optimal fixation and retention of the resulting wound dressing. PCC provides such a high level of adhesion, which is significantly higher than the adhesion rate of gauze dressings [4]. PCC also has a good vapor permeability level, high drainage and sorption, and prolonged capacity [4].

Research on this subject is being conducted and is associated with the study of the wound dressing composition and mechanisms of analgesic and antimicrobial effects.

Thus, the established clinical efficacy of PCC wound dressings developed is based on the above physicochemical properties and consists of ensuring reliable isolation of the wound surface for the entire healing period, complete absence of pain

syndrome, pronounced inflammatory reaction, and shortened treatment time.

CONCLUSIONS

When using PCC wound dressings, (1) the wound is protected against the aggressive environment of the mouth, including microflora and food debris, which prevents secondary infection; (2) there is no pain syndrome and pronounced postoperative inflammatory edema and hematomas; (3) the healing time of the surgical wound shortens; (4) there are no contraindications, side effects, or allergic reactions.

In addition, the use of the proposed wound dressing in the complex therapeutic measures for open postoperative wounds in the oral cavity is also economically reasonable since this significantly reduces the time spent on the doctor's work and eliminates the need for additional drugs.

Author contributions. S.S.K. put forward the concept of work and implemented the project administration and work management; O.V.N. and L.N.Kh analyzed the literature, conducted research, and collected and analyzed laboratory and clinical results.

Funding. The study had no external funding.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Kuznetsov N.A., Nikitin V.G. Shchadyashchiye khirurgicheskiye vmeshatel'stva i interaktivnyye povyazki v lechenii infitsirovannykh ran. *Khirurgiya. Prilozhenie k zhurnalu Consilium medicum*. 2006; (2): 39–46. (In Russ.)
2. Ksembaev S.S., Nesterov O.V., Musin I.N. et al. Multifunctional sorbent "Celoform" and its effectiveness in clinical dentistry. *Biosovmestimye materialy i novye tekhnologii v stomatologii: sbornik statej Mezhdunarodnoj konferencii*. Kazan'. 2014; 92–96. (In Russ.)
3. Galimov R.A., Khadyeva M.N., Nesterov O.V., Ksembaev S.S. Sorptio-applicational therapy pyo-inflammatory processes in clinical dentistry. *Prakticheskaya meditsina*. 2012; (1): 113–115. (In Russ.)
4. Khafizova L.N., Musin I.N., Ksembaev S.S., Nesterov O.V. Physicochemical substantiation of the effectiveness of the Celoform sorbent for the protection and treatment of an open wound surface. *Vestnik tekhnologicheskogo universiteta*. 2015; 18 (9): 178–182. (In Russ.)
5. Artyushkevich A.S. Indications for plastic surgery of the vestibule of the mouth. *Sovremennaya stomatologiya*. 2011; (1): 82–83. (In Russ.)
6. Bhola M., Newell D.H., Hancock E.B. Acellular dermal allograft for vestibuloplasty — an alternative to autogenous soft tissue grafts in preprosthetic surgical procedures: a clinical report. *J. Prosthodont*. 2003; 12 (2): 133–137. DOI: 10.1016/S1059-941X(03)00039-1.
7. Butler L., Salkin L.M., Freedman A.L. et al. The clinical relevance of microbiologic testing. Part 2: a comparative analysis of microbiologic samples secured simultaneously from the same sites and cultured in the same laboratory. *Int. J. Periodontics Restorative Dent*. 2003; 23 (2): 121–127. PMID: 12710815.

8. Sikkerimath B.C., Dandagi S., Gudi S.S., Jayapalan D. Comparison of vestibular sulcus depth in vestibuloplasty using standard Clark's technique with and without amnion as graft material. *Ann. Maxillofac. Surg.* 2012; 2 (1): 30–35. DOI: 10.4103/2231-0746.95313.
9. Vol'f G.F., Rateytskhak E.M., Rateytskhak K. *Parodontologiya.* (Periodontics.) M.: MEDpress-inform. 2008; 548 p. (In Russ.)
10. Ksembayev S.S., Vavilov Yu.G. *A method of making cellulose surgical cotton.* Patent for invention No. 2390591, Bulletin No. 15, issued at 28.5.2010. (In Russ.)
11. Hatoko M., Kuwahara M., Tanaka A. et al. Correction of bone deformity after resection of dermoid cyst using artificial dermis implantation. *Aesthetic. Plast. Surg.* 2002; 26 (1): 35–39. DOI: 10.1007/s00266-001-0005-y.
12. Akhmadullina G.A., Nesterov O.V., Ksembaev S.S. et al. Effectiveness of surgical dressing made of “Celoform” for prevention and treatment of alveolitis. *Kazan Medical Journal.* 2011; (1): 37–41. (In Russ.)
13. Galiullin A.N. *Obshchestvennoye zdorov'ye i zdravookhraneniye.* (Public health and healthcare.) M.: IKTS “Akademkniga”. 2008; 499 p. (In Russ.)