Surgical nail of biopolymer from sugarcane for preservation of the nail bed after avulsion

Unha cirúrgica de biopolímero de cana de açúcar para preservação do leito ungueal após avulsão

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ABSTRACT

Objective: Develop a surgical nail of BPCA with the purpose of producing a cover for the nail bed immediately exposed after avulsion of the nail plate. Method: The surgical nail of BPCA was produced from the BPCA gel, which has viscoelastic properties and is stable at concentrations of 0.6% and 0.8%. Results: The biocompatibility and low toxicity of the cellulosic polysaccharide allow to idealize its use as a medical device, serving as a mechanical barrier, protection of the nail bed and remodeling of the nail plate. The physico-chemical characteristics of the polysaccharide allow the production of a self-adhesive and resistant nail model, serving temporarily as a substitute for the nail plate. In addition, the cost of the surgical nail of BPCA is affordable. Conclusion: The surgical nail of BPCA appears to be a promising alternative for maintenance and healing of the nail bed.

Keywords: Nail Diseases; Biopolymers; Saccharum; Occlusive Dressings; Wound Healing.

RESUMO

Objetivo: Desenvolver uma unha cirúrgica de BPCA com o propósito de produzir uma cobertura para o leito ungueal imediatamente exposto após avulsão da lâmina ungueal. Método: A unha cirúrgica de BPCA foi produzida a partir do gel de BPCA, que tem propriedades viscoelásticas e é estável em concentrações de 0,6% e 0,8%. Resultados: A comprovada biocompatibilidade e a baixa toxicidade do polissacarídeo celulósico permitem idealizar a sua utilização como um dispositivo médico, servindo como barreira mecânica, proteção do leito ungueal e remodelação da lâmina ungueal. As características físico-químicas do polissacarídeo permitem a produção de um modelo ungueal autoaderente e resistente, servindo temporariamente como substituto da lâmina ungueal. Além disso, o custo da unha cirúrgica de BPCA é acessível. Conclusão: A unha cirúrgica de BPCA parece ser uma alternativa promissora para manutenção e cicatrização do leito ungueal.

Palavras-chave: Doenças da Unha; Biopolímeros; Saccharum; Curativos Oclusivos; Cicatrização.

NOTA

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INTRODUCTION

The nail is a cutaneous attachment with sensorially and exerts protection of the distal phalanx against traumatic impacts, it helps in the function of small objects pincer, it collaborates with the fine sensitivity and it contributes to the appearance of hands and feet[1-2].

From an epidemiological point of view, most nail injuries are caused by trauma and involve, particularly children and young adults[3]. The avulsion after trauma of the nail apparatus may be necessary for the evaluation of the stability of the nail bed or to drain a possible hematoma[4].

Among the surgical procedures of the nail apparatus, avulsion of the nail plate is the most [5]. Its indications have diagnostic and therapeutic purposes[6].

The removed nail plate itself can be used as a protective device, provided that in good conditions to cover the exposed bed[7]. In the impossibility of this, some materials have been suggested, however, many times, unavailable at the time of surgery and with high associated cost.

Previous studies have shown that a cellulosic exopolysaccharide obtained from sugarcane molasses, by the synthesis of Gram negative bacteria of the genus Zoogloea belonging to the family Pseudomonadaceae, provided an adequate cicatrization to the cutaneous wounds in animals, optimizing the cicatrization time and promoting the control of infection[8]. Other studies[9-11] show that the sugarcane biopolymer (BPCA) was efficient as a mechanical barrier and adjunct in the treatment of ulcerated lesions.

The guiding question of the study is to develop a surgical nail of BPCA capable of maintaining the nail bed, assisting in healing, avoiding adhesions, in order to reduce postoperative pain and improve tactile sensation. The aim was to develop a surgical nail of BPCA with the purpose of producing a cover for the nail bed immediately exposed after avulsion of the nail plate.

METHOD

The BPCA surgical nail

It is a polysaccharide obtained from sugarcane molasses synthesized by bacteria, being called sugarcane biopolymer (BPCA).

The surgical nail of BPCA was produced from the BPCA gel which has viscoelastic properties and is stable at concentrations of 0.6% and 0.8% at usual storage temperatures and in biological fluids (0-40 ° C). These properties make it applicable in vivo[12]. Due to its chemical composition and physical properties, BPCA does not induce immune responses and therefore has been considered a promising biomaterial with a wide range of applications in the biological and medical sciences[13].

Biomechanical tests with analysis of parameters such as tensile velocity, maximum shear force and maximum deformation force, showed that the BPCA membrane has similar results to expanded polytetrafluoroethylene - ePTFE[14].

The cytotoxicity of BPCA was tested in vitro by the production of nitric oxide, adhesion rate and cellular viability of alveolar macrophages with low toxicity in the MTT-3- (4,5-dimethylthiazol-2yl) -2,5-diphenyl tetrazoline bromide assay[15]. In another study[16], the authors also concluded that BPCA was safe when administered orally in rats at 2000 mg / kg body weight in a single dose, was not cytotoxic by the lactate dehydrogenase (LDH) activity test and showed a protective effect against myelotoxicity and genotoxicity induced by cyclophosphamide.

The surgical nails were produced in the form of 3x3cm plates with a thickness of 1mm. Flexible and moldable according to the size and shape of the ungual bed discovered, presenting a superior multiperforated surface and a spongy bottom, facilitating drainage of exudates and self-adherence to the bed (Figure 1).

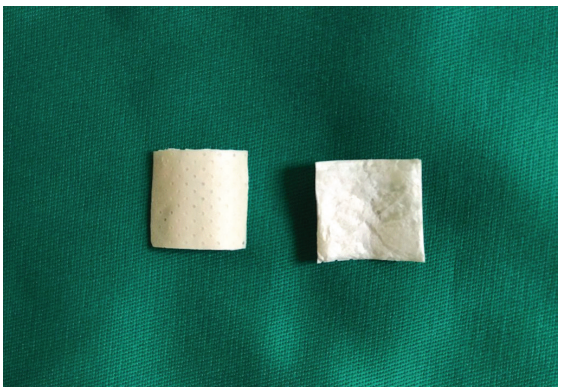

FIGURE 1 – Ungueal Dressing of Sugarcane Biopolymer: a) Top surface, multiperforated: facilitates drainage of exudate; b) Lower surface, spongy: promotes adherence to the nail bed.

Source: photo obtained during the preparation of the material.

The surgical nails of BPCA were individually wrapped in surgical grade type envelopes and sterilized previously with gamma irradiation of 25kGy[11].

They were manufactured and donated by POLISA© Biopolymers for Health, startup incubated at the Carpina Sugar Cane Experiment Station, linked to the Federal Rural University of Pernambuco (EECAC/UFRPE).

Procedures and Variables

After avulsion of the nail, according to the various techniques, the area will be washed with saline solution and gently dried gauze. Then, BPCA surgical nails will be applied over the nail bed involving the entire bare surface without the need for suture fixation. Then the cover will be covered with gauze and overlapping crepe bandage (secondary dressing). Patients will be instructed to remain for 48 hours without changing the dressing, which may remain longer, provided that in favorable clinical conditions.

The sociodemographic profile of the participants included in the research will be traced, in addition to being subjected to clinical measurements (weight and height) and laboratory (Hematocrit - Htc, Hemoglobin - Hgb, GJ, International normalized ratio - INR) based on MEASURE[17]. The length of stay of the surgical nail of BPCA to the nail bed will also be monitored.

The clinical research project was submitted and approved by the Ethics Committee for Research with Human Subjects (CEP/CCS/UFPE: CEP 1.501.560). The data presented in this article refer to the development of the prosthesis, that is, the surgical nail of BPCA.

Expected Results and Discussion

After trauma, the production of a new nail is suspended for approximately 21 days. Thereafter, an increase in the growth rate over the next 50 days and a decrease in the subsequent 30 days is observed. Nail growth becomes normal 100 days after the onset of trauma[18].

When surgical or traumatic avulsion of the nail plate occurs, the blade may be replaced on the nail bed provided it is in good condition, however, if this possibility does not exist, the nail should be replaced so that the integrity of the nail is maintained during the healing process, providing the growth of a healthy nail. For this purpose, some materials have been used: polyurethane sponge, non-adherent gauze, acrylic prostheses, pieces of radiography film and flexible polypropylene[7,19]. INRO® nail prostheses were developed to meet this demand, but their cost is high and often unavailable during surgery[20]. On the other hand, the surgical nail of BPCA has a low cost, since they derive from a fermentative process from molasses of sugar cane, local product and from a renewable source. The cost of the INRO® prosthesis is USD 52.80 (approximately R$ 218.00) per unit, while the estimated cost for the BPCA nail is R$ 50.00.

It is expected to use the surgical nail of BPCA: to maintain the original nail bed shape, to aid in the recovery of a healthy nail bed, to avoid adhesions between the cuticle and the proximal nail bed, to support a possible fracture of the distal phalanx, postoperative pain, and improve tactile sensation during the healing period[7]. The malfunctioning of the nail apparatus causes painful symptoms, requiring specialized medical attention, avulsion being the most frequent surgical procedure, with reflexes in the individual work capacity and with socioeconomic impact.

BPCA in its pure state presents elasticity, tensile strength, flexibility and can also be modeled in different forms, physico-chemical characteristics fundamental for the preparation of biological implants[9,11]. It is also worth noting the composition of this polymer which presents only polysaccharides, unlike other biological polymers[21].

Available in the form of gel, sponge, membrane and films, BPCA has been used in research projects as surgical dressings, based on data proven in different experimental and clinical applications[9-11].

The proven biocompatibility and low toxicity of the cellulosic polysaccharide allow to idealize its use as a medical device, serving as a mechanical barrier, protection of the nail bed and remodeling of the nail plate. The physico-chemical characteristics of the polysaccharide allow the production of a self-adhesive and resistant nail model, serving temporarily as a substitute for the nail plate. In addition, the cost of the surgical nail of BPCA is affordable.

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Interest conflicts

The authors declare no conflicts of interest.

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