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The Influence of Polyamide Fabric on the Healing Process of Burned Patients

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Abstract: *The study aims to present the results obtained following the burned patients micrografting, from the perspective of analyzing the physical and chemical properties of polyamide as a support for skin micrografts. To carry out the project, the data was obtained from the use of 100 micrografting kits with polyamide support which were analyzed and the results were interpreted in order to obtain relevant information regarding the effect of polyamide in accelerating the healing process, the rate of postoperative complications, as well as the acceleration in integration of the skin grafts.The comparative analysis was performed with a control group consisting of 108 free split skin grafts covered with classic cotton tulle. The conclusions of the study show that the use of polyamide in the therapeutic protocol of micrografting accelerates the process of grafts integration, while reducing the rate of postoperative complications, as well as decreasing the lenght of hospitalization.*

Keywords: *polyamide, micrografting, plastic, nylon, tensile properties, skin grafting*

Introduction

Micrografting technique has been proven to be the life-saving solution for patients wiht extensive burns. The enthusiasm generated within the scientific community by this innovative technique allowed the progressive improvement of the therapeutic protocol, culminating with the introduction of polyamide as a physical support for the application of micrografts [1]. Its physical and chemical properties have significantly contributed to improving the prognosis of burned patients, by accelerating the healing process, reducing overall duration of hospitalization, reducing complications in the context of a significant reduction in fluid losses at the level of grafted lesions.

Micrografts allow large areas of burns to be covered by harvesting a small skin graft, thus reducing the size of the donor area and the impact on the patient's general condition. The sectioning of the graft into multiple skin islands creates the context for the stimulation of epithelialization from all these islands, the length of the epithelialization frontispiece increasing exponentially compared to the classical grafting method. All these particularities of micrografting have aroused the interest of the international scientific community dedicated to the research of methods to improve the treatment of burns. In Romania, efforts are being made on all levels to increase the quality of treatment for burn patients, by building new dedicated centers, as well as by super-specializing the plastic surgeons by sending them to advanced training courses in countries of the European Union. In this context, research has been undertaken in order to understand the impact that micrografting has on the main indicators of efficacy and efficiency in the treatment of burn patients.

From a structural point of view, polyamides are made up of repetitive units anchored together by amide bonds (Figure 1).

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The physical and chemical properties of polyamides give this class of chemical compounds particularities and characteristics that have contributed to their widespread use in the automotive industry [2-4], in the field of textile materials, as well as the industry producing kitchen ustensils.

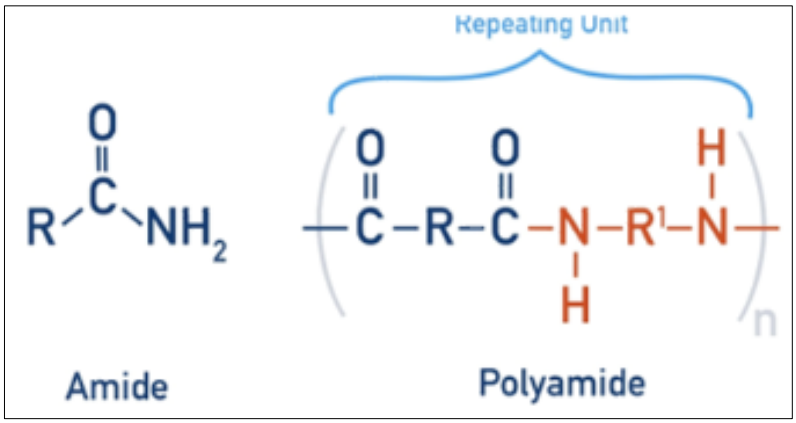

Figure 1. Polyamide chemical structure

Polyamides are divided into two broad classes: natural and synthetic. The category of natural polyamides includes wool and silk, while the category of artificial polyamides includes nylon, sodium polyaspartate and aramids.

Structural chemical peculiarities give polyamide products durability and high tensile and chemical resistance. The increased strength of polyamide is largely due to the flexibility of the aliphatic bonds in the amorphous regions. Polyamides are characterized by a low adhesion to surfaces, having low values of the coefficient of friction. They also present impressive mechanical qualities from the perspective of increased durability, as well as high thermal resistance [5-7]. The physical and chemical characteristics of polyamides are largely influenced by the 3D conformation of the oxygen, hydrogen, carbon and nitrogen atoms in their structure.

The low specific weight of polyamides is an advantage for their use in the medical field, the transparency of the dressings made of this material, offering medical staff the possibility of viewing the covered anatomical structures [8-10].

The chemical structure of polyamide allows the creation of dressings with a smooth surface, characterized by low adhesion, as well as a high resistance to abrasion, particularities that constitute an indisputable advantage in terms of the dressing change procedure.

In this context, skin grafts applied on a polyamide support, maintain their adhesion to the recipient anatomical area, detaching very easily from the protective dressing. Increased flexibility, abrasion resistance and hydrophobic character are also advantages of using polyamide fabrics for dressing skin grafts. The specialized literature shows and the experience of the specialists confirms that polyamide fabrics have a higher resistance to abrasion than cotton, being 5 times higher than wool [11].

The most frequently used polyamides are nylon 6 and nylon 66, which have increased applicability in the textile industry, the automotive industry, as well as in the industry dedicated to the production of sanitary materials [12-14].

The physical and chemical properties of polyamide have been intensively studied, the enthusiasm of the international scientific community being stimulated by the increased biocompatibility of this chemical compound. Research results revealed that by combining polyamide with hyaluronic acid and chitosan, a high antibacterial effect is obtained, thus substantially increasing the use of polyamides in the medical field, by widening the scope of applicability [15].

The increased tensile strength, high flexibility and low ability to stimulate the immune system have been the basis of its widespread use in the medical industry, so that polyamide is currently used to make sutures, venous catheters, medical prostheses, as well as different types of dressings. The 3D modeling capability also opens up opportunities in terms of making customized prosthetic materials (Figure 2).

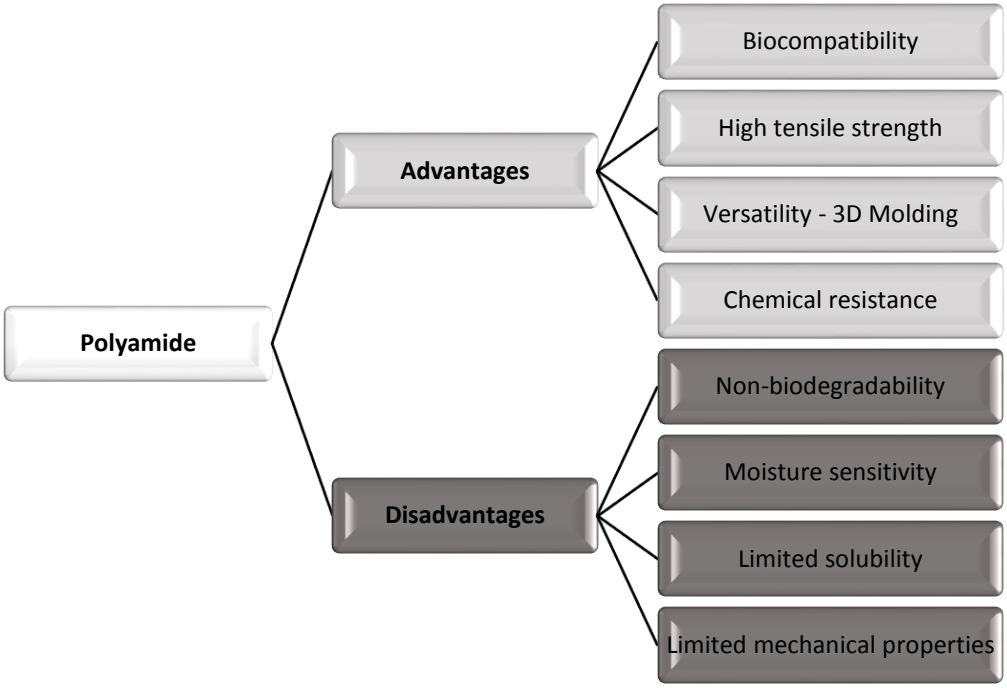

Figure 2. The main advantages and disadvantages of polyamides

The increased resistance of the chemical structure allows the use of medical products made of polyamide, along with a wide range of other chemical substances used to achieve asepsis and antisepsis (Figure 3).

Figure 3. Micrografting sugical kit -Image shows the polyamide fabric, the rectangular cork plates and the incission device

At the same time, its chemical peculiarities facilitate the creation of bioresorbable prosthetic materials, used in situations where temporary prosthetics of anatomical structures undergoing regeneration are necessary [16-17]. The increased biocompatibility contributes to the decrease of the risk of adverse reactions at the level of the tissues in contact with the polyamide medical products.

The increased modeling capacity allows the creation of personalized prosthetic materials through 3D printing, significantly increasing the applicability of prosthetic materials made of polyamide.

From the category of synthetic polyamides, nylon is the most frequently used in the medical industry, its properties recommending it for use in the production of angioplasty balloon catheters because its flexibility allows distension for the treatment of vascular obstructions [18-19]. The increased resistance of the device allows it to perform the unobstruction in the conditions of an increased pressure regime determined by the contractions of the heart.

In light of the above, polyamide is a chemical compound that has significantly contributed to the development of the medical industry, by offering new opportunities in terms of the shape, resistance and quality of biomedical products.

2. Materials and method

To carry out the study, two batches were created, the first batch included the data obtained from the use of 100 micrografting kits with a polyamide support, the second one was made up of the data obtained from the performance of 108 plasties with split free skin grafts, by the classic method, characterized by the use of cotton textile support.

The databases were structured in such a way as to provide relevant information regarding the comparative analysis between micrografting on polyamide support and classical grafting, from the perspective of the influence of these techniques on the healing period, the rate of integration of the grafts, as well as the overall rate of postoperative complications.

Surgical technique

In order to perform the micrografting technique, excision of the burn lesions was performed, followed by harvesting the skin grafts with electrodermatome. After harvesting, the skin grafts were sectioned by perpendicular chessboard incisions. In the next step, the grafts were attached to the polyamide fabric using the adhesive in the kit and were left for 3-5 minutes to increase adhesion to the polyamide dressing. Subsequently the polyamide fabric was expanded at angles of 90^0 in order to increase it's surface. After expansion the polyimide dressings were applied to the recipient area and fixed in position using a steppler (Figure 4).

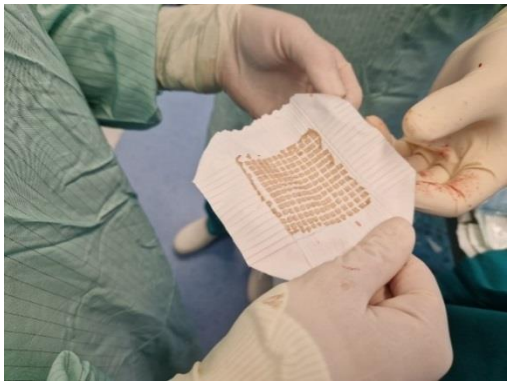

Figure 4. The expanded polyamide fabric after applaying the skin graft islands

Classical grafting was performed by harvesting skin grafts from the donor areas and applying them to the recipient areas after excision of the burn lesions.

Regarding the quality of the surgical teams' practical experience in performing the main interventions and daily dressings of the patients included in the study, a questionnaire with 5 questions was developed. To complete the questionnaires, the members of the surgical team rated the quality of the experience from 1 to 10, depending on the type of intervention.

The first question was dedicated to understanding the degree of difficulty of the main surgical intervention, from the perspective of the plastic surgeons involved in the study. In this regard, the operating team answered the question "*How do you rate the degree of difficulty of the main surgical*

intervention?", awarding marks included in the range of 1 - 10, according to the quality of the surgical experience.

The second question was formulated to provide information on the degree of complexity of the dressing change procedure. In order to obtain these data, the surgeons provided answers according to their own experience to the following *question "How do you rate the degree of complexity of the dressing change procedure?"*

The third question was designed to assess the total duration of the daily dressing, with the operative team answering the question *„How do you assess the total duration of the daily dressing change procedure?"*

In order to obtain relevant information regarding the ease of handling the support material, the question *„How do you evaluate the degree of difficulty of removinf the support material of the grafts?"* was developed.

The overall therapeutic experience was analyzed by completing the answers to the question *"How do you rate the entire surgical experience, including the stages of grafting, nursing and removal of the supporting material?".*

The patients included in the study had burn injuries of IIB-III burn degree, covering surfaces between 15% and 45 % body surface.

The data were processed in the Microsoft Excel system, in order to identify the averages, the median and the statistical significance of the information obtained as a result of the research.

3. Results and discussions

The analysis of the healing period associated with the micrografting technique revealed an average lenght of hospitalization of 45 days, compared to 63 days in the case of the group of patients (II) who benefited from grafting by classic method of plasty with free split skin graft, in the context of the existence of larger residual lesioms in the case of patients included in group II.

The graft integration rate recorded values of 87% in the case of patients who benefited from micrografting, compared to 84% in group II. The physical properties of the polyamide being interpreted by the operative team as the determining factor of difference, in the context of the low adhesion of this polymer to the receiving surface, compared to the cotton tulle, which has an increased tendency to integrate.

Regarding the overall rate of postoperative complications, it recorded values of 6% in the case of group I, for patients in group II (classical full-thickness skin grafts) to register a complication rate of 9%. Complications identified in the study were: hemorrhage, graft infection, donor site infection, and delayed healing.

The results of the subjective analysis of the surgical experience regarding the treatment of burned patients, by the two methods, revealed the superiority of micrografting in 4 of the 5 aspects included in the questionnaire (Table 1).

Tabel 1. Questionare result from the surgical team perspective

Question	Full-thickness skin grafts	Micrografting on polyamide support
1. How do you rate the degree of difficulty of the main surgery?	8	9
2. How do you evaluate the degree of complexity of the dressing change procedure of the burned patients included in the study?	9	5
3. How do you rate the total duration of the daily dressing change procedure?	9	7
4. How do you rate the degree of difficulty of removing the graft support material?	9	6
5. How do you rate the entire surgical experience, including the stages of grafting, nursing and removal of the support material?	7	9

The results of the analysis of the questionnaires obtained after they were completed by the members of the surgical team, reveal the fact that from a subjective perspective, the micrografting technique offers substantial advantages, in terms of the lightness of performing daily dressings, the polyamide compresses having a low adhesion to the recipient area (Figure 5).

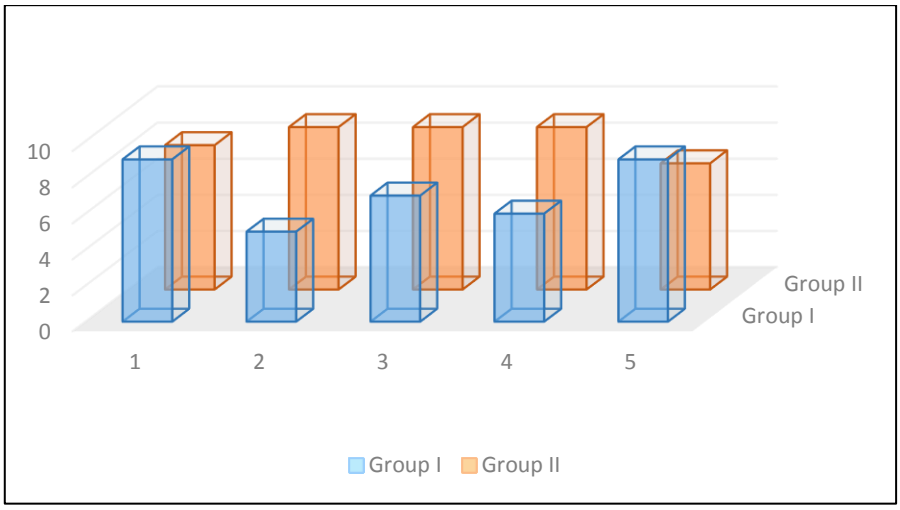

Figure 5. Questionnare statistics from the surgical team perspective

Polyamide dressings offer significant benefits over cotton dressings in terms of low adhesion, high chemical stability and hydrophobicity. The absorbent properties of cotton fabrics offer benefits in the case of their use for the dressing of intensely exudative lesions, however, this characteristic represents a disadvantage in the case of covering skin grafts, due to the increased risk of infection associated with the stagnation of pathological secretions at the level of these dressings. Polyamide, on the other hand, is inert from this point of view, the secretions being evacuated through the incisions made in the fabric, being taken over by the absorbent dressing that is changed daily, thus significantly reducing the risk of septic complications.

The increased adhesion of cotton compresses is a disadvantage of this type of dressing, often associated with damage to the graft when the dressing is changed. The chemical structure of polyamide, as well as its physical characteristics, significantly reduce the adhesion of dressings to the graft, damage to the grafts during dressing changes being an extremely rare complication.

4. Conclusions

The polyamide fabric offers significant benefits in terms of improving the prognosis of burn patients after grafting, accelerating the process of graft integration in the context of limiting liquid losses from the wound. The physical properties of polyamide allow easy detachment of the dressing from the receiving area, thus limiting additional injuries associated with changing the dressing. Micrografting is a very good solution for solving complex cases, especially for patients with extensive burns that exceed 30% of the total body surface.

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