

Formalizing the conceptual-applicative framework of smart textile fibers in medicine

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REZUMAT – ABSTRACT

Formalizarea cadrului conceptual-aplicativ al fibrelor textile inteligente în medicină

Articolul abordează probleme legate de domeniul disciplinar al chirurgiei medicale, care impune caracteristici deosebite ale fibrelor, cu potențial fizico-chimic și proprietăți de rezistență puternic controlate. Clasificările propuse și liniile de abordare a fibrelor textile în medicina generală și, în particular, în chirurgie, sunt de natură teleologică și, în egală măsură, reprezintă premise pentru o taxonomie generică în domeniu. Propunerea originală în acest cadru este de abordare extinsă a multi-tipo-dimensiunilor de fire chirurgicale în intervențiile clinice specifice, pornind de la constatarea că, în fapt, cantonarea în tipo-dimensiunea fixă/forma exclusivă circulară a firului chirurgical înseamnă stagnare, temperarea inovării de granita în domeniu.

Cuvinte-cheie: industria textilă, fibre textile inteligente în medicină, taxonomie generică în domeniu

Formalizing the conceptual-applicative framework of smart textile fibers in medicine

The article addresses issues related to the discipline of medical surgery requiring special fiber features with physicochemical material potential and strongly controlled resistance properties. The proposed classifications and lines of approach of textile fibers in general medicine, and in particular in surgery, are of a teleological nature and equally are prerequisites for generic taxonomy in the field. The original proposal in this context is to expand the multi-type dimension of surgical wounds in specific clinical operations, starting from the finding that in fact cantoning in the fixed-type size/exclusive circular shape of the surgical thread means stagnation, moderation of innovation of rupture in the field.

Keywords: textile industry, smart textile fibers in medicine, generic taxonomy in the field

INTRODUCTION

The use of textile materials (fibers, fabrics, yarns, bands, etc.) in preclinical and clinical medicine implies a feasible knowledge of: 1) the physico-chemical properties of the textile material, 2) the structure explained by the properties, 3) the chain of molecules in the fibers of the fabric, 4) the considerable effects induced on the human body at the "fiber-skin" contact in surgery, etc. Textile fiber is the natural, artificial or composite material characterized by its long length, extremely low thickness (thinness), fineness and flexibility. It is recognized that in the usual manufacturing of textiles system, artificial polymers play a decisive role in vinyl (including acrylic), polyamides, polyolefin, polyesters, to which natural polymers, namely proteins and cellulose, are added. In clinical medicine, from the perspective of physical properties, basic requirements for textile fibers are imposed starting from: 1) breaking strength, 2) continuity, 3) as long as possible, 4) extensibility, 5) elasticity. In medicine, in our opinion, it is of interest to use "smart fibers" that could translate various values of medical knowledge recorded in surgical sites in the human body.

RELATED LITERATURE

In papers elaborated by Hearle J.W.S. and Morton W.E. (2008), [6], Horrocks A.R. and Anand S.C., (2000), [7], Dattilo P. et al., (2002), [3], Nelson G., (2002), [11], Czajka R., (2005), [2], Tao X., (2001),

[12], etc. there are presentations, descriptions, assertions, conceptual and practical approaches to textile fibers used increasingly in medicine. Intelligent/smart textile and clothing are topics described by Mattila H., (2006), [10], also van Langenhove L., (2007), [13], describes significantly aspects related to smart textiles for medicine and healthcare. Particular concerns in the field are also found in the works carried out by Anand S.C., et al., (2005), [1], respectively Lymberis A. and Olsson S., (2003), [9], which highlights the role of biomaterials in the smart biomedical area. A particular sub-domain is that of the yarns of surgery textile fibres for suture. Textile surgical implants are used in methods of intracorporeally suturing issues (Ellis J.G., 2013), [4], which add method of attaching surgical needles to multifilament polyglycolic acid absorbable sutures (Epstein M. and Schmidt E., 1971), [5] It can be noticed that the scientific literature in the field has updated topics, and fiber textiles are perfected in line with the accelerated technological progress in invasive/non-invasive medicine.

EXPERIMENTAL WORK

Methods, classification and specific remarks

Some polysaccharide-type fibrous substances found in "chitin" are medical uses by derivative chitosan. In the context, the constituent presence of alginic acid occurs when the fibers obtained are highly crystalline

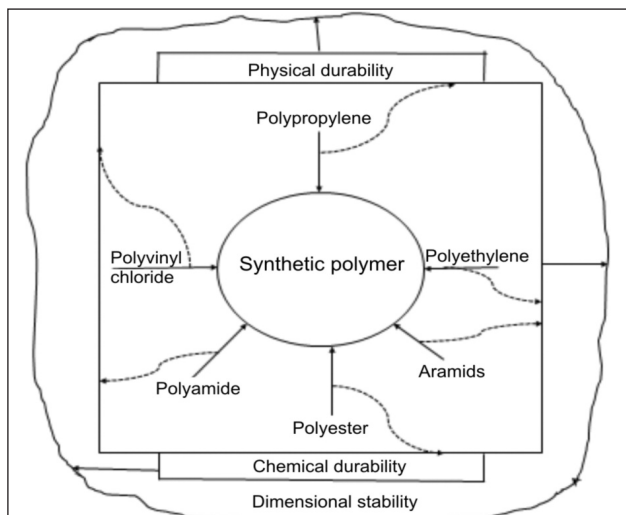


Fig. 1. Suitable synthetic polymers for medium to long applications in civil and agricultural engineering (Source: Authors, 2017)

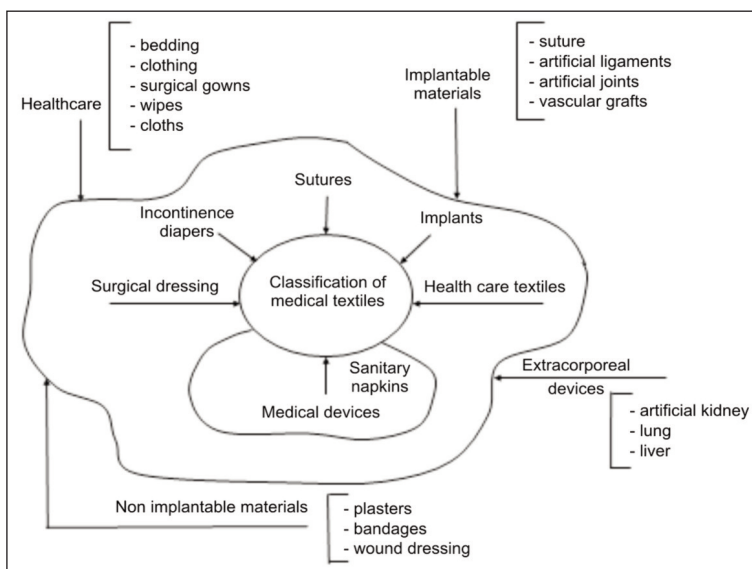


Fig. 2. Characterization of classification of medical textiles (Source: Authors, 2017)

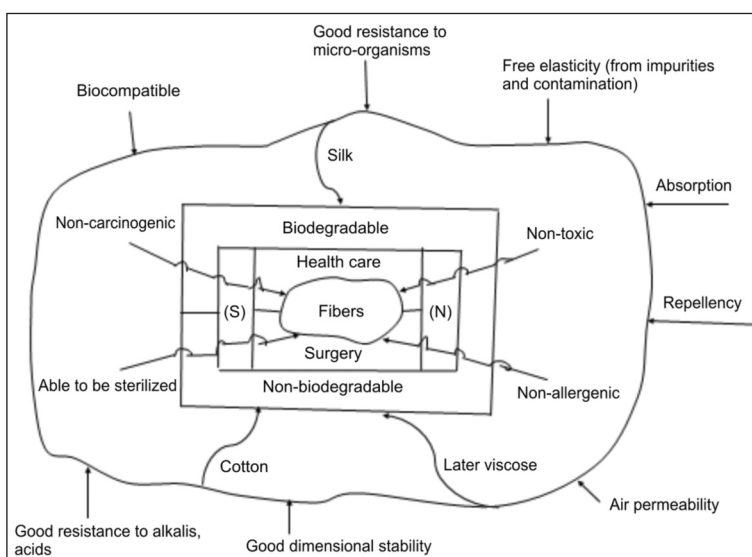


Fig. 3 Characteristics of textile fibers (types) used in health care and surgery. (Source: Authors, 2017)

and real oriented. These yarns are subject to degradation because of their acidity, but different metal salts neutralize their rate of dissolution/disappearance. Medical fibers require biological compatibility. In the context, "smart fibers" have to prove special properties that mainly refer to radiation-absorbing, biological, electrical, diffusion, magnetic, etc. They could serve as thermo regulators, responsive to various stimuli, passive electronic instruments, transducers, etc. It is already recognized that certain substances/piezoelectric materials such as polyvinyl fluorides ($\text{CH}_2\text{-CF}_2$) prove piezoelectric properties, configuring classes of particular polymers, and the addition of carbon to provide electrical conduction improves their range of uses in medicine. It is worth noting that in addition to the chemical and physic-mechanical properties, the dimensions of medical textile fibers are of crucial importance in modern medical applications. Optimum lengths of 1–10 cm,

0.1 mm convolution spacing, 10 micrometer diameter diameters, lamination up to 0.1 micrometers, making micro-fibrils with dimensions of 10 nm are dimensional requirements/already generally required for textile fibers used in medicine. Moreover, it reaches this frame and dimensions such as molecular width of 1 nm, knowing that atoms of C, N, O, H can reach 1 \AA (10^{-8} cm). In the traditional view, when the fibers are in the group it is appreciated that long fibers ensure cohesion, and short fibers sustain breaks. Typically, the fibers are present as amorphous sub-portions that support infrastructures: a) partially crystalline, b) linear polymers or c) partially oriented. Jeffries R., et al. (1969) [8], shows that structural clutter can occur in the textile material, for example when natural polymers such as celluloses are contacted with various other degradation substances. The author shows, by way of example, that the cotton effects in disordered textiles are: non-freezing water (16%), acid hydrolysis (10%), alcoholysis (10%), dinitrogen tetroxide oxidation 43%, iodine sorption (13%), etc. We find that synthetic polymers found in artificial textile fibers have applications in civil and agricultural engineering (figure 1).

Combination of medical science and textile technology offers a new research alignment and applications for medical textiles. We note, however, that the development of new fibers is conditional on manufacturing technologies (figure 2). The disciplinary field of medical surgery requires, however, special features regarding fiber, which must have physico-chemical material potential and strongly controlled resistance properties (figure 3).

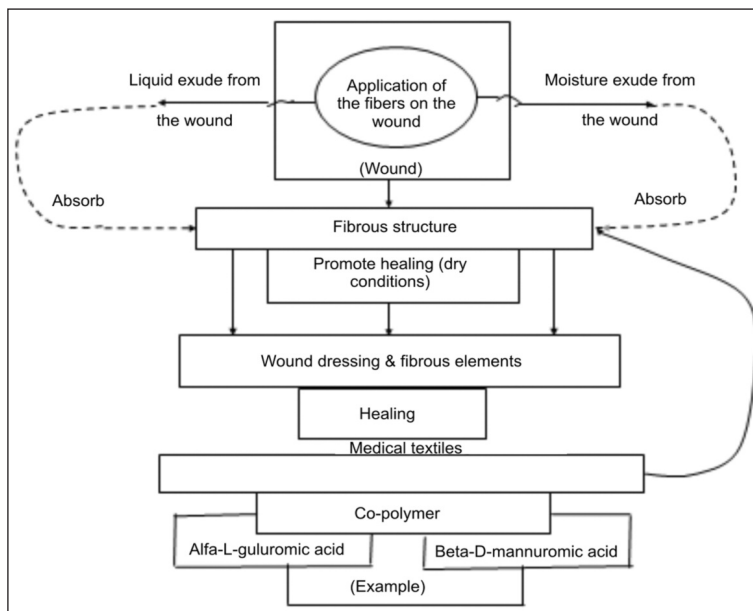


Fig. 4. Conditions of fibrous structure to respond compliant to applications on the wound. (Source: Authors, 2017)

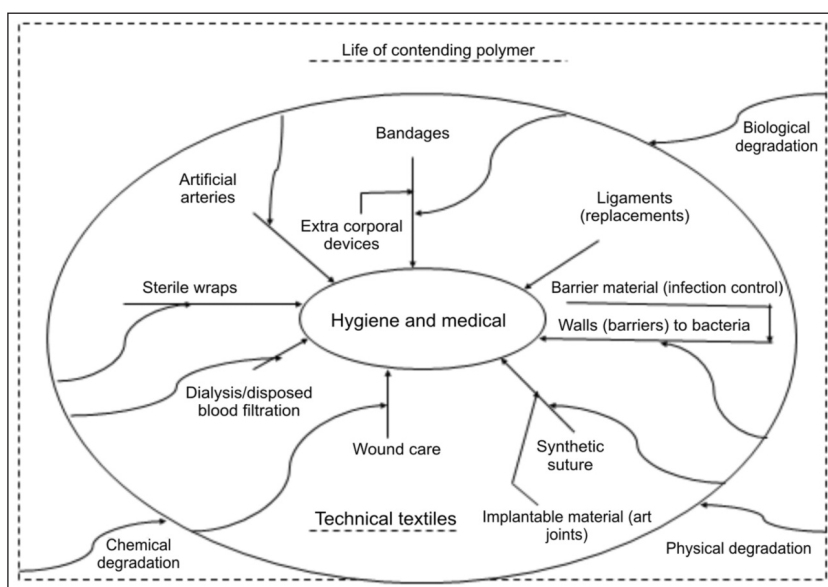


Fig. 5. Application of technical textile in hygiene and medical. (Source: Authors, 2017)

In the context, the fibrous structure must respond with real physical compatibility to the applications on the wound (figure 4).

In the same general medical framework, special textile fibers must respond with specific compatibility with the health and medical conditions (figure 5).

The above proposed classifications and lines for approaching textile fibers in general medicine, and in particular in surgery, are of a teleological nature and equally are prerequisites for generic taxonomy in the art.

RESULTS AND DEBATES

Characterization of intelligent/smart yarns/fibers in surgery operations

In surgery, the specific yarns/fibers used have the circular section, in all the usual cases, for all types of

interventions known in the present, when there is a need for osmotic articulation of the different portions of the human body upon which incision has occurred. Circular sections (S_c) are calculated with the relationship:

$$(S_c) = \pi r^2 \quad (1)$$

with r = radius (1/2 of the thickness) of the textile thread.

In the context, for a range (0,...,1) it is possible to vary the circular section (thickness) as follows:

$$(S_c)_0 - (S_c)_i = (\pi r^2)_0 - (\pi r^2)_i \quad (2)$$

with the conditions:

- 1) $r_0 > r_i \sim (S_c)_0 > (S_c)_i$ = decreasing thickness, (i)
- 2) $r_0 = r_i \sim (S_c)_0 = (S_c)_i$ = maintaining thickness, (ii)
- 3) $r_0 < r_i \sim (S_c)_0 < (S_c)_i$ = Increasing thickness, (iii)

The surgical user's case of special thread working in the operating theaters shows the quasi-absolute frequency of the situation (ii). Our proposal in this traditional setting is to expand the multi-type dimension of surgical thread in specific clinical operations, starting from the finding that in fact cantoning in the fixed-type size/exclusive circular shape of the surgical thread means stagnation, breakthrough innovations in the field. The advantages of such an approach are to establish an optimal linear density through the longitudinal variation of the size of the surgical cord radius, creating optimized quantitative desorption conditions in a controlled time. Next, it is possible to switch to the geometrical remodeling of the section

of the surgical wires, reaching the ellipsoidal, rectangular, square, or irregular shapes of the sections, which, in accordance with the requirements of the surgical operations would mean the revolution of the products of this type in the field, chosen when feasible solutions are found for the biological degradation of technical textiles (figure 6).

In fact, we have to deal with the harmonization of the former sectional of the surgical thread with surgical suture requirements so that quantitatively and in time to provide optimized alignments for controlled, effective resorptions. Some properties, such as torsional rigidity, degree of thickening, in/non-uniformity, variability of fineness, etc. are otherwise perceived/measured when considering transverse forms and dimensions.

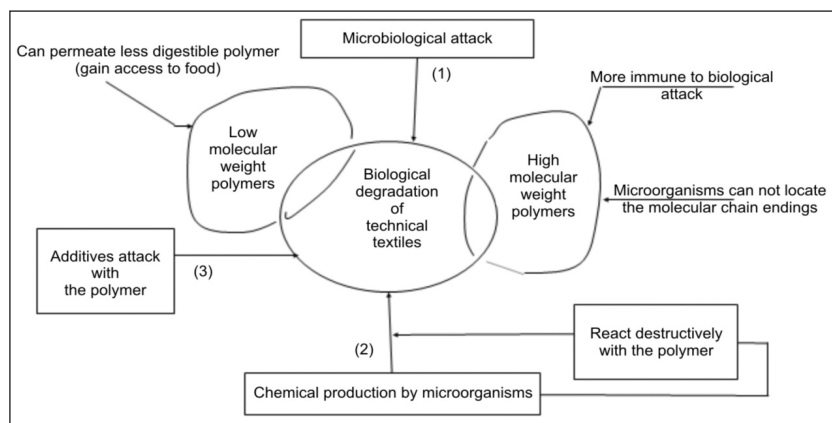


Fig. 6. Some issues on biological degradation in medical of technical textiles. (Source: Authors, 2017)

CONCLUSIONS

Geometric remodeling of the section of surgical wires means reaching the ellipsoidal, rectangular, square,

recommended that an extended approach of multi-type-sized surgical wires be performed in specific clinical surgery operations.

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