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Research into Materials Used in Abdominal Wall Repair

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Abstract

The future of research in the treatment of hernia is directed mainly in two ways. The first is in genetic research, focusing on the goal of preventing the occurrence of hernia. The second (and more realistic), addresses the introduction of a new generation of biomaterials and surgical techniques that minimize aggression hernia repair, reduce surgical time and facilitate post-operative recovery of these patients. In this second line of action appear the most important advances in the field of minimally invasive techniques and materials used to repair the hernia pathology.

The development of materials currently employed in hernia surgery has focused almost entirely on improvements on the screens, coatings and methods of fixation. The point has been reached of trying to unite these concepts, creating new self-adhesive mesh, coated meshes of various substances that incorporate improvements in both fields of research.

Keywords: Abdominal wall; Hernia; Mesh; Coating; Fixation; Stem cell, Growth factor

Introduction

The current trend is to use biologically inert meshes with an integration capability, large pores, and small amounts of material that are easily manageable [1].

What innovation can be added to these meshes?

We highlight three ways to improve the actual meshes, in relation to fixation, the placement of the mesh and coatings. We have experimented *in vitro*, *in vivo* and with patients in all of this three areas and we reflect on the actual and future lines below a reflection of the actual and future lines of strategical research in abdominal wall prosthesis [1-3].

Self-fixing

Incorporated mechanical systems (Adhesix*, Parietene Progrip*): Grips or other systems that can fix the mesh properly and with an equivalent stabilization to that of conventional sutures (Figure 1) [4].

Adhesives that dissolve on contact with tissues: absorbable films attached to mechanical systems (e.g. collagen film and glycerol are quickly absorbed, Adhesix[®] and Progrip Laparoscopic[®] this film can be used in laparoscopy to introduce the mesh through a trocar, like any other mesh without requiring specific preparation).

New activated biological adhesives: Increasing angiogenesis and fibroblast growth, enriched with growth factors, which totally replace the mechanical fastening [5].

Placement of the mesh

Three-dimensional meshes: These meshes have their main use to be introduced in small spaces; meshes with memory for self-expand. (Composix Kugel[®], 3DMax[®]) [1,3].

Positioning systems (laparoscopic surgery): EchoPS[®], AccuMesh[®], positioning using magnets, etc.

Coatings

Activity against infection

- Antiseptics (derivatives of chlorhexidine (Dual Mesh Plus®), Triclosan (Vicryl Plus suture®)

- Antibiotics (vancomycin, cephalosporins)

- Metals (silver carbonate (Dual Mesh Plus®)

Our research group has experimented with absorbable mesh (Gore BioA*) embedded in antibiotics (cefazolin), with excellent results against bacterial infection caused by *S. aureus inocula*. (Figure 2) The problem of joining the mesh pre-made which already contains antibiotic, is the possible side effects or risk of intolerance overdose. That is why the possibility of incorporating an slow-release antibiotic from prolonged septic field, and include those antibiotics selected as the result of a previous antibiogram, seems more attractive for the future. The problem is the dosage: the antibiotic release coefficient should be calculated and will vary depending of the mesh material [6,7].

Decreasing the adhesion to prosthetic material and improving integration

- Metals (titanium (Timesh*))

- Fatty acids (omega 3 (C-QUR*)).

In the experimental surgery we performed tests on using the fatty acids of the monolaurate family; the bactericidal activity *in vitro* has been published before in the literature. The shape of the mesh soaked in these acids is complicated because should be dissolved in alcohol solutions, but both *in vitro* and *in vivo* they have demonstrated very promising activity against infection. We have not applied its use to the field of adhesions, although I theory it could be helpful here too (Figure 3).

The results of mesh impregnated with omega-3 acid show that this cover maintains the advantages of integration versus polypropylene composites with a much lower adherence rate than that of tissues, which would allow intraperitoneal placement. Although human studies are still scarce, it is expected that the side effects of fatty acids are practically non-existent and tolerance is excellent, since the molecules are naturally in the organism, which means the reaction to a foreign

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Figure 1: Comparison between self-gripping mesh and conventional mesh fixed with sutures.



Figure 2: PGA-TMC mesh embedded in cefazolin. Mesh used to treat *S. Aureus* infection of the embedded absorbable prosthesis.



Figure 3: *In vitro* research using fatty acid coating in infected model with polypropylene meshes (left: cultivation of control in infected mesh; right: cultivation of infected and coated or soaked mesh with fatty acid).

body is minimized [8].

The general trend in coating is to use biologically active products (bacteriostatic-bactericidal, insulating barrier) harmless to humans: fatty acids, metals, polysaccharides (complex 2QR crusaders galactoarabinan polyglucuronic acid polymers), etc.

Activating regeneration: Stem cells: In the stem cell research, there are different lines of development that seek to replace the usual prosthetic materials with biomaterials that have better integration. In those studies that have shown better results, the stem cells have been used in various media or vehicles, such as biological matrix and meshes (both biological and synthetic) that already exist in the hospital industry. Although the results are presented as promising, no randomized studies comparing relapse rate and adhesion between the non-application or stem cells have been found; so it cannot be concluded that the results are attributable to the use of stem cells. Nor have any studies on this subject been found involving humans. Using a real fabric exclusively generated from stem cells that can be used as hernia prosthesis has yet to be achieved.

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- Growth factors (GF) may apply to fibroproliferative and angiogenic stimulators such as bTGF, bFGF and PDGF (very derivatives present in the fibrin glue, which increases angiogenesis, improving the integration of the mesh fixed with biological glues) [5,9-15].

In a brief reflection on the future of these strategies is noteworthy that further progress in hernia surgery: promising new lines of research with autologous biologic meshes, or coated stem cells, growth factors and similar cell implants. Undoubtedly, the future is slowly leans meshes with autologous tissue that is absorbable over a medium–long period of time, with the idea of creating a genuine regeneration of the abdominal wall using a synthetic matrix. The idea is to avoid the use of exogenous material and force the body to create its own tissue capable of repairing the defective wall.

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