

AGAR-AGAR/COLLAGEN RESORBABLE MONOFILAMENT SUTURE

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Abstract- Suture materials are classified into two broad categories: resorbable and nonresorbable. Resorbable sutures lose their entire tensile strength within 2-3 months, while nonresorbable suture materials retain their strength longer than 2-3 months. Actually, the classical suture material used is a fell expensive. This paper present a procedure for produce a resorbable sutures are made from blend Agar-Agar and collagen (A-A/Col), using a roto spinning of the polymers solution. The applicability of new material is a good example of resorbable suture material to future surgery.

Keywords - Agar-agar; collagen; suture material; resorbable material

I-INTRODUCTION

Enormous advances have been made to development of better suture materials. The classical suture materials are the proteinaceous catgut and silk [1]. Improved understanding advances have enabled us to obtain synthetic sutures with programmed absorption time, optimized tensile strength and minimal tissue reactivity. The development of absorbable monofilament materials which offer the benefits of easy glide and low tissue trauma as a result of their monofilament structure, and the capacity of gradual absorption within the healing tissues [2;3].

Absorbable sutures include plain gut (made from the submucosa of sheep intestine and serosal layer of cattle intestine), chomic gut (plain gut precipitated with chromium salts) synthetic polymers of polyglycolic acid (Dexon), poly-9-glycolide-lactide (Vicryl), polydioxanone (PDS), and polyglyconate (Maxon). Gut sutures are constructed primarily of interlacing collagen molecules; Maxon and PDS are monofilaments; Dexon and Vicryl are prepared as braids. These absorbable sutures are used when their presence is required temporarily. They incite varying degrees of tissue response and degraded by hydrolysis (dexon, Vicryl, PDS, Maxon) and enzymatic digestion and phagocytosis (gut). Each of these sutures behaves differently in the surgeon's hands and in host tissues [4].

Among natural polymers, agar is an unbranched polysaccharide with sulfate functional groups. Agar is a hydrophilic colloid extracted from marine algae of the class Rhodophyceae that composed structure of 1, 3-linked-d-galactose and 1, 4-linked 3, 6-anhydro-l-galactose units [5]. Collagen, a constituent of skins of animals, is one of the most abundant proteins and made up of polypeptide chains, with the conformation of a left-handed helix [6]. This protein is considered as an ideal material for biomedical applications with its innate biocompatibility, strength

through cross-linking, self-assembly, aggregation, and easily modifiable characteristics [7].

The biological and mechanical characteristics of new materials for suture need to be investigated in order that the surgeon can select the most appropriate for each surgical application. The present purpose is study the characteristics of a new resorbable monofilament suture we recently developed from Agar-Agar and collagen (A-A/Col) as a new monofilament sutures.

II-MATERIALS AND METHODS

Materials

Post to investigate the effect of viscosity composition to evaluate the eventual interplay between parameters connected to the solution and to the coagulation conditions during spinning the polymeric blend were prepared using water at 100°C as solvent and Agar-Agar and collagen at 90 and 10 wt% when drying. Water evaporation in solution was the maximum at 10%, after them the acetone were auditioned. The temperature of blend solution was adjusted between 60 and 85°C in order to achieve an optimal viscosity the suspension the type polymers for roto technique was used by preparation of the rotating spindle.

The monofilament sutures with USP sizes ranging from 0 to 5-0 were used. Commercially available sutures including PDS II®, MONOCRYL®, MAXON® were used for comparison.

Animals

Swiss male mice (30–35 g) were obtained from the Evandro Chagas' Animal Resources Center, Belém, Pará, Brazil. They were randomly assigned to two groups of 4 animals and maintained in plastic boxes, with food and water *ad libitum*, under a 12 h light/12 h dark cycle. The

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room temperature was maintained at 22 ± 1 °C. The animals were acclimatized to the laboratory for at least 1 h before the experiments that were carried out between 8:00 and 13:00 h in order to avoid circadian influence. All experiments reported in this study were carried out in accordance with current guidelines for the care of laboratory animals and ethical guidelines for investigation. All efforts were made to minimize the number of animals used and their suffering.

In vivo experiments.

Healthy animals mice were anesthetized with 20mg/ml Ketamine, 4mg/ml Xilazine; and 0,3 mg/ml Diazepan in 0.9% NaCl. One centimeter parallel lengthwise incision was made on the back of the mice. The (A-A/Col) were sterilized by ethylene oxide gas for 24 hr. The material was inserted into subcutaneous space and stabilized using suture. The mice were euthanized in CO₂ chamber 24 hours; 24 hours after implantation.

3D- cell culture

The NIH3T3 cells were cultured at a humidified atmosphere with 5%CO₂ at 37°C in Dulbecco's modified Eagle's medium (DMEM) and supplemented with 10% fetal bovine serum and 2% antibiotics (200mg/ml penicillium and 200mg/ml streptomycin). The (A-A/Col) were sterilized by ethylene oxide gas for 24 hr. The material were coated with fetal bovine serum were placed into 4-well culture plate, and the cells were seeded at 5×10^5 .

The proliferation of NIH3T3 cells on (A-A/Col) was determined using MTT (3-[4, 5-dimethylthiazol-2yl]-2,5-diphenyl-2H-tetrazoliumbromide) assay. The medium was removed and MTT solution (5mg/ml) was added to each well after 24 h, then incubation at 37°C for 4 h to allow the formation of formazan cristal.

III- RESULTS AND DISCUSSION L-*

The tensile strength of A-A/Col sutures used in this study is given in Table 1, also lists the strength of synthetic resorbable monofilament sutures currently available. It is seen that A-A/Col sutures have a slightly lower tensile strength than currently available sutures, irrespective of their diameter. In addition, we compare with PLA/PCL (lactide/caprolactone copolymer) used by Tomihata et al 1998. Our result demonstrated that the A-A/Col suture material present a specific tensile strength when compare to commercial and Tomihata et al 1998 [8].

As shown in figure 01, after 24h of implantation of (A-A/Col) in subcutaneous tissue, was observed the absence of material insight the subcutaneous tissue (Figure 1). The qualitative examination of the suture material present in the biopsies revealed: complete absorption of (A-A/Col) 24 hours after execution of the suture. The data obtained from this study correspond with the modality of absorption of the absorbable monofilament sutures examined. The relevance of these findings in rats is debatable.

Table 1- Mechanical strength of A-A/Col and commercially available sutures before implantation.

	USP size	Diameter (mm)	Tensile strength (g)	Specific Tensile strength (g/d)
A-A/Col (90/10)	5-0	0,1415	1746	12.34
PLA/PCL (75/25)*	3-0	0,315	3098	3.63
PDS II®	3-0	0,298	3558	3.94
MONOCRYL®	3-0	0,292	4274	4.79
MAXON®	3-0	0,285	4602	5.30

Since the metabolic rate and body temperature are higher in the rat than in the human, Sewell stated that the rate of absorption and the tissue reaction would be smaller in the human than in the rat [9].

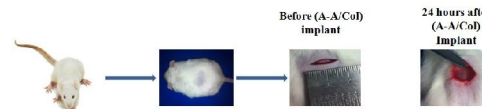


Figure 01: Qualitative assay of A-A/Col implant *in vivo*.

In the same case, the material was submerged in DEMEM with cells to *in vitro* test, but 12 hours after placement the material were not observed (Figure 2). Despite this, the MTT assay could not show cytotoxicity, in both groups cells and cells plus A-A/Col. It is indicating which the material at now presents a high absorbable and hydrolysis index. It is important to biocompatibility of A-A/Col, but we need change the formulation to improve the increase time of absorption.

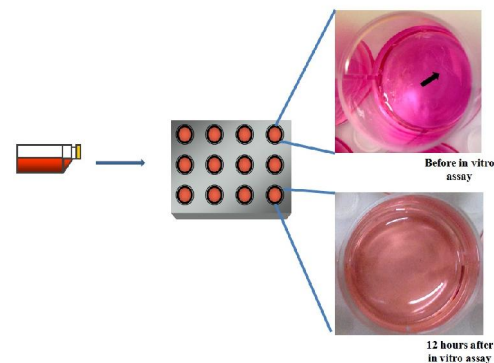


Figure 02: Qualitative assay of A-A/Col implant *in vitro*.

The most important attributes of agar is its ability to form hard gels at very low concentrations (0.04%) and it has been broadly utilized as a gelling agent in processed foods, pharmaceutical products and cosmetics, besides applications in biotechnology and medicine [8]. Atef and colleague have demonstrated that suspension of cellulose was successfully

prepared via acid hydrolysis from microcrystalline cellulose that the most of the obtained nanoparticles were 30 nm. In the next step of our study, these NCC incorporated into agar films and properties of the prepared films were [9]. Due to its thermoplasticity, biocompatibility, biodegradation and moderate water resistance, agar has been tested as an alternative source for the petroleum plastic packaging materials [10]. It corroborate with our idea to use Agar to blend in suture material.

Therefore, Collagen-based biomaterials find several applications such as scaffolds, artificial tissue, prosthesis, drug carrier, and cosmetics. Collagen has been used as a suture material for many years, for example Catgut is the suture material more used in surgery, due to its controlled biodegradation rate and biocompatibility [11].

The catgut is from sheep intestine. Some main drawbacks of catgut sutures are: (1) Due to their natural origin, catgut sutures vary greatly in tensile strength from batch to batch', 'A rapid loss in tensile strength is always noted in the first days after implantation, when the suture has to withstand the high tension of the tissues maintained in apposition [12]; (2) A strong inflammatory reaction is observed in the first days after implantation [12]; (3) The material is very expensive.

IV-CONCLUSIONS

In conclusion, the newly developed A-A/Col suture is natural material strong, present biocompatibility but quickly biodegradable. Despite, it could be promising as a resorbable monofilament suture.

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