



# Monofilament Sutures in Digestive Surgery - Past and Present

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**Citation:** Izzo P, Izzo L, De Intinis C, Sibio S, Basso L, et al. (2023) Monofilament Sutures in Digestive Surgery - Past and Present. J Regen Med 12:1.

**Received:** 15-December-2022, Manuscript No. JRGm-22-83654;

**Editor assigned:** 17-December-2022, PreQC No. JRGm-22-83654 (PQ);

**Reviewed:** 03-January-2023, QC No. JRGm-22-83654;

**Revised:** 06-January-2023, Manuscript No. JRGm-22-83654 (R);

**Published:** 13-January-2023, DOI:10.4172/2325-9620.1000235

## Introduction

The most commonly used threads for the synthesis of fabrics are composed of organic, synthetic and natural fibers. The most commonly used organic material sutures are catgut and chromic catgut. The most used synthetic materials are polyester for multifilaments and prolene and polypropylene for monofilaments. The most commonly used natural fibres are linen and silk. The purpose of this work is to report the results obtained using the various suture materials in the preparation of the anastomoses, carried out on patients operated on the digestive system at the III Surgical Clinic in the period 1977-85. The decade from 2012 to 2022 was examined with the same surgeons but with the introduction of new synthesis' devices.

These devices (stappler, mechanical stapplers) have standardized the procedure in open surgery, video-laparoscopy and in the last decades

in robotic surgery too: all surgeons have the possibility to work in the same way and surgical times have been reduced. However, there are still some manual sutures such as choledoch-duodenum, ureter-bladder anastomoses, all the transplant anastomoses and vascular sutures.

## Materials and Methods

From February 1977 to May 1985 n.154 intestinal anastomoses, of which 93 male and 61 female patients (Table 1). In particular, 29 right hemicolectomies, 23 anterior sigmoid resections, 7 sub-total colectomies, 21 left hemicolectomies were performed. In 48 cases the anastomosis was made in monofilament, while in the other 106 cases traditional materials were used (Table 3).

From 2012 to 2022 168 intestinal anastomoses were performed with the stapler (Table 2).

## Results

In the 48 anastomoses performed with monofilament, the canalization took place on average on the third-fourth day, while the hospital stay was fifteen-eighteen days. In the other 106 anastomoses performed with multifilament, the intestinal canalization was restored on the fifth to sixth day and the patients were discharged on average in eighteen to twenty days.

The most frequently observed complications, related to the anastomosis, were infection and dehiscence. As regards dehiscence, in the first group (monofilament) six cases of infection and two cases of dehiscence were observed, when the suture was performed in a single layer and no cases in the double layer anastomosis. In the second group of patients in which the anastomosis was made using multifilaments, there were ten cases of infection and three dehiscences, between the single-layer anastomoses and four cases of infection and one dehiscence in the double-layer ones (Table 4,5).

Instead, analysing the data collected with our study, it has been possible to observe that with the mechanical stappler the recovery of normal bowel function has occurred during the third day after the surgical operation and dehiscences have been reduced such as the recovery-days. On the contrary, as concerns the mechanical devices' costs, they are as expensive as they were in the past.

**Table 1.** Casuistry from 1977 to 1985.

Ileocolic anastomosis	29
Colocolic anastomosis	21
Ileorectal anastomosis	7
Colorectal anastomosis	23

**Table 2.** Casuistry from 2012 to 2022.

Ileocolic anastomosis 31 (OPEN) 9 (VIDEOLAPARO) 11 (ROBOTICA)
Colocolic anastomosis 39 (OPEN) 10 (VIDEOLAPARO) 9 (ROBOTICA)
Ileorectal anastomosis 5 (OPEN) 11 (VIDEOLAPARO) 7 (ROBOTICA)
Colorectal anastomosis 8 (OPEN) 15 (VIDEOLAPARO) 13 (ROBOTICA)

**Table 3.** Colorectal anastomoses-Traditional sutures.

Traditional Sutures	
Material	Natural, Synthetic, Metallic
Characteristics	Sterility, Resistance, Knot strength, Manageability, Capillarity, Tolerability, Absorbability
Choice	Synthetic monofilament (polyamide, polypropylene)
	Metallic
	Natural multifilament (silk), Synthetic (polyester, polyglycolic acid, polyglactin 910), Metallic
Suture layers	Single layer
	Double layer
Surgeon's habits	

**Table 4.** Colorectal anastomoses- Double layer.

Double Layer			
Sutures	No. of cases	Dehiscence	
		No.	%
Cotton 3 « O » Chromic catgut 5 « O »	218	17	9
Silk 3 « O » Chromic catgut 5 « O »	20	3	15
Multifilament 5 « O » Chromic catgut 5 « O »	17	4	24,5
Chromic catgut 3 « O » Chromic catgut 5 « O »	6	3	50
Polypropylene 5 « O » Chromic catgut 5 « O »	4	1	25
Multifi. Dacron 5 « O » Chromic catgut 5 « O »	2	1	50
Total	267	29	10,8

(H.D. Trimpi, 1977)

**Table 5.** Colorectal anastomoses- Monolayer.

Monolayer			
Sutures	No. of cases	Dehiscence	
		No.	%
Metallic monofilament 5« O »	588	15	2,56
Metallic multifilament 5« O »	1115	7	6
Mersilene 5 « O »	7	4	57,1
Propylene 5 « O »	4	1	25
Nylon monofilament 5 « O »	3	1	33,3
Total	1717	28	3,9

(H.D. Trimpi, 1977)

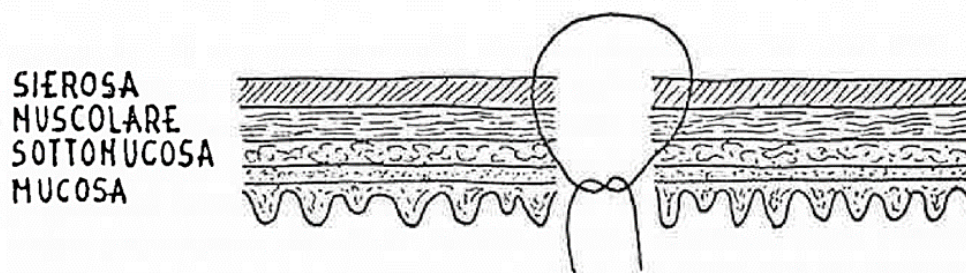
## Discussion

The characteristics that must guide the choice of suture material, especially in digestive surgery, are: sterility, softness, knotability, smoothness, low capillarity, compatibility with tissues, possibility of being colored, resistance to tension, reduced elasticity; all of which can be generically defined as manageability [1-6]. Today the absolute sterility of the suture materials avoids those infections, previously described in the literature, due to the bad sterilization of the suture threads; as a result, dehiscences due to this cause have been reduced.

Softness is the peculiar characteristic of silk and linen threads and of almost all multifilaments (synthetic or not); this also entails good knotability especially as regards silk and linen. The tightness of the knot is characteristic of multifilaments however, if intertwined, they are rough and therefore not very suitable for making continuous sutures; they can also have a saw effect on the tissues (**Figure 1**). The

term handling of a suture material also includes the property of being visible in the operating field; in fact the suture threads are produced already colored with natural substances well tolerated by the body, the most used colors are blue, black, and green.

The non-capillarity of the thread is an important characteristic for a good suture material to be used in abdominal surgery [7-12]. By capillarity we mean the ability of liquids to progress spontaneously in very confined spaces; this phenomenon is present in multifilaments which allow both the organic liquids and the microorganisms contained therein to pass between the interstices of the individual fibers; this phenomenon is called "wick effect" (in abdominal surgery it is also called "night bile"). An attempt has been made to eliminate this drawback by coating the multifilaments with silicone or Teflon and thus making them partly waterproof; many Authors, in fact, believe that the capillarity of the suture materials is responsible, in many cases, for dehiscences, foreign body granulomas and prolonged inflammatory reactions [8].



**Figure 1.** Suturing of submucosa muscular serosa.

The antigenic power of suture materials is a further problem. In fact, it has been demonstrated that all threads commonly on the market cause the release of histiocytes, granulocytes and inflammation mediators within the organic tissue: that is a real foreign body reaction of varying intensity depending on the materials used [13-20]. This reaction naturally negatively affects the healing times of the anastomosis and persists until the suture material is expelled or completely reabsorbed.

As regards the “disposable” staples of the mechanical staplers, it has been seen that of all the suture materials, stainless steel is the one that stimulates the least reaction and is covered in a short time and incorporated in a sort of cicatricial connective tissue capsule. Until some time ago (about 45 years) the materials most used in digestive surgery were catgut, silk and linen, synthetic suture materials did not yet exist on the market [20-22].

It has been demonstrated [23] that organic and natural threads can create major drawbacks due to their structure, there were also problems inherent in sterility. For example, catgut polluted by pathogenic germs has been responsible for frequent cases of tetanus [12]. Sterilization by heat causes the denaturation of the proteins in the catgut and this considerably reduces its tensile strength; moreover, the thread introduced into the tissues is reabsorbed in a few days [24-27]. The same goes for linen and silk which, if sterilized in an autoclave more than once, lose their tensile strength. The problem has been solved as sterilization is now achieved by “ethylene oxide” or radiation; both methods are effective both against bacteria and spores without altering the quality of the sterilized material.

Researches [28] on the problem of the body’s antigenic response have shown that catgut threads cause the most intense and prolonged reactions since they have a high antigenic power (being heterogeneous animal proteins). Natural fibers and synthetic threads which have little antigenic power follow in order. The organic materials (simple catgut in particular), once introduced into the tissues, moisturize, hydrate and consequently lose much of their holding power; furthermore as already mentioned, they determine a considerable inflammatory response with the attraction of polymorphonuclear cells and macrophages which in a short time denature the thread used and eliminate it by phagocytosis. Consequently, the safety of the seal and therefore the tensile strength of the catgut does not exceed seven days; in tissues with normal scar evolution it is reabsorbed in about two weeks, if an infection superimposes itself at the level of the anastomosis, its tensile power is lost within a few days. Furthermore, the gastric, biliary, pancreatic and enteric juices digest it within a day or so. All these reasons discourage the use of catgut in intestinal anastomoses. Catgut can find indications only in muco-mucous sutures or in those performed at full thickness for the

purpose of carrying out hemostasis; the seal is entrusted to the serum-muscular suture performed either with silk or with linen. In biliary surgery, catgut is not recommended both for what has already been said previously, and for the considerable sclerotic reaction it triggers (long-term stenosis).

Synthetic materials such as polyglatin 910 (Vycril), polyglycolic acid (Dexon) and polydioxanone (PDS) are rigid polymers, devoid of antigenic power that stimulate an inflammatory and sclerotic reaction so slight as to minimally interfere in the normal wound healing process. Absorption does not occur by digestion as in organic materials but through a hydrolytic depolymerization process, which over time transforms the polymer into glycolic acid which in turn is eliminated by the kidneys and lungs. Reabsorption occurs uniformly and is completed within about ninety days and it does not appear that inflammation or anything else influences this process; their tensile strength decreases slightly over time (about 25% on the fifteenth post-operative day).

Non-resorbable synthetic materials, whether multifilaments or monofilaments, composed of prolene or polypropylene, generate a modest and limited inflammatory reaction, much lower than that produced by organic materials and natural fibers. They present considerable resistance to both physical and chemical agents, good handling, absence of capillarity, resistance and biological inertia. The main inconvenience is due to the poor hold of the knots, which have a tendency to untie so that it is generally necessary to tie more than five knots; this involves a considerable loss of time and a greater quantity of filament left in the tissues. Due to their characteristics, the latter described materials can be used to make very secure sutures without particularly interfering with the wound healing process; their stimulating action on fibroblasts is quite limited.

## Conclusion

In the light of the above facts, we believe that a suture thread suitable for digestive surgery must have the following characteristics: maintain a resistance to tension up to the moment of coalescence of an anastomosis; it should be rapidly absorbed so as not to form foreign body granulomas or stones in renal and biliary surgery; it should behave like biologically inert material, without causing particular tissue reactions; finally, it should have good handling characteristics and a color that is clearly evident compared to the dominant colour (red) of the operating field.

In the light of our experience and that of other Authors, it is advisable to use polymers and in particular those packaged in the form of monofilament, because they give fewer complications and give greater guarantees in biliary-digestive anastomoses.

On the basis of our experience, among all the old and new generation suture techniques, the most suitable ones, also in the light of experimental data are synthetic polymers and the modern mechanical devices (stapplers and mechanical stapplers). So in conclusion, according to our surgical experience, we agree that in Robotic Surgery the mechanical stapler could be the gold standard technique.

This substantial difference in percentage in favour of synthetic monofilaments can be attributed to the fact that, although they are absorbable like catgut, they maintain an adequate resistance to tension for the period necessary for the definitive coalescence of a suture and, moreover, they have a tensile behaviour which is well predictable. It has been demonstrated that for the polydioxanone monofilament the capillarity phenomenon is very reduced and the so-called "evening bile" does not occur in the post-operative period. The use of this material and of monofilaments in general has proved useful in cases where the patient's conditions had expired, the presence of jaundice, in the course of infections, in tumors, in which the wound repair process is slower than the usual and therefore it is necessary to use a material that ensures the hold of the suture for longer. The polydioxanone disappears from the tissues after six months and this fact is a good advantage.

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