METHODS

Tissue Reactions to Modern Suturing Material in Colorectal Surgery

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Morphological changes in the wall of the large intestine were studied after its manual suturing by a double-row interrupted suture with modern suture threads. Light and scanning electron microscopy showed "fuse properties" and "sawing effect" of polyfilament twisted threads (*e.g.* vicryl). Monofilament threads were free from these drawbacks and therefore were preferable. Metal elastic threads on the basis of titanium-nickelide alloys caused no inflammatory changes in tissues.

Key Words: *manual suture; suture threads; pathomorphology*

The number of patients with diseases of the distal compartments of the gastrointestinal tract is increasing [3], the incidence of postoperative complications in these pathologies remaining high (10-15%) [4,6]. The main cause of complications is incompetence of anastomoses. Requirements to technology of suturing in colorectal surgery are particularly high because of the anatomic and physiological characteristics of the large intestine: weakness of the wall, liability to ischemia, presence of aggressive microflora and active enzymes in the intestinal lumen, and liability to bacterial translocation.

The most widely used and available method for connection of the colonic loops is the ligature method with more than 400 modifications; the number of suturing material variants is more than 100 [2]. Despite all advantages of single-row inter-intestinal anastomosis, precision technology of anastomosing, and various methods for protection, the double-row anastomosis is used most often.

Vicryl [5], PDS, maxon, polysorb, and biosin are used for the creation of colorectal anastomoses. These synthetic suture threads are strong, atraumatic, cause less pronounced inflammatory reaction, and have guaranteed duration of strength and resorption periods [1,5]. Introduction of these suture materials into clinical practice promoted wider use of single-row manual suture, which reduced the incidence of anastomosis incompetence to 0.5-7.0% and mortality to 5% [10].

Metal threads from titanium nickelide alloy are a perspective suture material. They are biochemically and biomechanically compatible with body tissues and exhibit superelastic characteristics.

We studied modern suture threads used for creation of ligature anastomoses on the large intestine using histological methods and electron microscopy.

MATERIALS AND METHODS

For comparative analysis, colorectal anastomoses were formed by the method of Pirogov—Lamber in 20 dogs using monofilament threads (polypropylene), polyfilament twisted thread (vicryl), and titanium nickelide threads.

Histological preparations were stained with hematoxylin and eosin, after van Gieson, and after Slinchenko.

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The preparations were examined under an ISM-840 scanning electron microscope (Jeol). The severity of inflammatory and sclerotic changes in tissues was evaluated.

RESULTS

Suture threads are foreign incorporations promoting the formation of wound channels, through which enteric microflora penetrates into the deep layers of the anastomosis and into the abdominal cavity, thus increasing the risk of anastomosis incompetence. Suturing of tissues with polyfilament twisted threads led to the formation of a large tissue defect around the thread, known as "sawing effect". A ligature channel formed, through which enteric microflora penetrated into tissues, infects them and promotes the development of acute inflammation. Electron microscopy showed that the ligature channels were retained until day 14 postoperation, though the defect started to fill with exudation from the edges. The knot was competent and did not come apart (Fig. 1, *a*). Monofilament threads were characterized by good sliding and did not form ligature channels during tissue suturing; the tissues tightly adhered to the thread (Fig. 1, *a*).

Only polyfilament suturing threads demonstrated "fuse properties" [1]. Electron microscopy on day 14 showed few coccal microorganisms on the surface of twisted threads (Fig. 1, *b*). However, solitary coccal microorganisms (representatives of enteric microflora) were also detected near the monofilament threads (Fig. 1, *c*). The presence of microflora in the depth of tissues and on suture material during this postoperative period indicates that "fuse properties" are also intrinsic of the monofilament thread, though to a lesser degree.

It is assumed that modern synthetic absorbable materials are biologically inert. The inflammation developing around them is weak, in contrast to inflammation around catgut. Electron microscopy showed moderate cellular inflammatory reaction around polyfilament, but not monofilament threads. Inflammatory exudation cells (neutrophilic leukocytes and macrophages) aggregated on vicryl filaments, which promoted their gradual degradation. Macrophages formed numerous processes, contacting with each other and with other cells (Fig. 1, *d*).

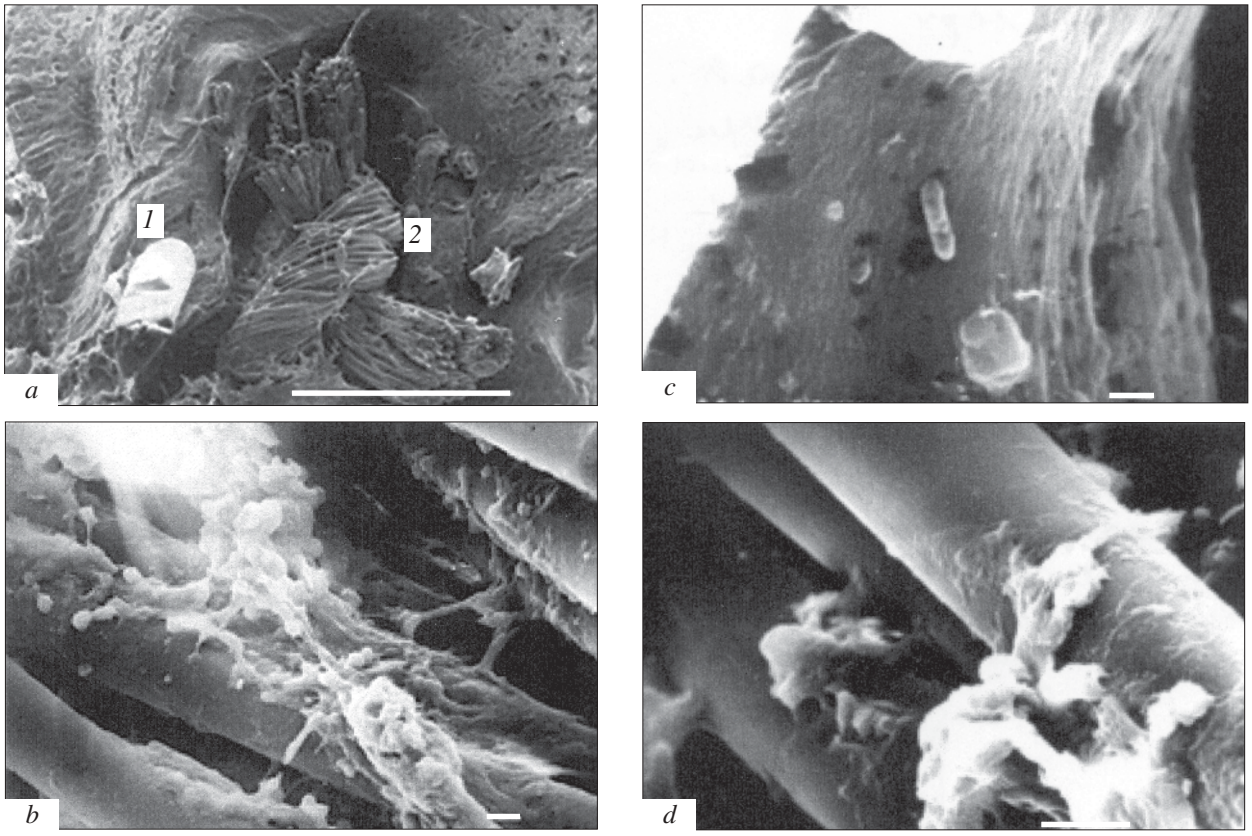

Fig. 1. Changes in tissues during application of modern suture material. *a*) two types of suture material: monofilament (*1*) and polyfilament (*2*). Tissue defect around twisted thread on day 14 postoperation; *b*) solitary elements of coccal microflora on polyfilament threads; *c*) solitary elements of coccal microflora near monofilament thread; *d*) ameba-like spreading of leukocytes and macrophages on the surface of a bundle of twisted thread. Scanning electron microscopy, ×37 (*a*), ×600 (*b*), ×7500 (*c*), and ×1400 (*d*).

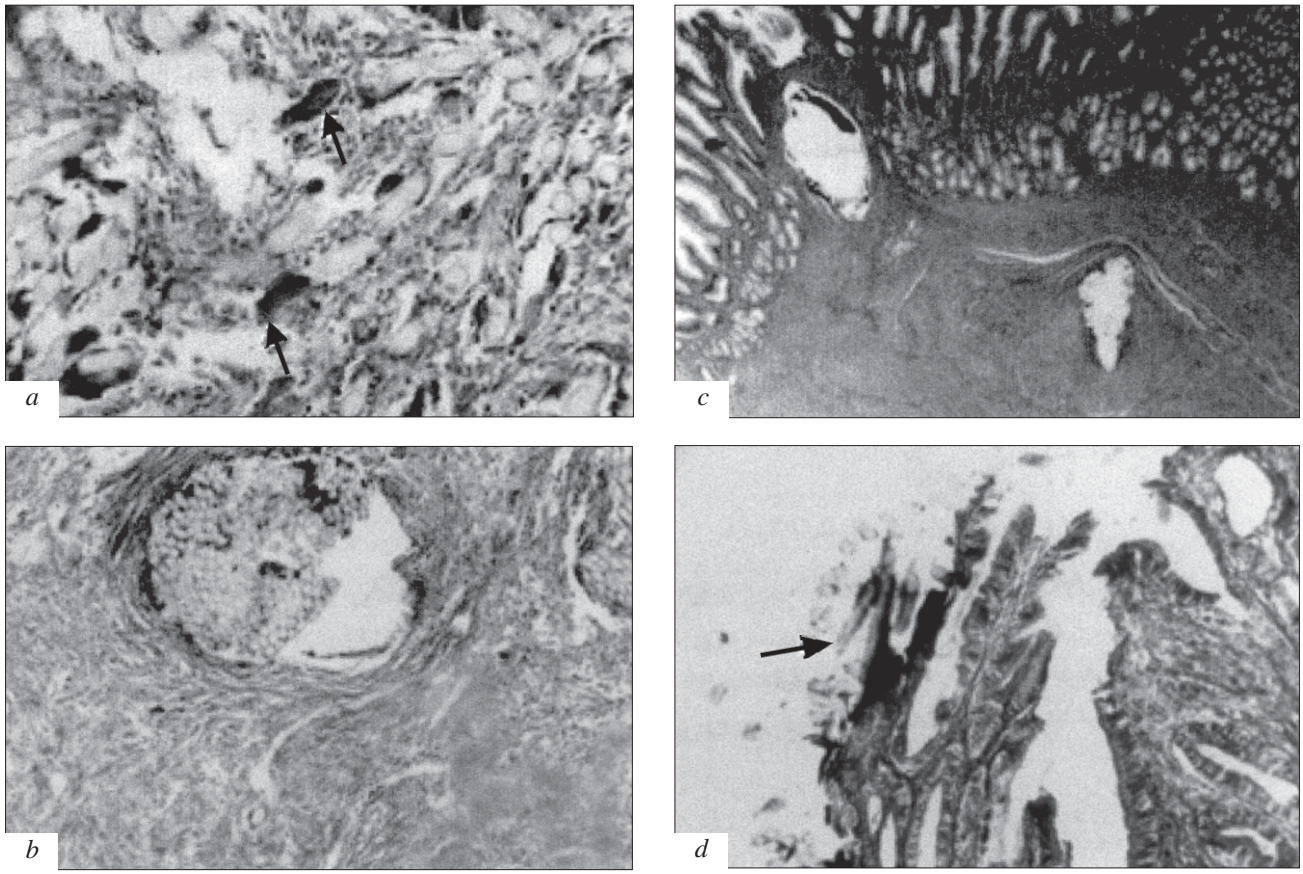

Fig. 2. Pathomorphological changes in tissues sutured with polyfilament threads. *a*) Pirogov—Langhans type multinuclear giant cells (shown with arrows) around suture threads on day 21 postoperation. Hematoxylin and eosin staining, ×140; *b*) collagen fiber growth around fragments of degrading thread on day 30 postoperation; van Gieson staining, ×140; *c*) ligature shift towards the organ surface on day 60 postoperation. Ligature threads in the enteric submucous and mucous membranes, hematoxylin and eosin staining, ×70; *d*) suture material (arrow) in intestinal lumen on day 30 postoperation; Slinchenko staining, ×70.

Histological study of tissue adjacent to vicryl thread at early terms after surgery showed microabscesses in which neutrophilic leukocytes predominated. Manifest productive reaction with the formation of foreign body granulomas was detected on days 21-30. The threads underwent gradual biodegradation; numerous disorderly multinuclear giant cells of the Pirogov—Langhans foreign bodies accumulated around the threads (Fig. 2, *a*).

Long-term presence of suture material in tissues maintains chronic inflammation and excessive formation of the connective tissue. Collagen fibers grew around fragments of degrading threads (Fig. 2, *b*). Connective tissue capsule gradually formed, its walls consisted of coarse collagen fibers. Chronic inflammation was also maintained by shifting the ligatures from the depth of tissues towards their surface; they were found in the submucosa and mucosa. Microabscesses formed around these threads (Fig. 2, *c*). Chronic productive inflammation around the threads prolonged the regeneration period and led to coarse stenoses of the anastomoses. Sequestration of ligatures into the intestinal lumen lasted for a long time and was detected on days 60-90 postoperation (Fig. 2, *d*).

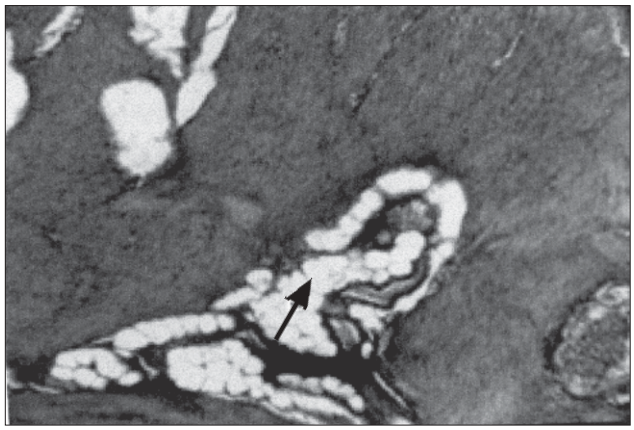

Fig. 3. Pathomorphological changes in tissues sutured with metal threads. No inflammatory changes on day 14 postoperation after tissue suturing with titanium nickelide thread (arrow). Hematoxylin and eosin staining, ×140.

No inflammatory reaction developed during the early postoperative period after suturing of tissues with metal thread (Fig. 3, *a*).

Hence, modern synthetic suturing materials are not free from drawbacks. Polyfilament twisted threads (vicryl) retain their "fuse properties", cause the development of "sawing effect" in tissues, their biodegradation is slow, inflammatory and sclerotic changes develop around them, and therefore, monofilament threads, free from these drawbacks are preferable. The use of elastic metal threads based on titanium nickelide alloys, around which no inflammatory reaction develops, seems to be perspective suturing material for abdominal surgery.

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