Conference paper

Antireflux Compression Biliodigestive Anastomoses Formation with the Usage of the TiNi Shape Memory Implant

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Abstract

The usefulness of the anastomotic device for the valve compression anastomoses formation among animals was evaluated. The implant is made of the nickelidtitanium alloy (TiNi) in the form of two rounds of the TiNi wire which ends are unbent to the opposite sides. In the area of the unbent rounds the compression isn't carried out, the tissue isn't squeezed. And further there is a formation of the valve. 26antirefluxbiliodigestive compression anastomoses on the small bowel are created during the experiment. They include 13 choledochojejunostomy and 13 cholecystojejunostomy. We studied the terms of the compression devices failure, the mechanical and biological durability of these anastomoses, the primary permeability of anastomoses and carried out the microscopic examination of the compression suture. No complications connected with the use of the compression device were noted. We proved that all the valve compression anastomoses created with using the TiNi shape-memory implant are mechanically and biologically tight. The compression devices eliminated from the zones of anastomoses on the 7th-8th day after the surgery in all cases. The microscopic examination showed the insignificant development of sclerosis in the compression zone and full adaptation of all organ layers. The created valve reduced the reflux of intestinal contents that lessened the probability of development of acute and chronic cholangitis in the postoperative period. The use of the TiNi implant allows

to carry out the operation twice quicker. Such anastomosis has high physical durability and small bacteriological permeability.The new way of the formation of valve biliodigestive compression anastomoses allows to create stronger and more reliable anastomoses and prevent the development of typical complications.

1 Introduction

The surgery of the biliary tract remains an urgent medical problem. Despite the numerous attempts to improve the technique of the manual and mechanical anastomosis formation nowadays it isn't possible to overcome the negative sides of such connection of the ends of the bowel. The sutural threads, metal clips being foreign particulates between the tissues extend the angenesis terms. The formation of the wound channels promotes the penetration of the intestinal microflora into the wall of the gut and the bile duct and it causes the development of the acute purulent inflammatory reaction in the early terms after the operation; further it leads to the stricture formation of anastomosis. Also the high cost of the modern staplers is of high value for the daily work of surgeons.

In the opinion of the number of authors [1] the best conditions for the tissues regeneration are created in the case of compression anastomoses formation. Various devices made of magnetic alloys, the biofragmented rings of BAR, the TiNi shape-memory superelastic devices are developed for their creation [2, 3, 4, 5, 6, 7, 8]. The insolvency of the compression anastomoses averages 2-8%, and the lethality is 1-4% [5, 7, 8].

The absence of the reflux of the intestinal contents into the lumen of the biliary tract is another important factor. It leads to the development of anastomositis, cholangitis and cholecystitis in the early postoperative period. That is undesirable in the conditions of the newly created anastomosis. Such mechanism of protection allows to create only a newly formed valve between the gut and the biliary tract. Such barrier will prevent the reflux of the intestinal contents into the lumen of the common bile duct and will reduce the probability of the postoperative complications both in the early and in the late postoperative period.

2 Experimental

The research work was performed at the Siberian state medical university in the course of the experiment. The method of the antireflux compression biliodigestive

anastomoses formation with the use of the TiNi shape-memory device was developed together with the engineers of Scientific Research Institute of Implants and Shape Memory Materials (Tomsk State University) [9]. The device was made in the form of two rounds of a TiNi wire which ends are unbent to the opposite sides. In the area of the unbent rounds the compression wasn't carried out, the tissue wasn't squeezed and further there was a formation of the anastomosis valve zone. For the creation of the anastomosis we used the compression device from the TiNi wire which thickness was 1 mm and the size – 5 x 12 mm. We used devices from the wire of the same alloy with the thickness of 1,5mm and the size of 7x 16 mm for the cholecystojejunal anastomosis formation

Fig. 1. Device for valve compression anastomosisformation

In the experiment 26 mongrel dogs took part, they were used to develop the formation technique and to study the antirefluxbiliodigestive anastomosis. All the animals were divided into 2 groups. In the first group the experimental animals underwent the surgery of the valve compression choledochojejunal anastomoses formation with use of the TiNi shape-memory implant (13 dogs). In the second group the experimental animals underwent the valve compression cholecystojejunal anastomoses formation with the same device (13 dogs).

The technique of the choledochojejunal and cholecystojejunal anastomosis formation was worked out during the experiment. The terms of the failure and migration of devices are determined. The mechanical durability and special aspects of the morphogenesis of the compression seam were studied. Also the antireflux properties research and bacteriological research of the created anastomosis were fulfilled.

The mechanical durability was determined by the pneumahydraulic forging by V.P. Mateshuk's technique (1968) in different terms after the operation (from 1 to 90 days).

The terms of the implant failure were defined by roentgenoscopyand survey and roentgenography of the abdominal cavity.

The roentgenography with barium suspension was carried out to assess the antireflux function. The intake of the histological material was carried out on the 1st, 3rd, 7th, 14th, 21st, 30th, 90th days. The bile intake was carried out for the bacteriological research.

3   Results and discussion

The techniques of choledochojejunostomy and cholecystojejunostomy are the same. 26antireflux compression anastomoses were created using the developed device. 13 anastomoses were performed between the acholedoch and the jejunum. And 13 anastomoses were created between the gall bladder and the jejunum.

The operation was performed as follows: the laparotomy and examination of the abdominal cavity were carried out. The distal part of the common duct was separated and taken with the handles (Fig. 2), it was tied up below and cut. Then nearby the loop of the jejunum was placed. The anastomosis was imposed on the antimesenteric part of the gut. The jejunum wall was infiltrated by the physiological salt solution (Fig. 3). The serous-muscular layer was peeled. The serous and muscular layers were cut longitudinal up to the subsmucous one. The platform with the size of 2×2 cm was freed. The choledochwas placed on the platform(Fig. 4). The submucous layer at the distal end of the common bile duct was cut (Fig. 5). The compression device which was cooled to 00+10 C was taken out of the alcohol and we moved apart its rounds to the distance of 5 mm with two forceps. One of the implant rounds was put into the choledoch lumen (Fig. 6) and the other round into the gut lumen smoothly and quickly.

The compression device recovered the initial form under the influence of the tissue heat and tightly squeezed the gut wall and the choledoch wall between the branches. The time of the rounds coming close is 5-7 sec. Then the serous layer over the choledoch was sewed. The tunnel appeared (Fig. 7). The choletcystojejunal anastomosis was carried out in a similar technique.
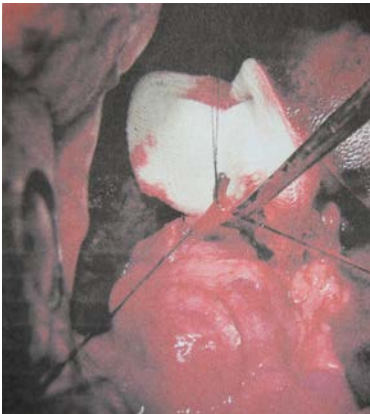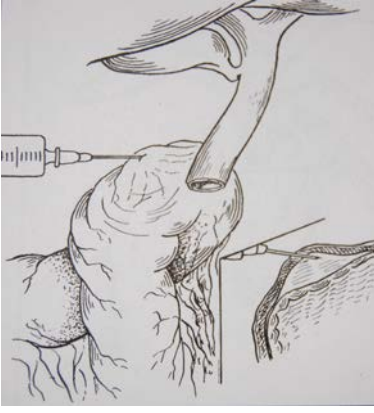
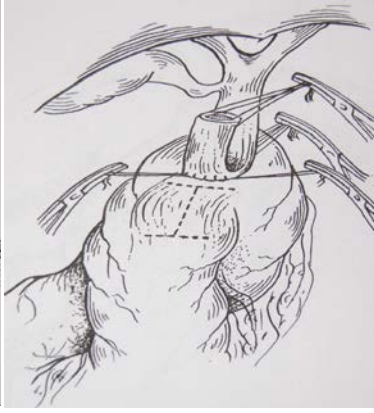Fig. 2. Point out a distal part of common duct
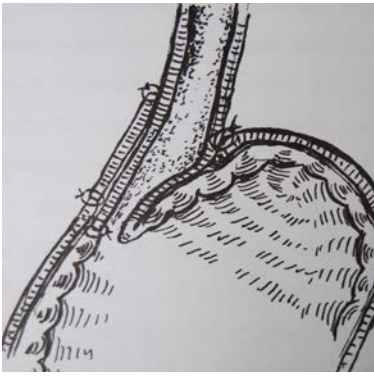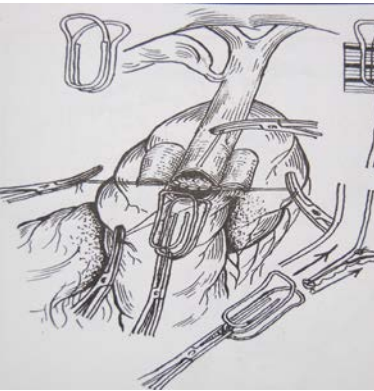
Fig. 3. Infiltration of a jejunum wall

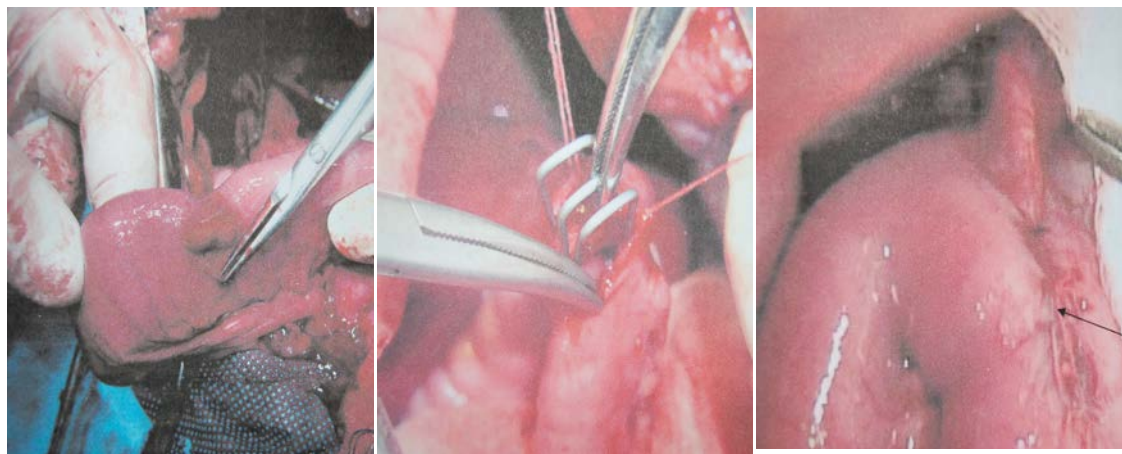Fig. 4. Place the choledoch on the platform

Fig. 5. Section of a submucous layer

Fig. 6. Implant enters one round into the choledoch and the gut lumen

Fig. 7. The created tunnel

In the postoperative period one animal died. The death was connected with the anesthesia complications (overdose of medicines). The complications connected with the use of the compression device are not noted.

On the first day the mechanical durability of the anastomosis was 127 mm Hg. The lowest mechanical durability of the compression anastomosis was observed on the 3rd-4th day after the surgery (96 mm Hg) and increased on the seventh day up to 150 mm Hg, and on the 14th day it increased up to 216 mm Hg. Further on all the specimens it was 240-260 mm Hg. The anastomosis is considered tight if it maintains the pressure more than 50 mm Hg.

The bile was sterile during the bacteriological research. It confirmed the antireflux qualities of anastomoses.

Within five days after the operation the devices were in the place of the created anastomoses. On the 6th-8th days the devices were still fixed by the necrotic tissues but they were mobile. All the dogs' compression devices were absent in their abdominal cavities on the 7th-8th day. The complications connected with the migration of the implant weren't noted. The primary permeability of the valve compression anastomoses was kept during all the experiment terms.

The inflammatory reaction went with minimum reactive changes in the anastomoses layers and was short-term according to the results of the histologic researches of the valve compression anastomoses. Epithelization of the mucous

layer began on the 7th day and it came to an end by the 14th day. From the 21st day to the 30th one there was a recovery of the mucous membrane structure. The process of regeneration went with the minimal symptoms of sclerosis. It led to the complete adaptation of all the layers of choledoch and jejunum. The cicatrix maturing with the vascular reorganization came to the end by 30th day after the surgery. On the 60th day there was a reduction of the cicatricial tissue thickness. The conducted microscopic examination showed the healing of the compression anastomoses has the same nature as the primary tension and had considerable advantages over the manual suture.

The common bile duct didn't extend in the postoperative period. There was no biliary hypertension. The size of the valve was 6x4 mm and it was elastic.

4   Summary

The anastomosis is carried out twice quicker when using the TiNi shape-memory implant. The operation is bloodless and excludes using the suture material in the zone of anastomosis. This type of anastomosis has the high physical durability and small bacteriological permeability since the thread isn't used. The wound is healed by type of the primary tension with the minimum inflammatory reaction and insignificant development of connective tissue. The created valve prevents the reflux of the gut contents into the biliary duct and blocks the development of the acute and chronic cholangitis.

Using the TiNi shape memory implant and performing the operation according to the offered sequence and technique prevent the formation of the postoperative stenosis of anastomosis.

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