UDC 615.471+616.34-006+614.253+93/94
DOI: 10.56871/MHCO.2024.51.82.010

RUSSIAN PRIORITY IN THE CREATION OF CIRCULAR STAPLING APPARATUS FOR RECTAL SURGERY: FROM “SPUTNIK” TO “RUSSIAN GUN”

© *Petr V. Tsarkov[1], Inna A. Tulina[1], Svetlana V. Krylova[2], Nikolay N. Krylov[3]*

[1] I.M. Sechenov First Moscow State Medical University (Sechenov University). 8, building 2 Trubetskaya str., Moscow 119048 Russian Federation

[2] Humanitarian Institute of the Russian New University. 22 Radio str., Moscow 105005 Russian Federation

[3] Institute of Social Sciences of I.M. Sechenov First Moscow State Medical University. 8, building 2 Trubetskaya str., Moscow 119048 Russian Federation

Contact information: Nikolay N. Krylov — Doctor of Medical Sciences, Professor, Institute of Social Sciences, I.M. Sechenov First Moscow State Medical University. E-mail: nnkrylov01@yandex.ru ORCID: https://orcid.org/0000-0003-0078-9171 SPIN: 6136-8608

For citation: Tsarkov PV, Tulina IA, Krylova SV, Krylov NN. Russian priority in the creation of circular stapling apparatus for rectal surgery: from “sputnik” to “Russian gun”. Medicine and Health Care Organization. 2024;9(2):114–124. DOI: https://doi.org/10.56871/MHCO.2024.51.82.010

Received: 26.03.2024 ***Revised: 08.05.2024*** ***Accepted: 15.07.2024***

ABSTRACT. The requirements for the workmanship of the XXI century surgeon can be formulated by three main conditions: the ability to properly handle video (robot)-assisted equipment, safely use a variety of electrosurgical instruments and use all kinds of stitching devices for their intended purpose. One of the areas of modern surgery in which it is no longer possible to imagine the usage of a classic manual suture is a low colorectal anastomosis using a special stitching device in rectal cancer surgery. For the first time, a circular stitching device was developed for this purpose and used in the USSR. In the literature review, we traced the stages of the work of Russian engineers and surgeons from the creation of a circular stitching device for working on the main vessels — the “Soviet Sputnik in surgery” to the forthcoming of the “Russian gun” — a stapler for the colon suture with low anterior rectal resection in case of cancer. The key event for the introduction of the advanced scientific idea of Soviet engineers in the USA was the export of a domestic industrial design abroad by the American surgeon M. Ravitch. The great role of the famous British surgeons J. Goligher and R. Heald in the introduction of this technique around the world is emphasized. The article describes the background of the term “Russian gun”, the advantages and disadvantages of the first Soviet models of stitching devices, the stages of a gradual change in the negative attitude of foreign surgeons by introducing new modifications into widespread practice around the world, as well as the objective reasons for their replacement with American devices.

KEYWORDS: the history of medicine in the modern era of Russia, mechanical stitching devices

РОССИЙСКИЙ ПРИОРИТЕТ В СОЗДАНИИ ЦИРКУЛЯРНЫХ СШИВАЮЩИХ АППАРАТОВ В ХИРУРГИИ РАКА ПРЯМОЙ КИШКИ: ОТ «СПУТНИКА» ДО «RUSSIAN GUN»

© *Петр Владимирович Царьков[1], Инна Андреевна Тулина[1], Светлана Вадимовна Крылова[2], Николай Николаевич Крылов[3]*

[1] Первый Московский государственный медицинский университет имени И.М. Сеченова (Сеченовский Университет). 119048, г. Москва, ул. Трубецкая, д. 8, стр. 2

[2] Гуманитарный институт Российского нового университета. 105005, г. Москва, ул. Радио, д. 22

[3] Институт социальных наук Первого Московского государственного медицинского университета имени И.М. Сеченова. 119048, г. Москва, ул. Трубецкая, д. 8, стр. 2

Контактная информация: Николай Николаевич Крылов — д.м.н., профессор Института социальных наук Первого Московского государственного медицинского университета имени И.М. Сеченова. E-mail: nnkrylov01@yandex.ru ORCID: https://orcid.org/0000-0003-0078-9171 SPIN: 6136-8608

Для цитирования: Царьков П.В., Тулина И.А., Крылова С.В., Крылов Н.Н. Российский приоритет в создании циркулярных сшивающих аппаратов в хирургии рака прямой кишки: от «спутника» до «Russian gun» // Медицина и организация здравоохранения. 2024. Т. 9. № 2. С. 114–124. DOI: https://doi.org/10.56871/MHCO.2024.51.82.010

Поступила: 26.03.2024 ***Одобрена: 08.05.2024*** ***Принята к печати: 15.07.2024***

РЕЗЮМЕ. Требования к искусству хирурга XXI века можно сформулировать тремя основными условиями: умение правильно обращаться с видео(робот)-ассистированной техникой, безопасно применять разнообразные электрохирургические инструменты и вместо ручного шва чаще использовать сшивающие аппараты. Одна из областей современной хирургии, в которой уже невозможно представить использование классического ручного шва, — это низкий колоректальный анастомоз с помощью специального сшивающего аппарата в хирургии рака прямой кишки. Впервые с этой целью циркулярный сшивающий аппарат разработали и применили в СССР. Мы проследили этапы работы русских инженеров и хирургов от создания циркулярного сшивающего аппарата для работы на магистральных сосудах — «советского искусственного спутника в хирургии» до появления «Russian gun» — степлера для шва толстой кишки при низкой передней резекции прямой кишки по поводу рака. Ключевым событием для внедрения передовой научной идеи советских инженеров в США стал вывоз за рубеж отечественного промышленного образца американским хирургом M. Ravitch. Подчеркнута большая роль знаменитых британских хирургов J. Goligher и R. Heald в распространении этой методики по всему миру. В статье описана история появления термина «russian gun», достоинства и недостатки первых советских моделей сшивающих аппаратов, этапы постепенной смены негативного отношения к ним зарубежных хирургов введением в широкую практику новых модификаций во всем мире, а также объективные причины их замены американскими девайсами.

КЛЮЧЕВЫЕ СЛОВА: история медицины в новейшую эпоху России, механические сшивающие аппараты

INTRODUCTION

If we try to compare the appearance, purpose, and usability of instruments for dividing, dissecting, and fixing operated organs and tissues, it will become clear that medical culture in different corners of the Oikumene has created convenient, practical, specialized devices, which are easily recognizable today, laconic and perfect as the surgeon's hand. These devices used to be a part from the arsenal of a clueless physician working in the volcanic ash-filled ancient Roman city of Pompeii (79 A.D.) [1], bizarre and refined equipment resembling the shape of exotic animals and birds, manipulated by the ancient Indian physician Sushruta (600 B.C.) [2], forceps, lancets and dilators of Persian encyclopedists Razes (X–XI c.) and Avicenna (X–XI c.), Europeans Ambroise Paré (XVI c.) and Jean Larrey (XVIII–XIX cc.), and a set of instruments of a surgeon of the early XIX c. from Munich (Kingdom of Bavaria) [3]. It is obvious that for a long time these sets of instruments did not change significantly with regard to their purpose, shape, size. Thus, they could be easily used in a dressing room of a modern outpatient clinic, provided that they were sterilized. In the second half of the XIX century it became possible to penetrate into the abdominal and thoracic cavities using knowledge of topographical anatomy, asepsis, antisepsis and general anesthesia. Subsequently, the devices were supplemented with new instruments allowing not only to stop bleeding and tie vessels, but also to cross parenchymatous, hollow and tubular organs, as well as to sew them after resection. They expanded capabilities of physician's fingers, although their availability and widespread use made it evident that the same medical instruments were used in different ways by physicians. The more a doctor knew and could do, the more specialized instruments he had, the greater his skill became. Surgery in the XIX and XX centuries rapidly became more and more complex. Surgeons penetrated into such hard-to-reach corners of the body, where it was increasingly difficult

to ensure proper exposure and illumination. The most critical stages — first of all, the formation of anastomosis (anastomosis) in the depth of the wound, with small sizes of the angle of inclination of the surgical action required from the surgeon delayed (or rare and shallow) breathing, slow heart rate (as in sniping), suppression of tremor of the fingers, scrupulous technique of possession of the needle holder and knotting surgical thread. During this period, the importance of individual and team manual skills, the ability to work in a team, honed to automaticity increased.

In the XX century, the frequency of suture divergence of colorectal anastomosis varied from less than 5% to more than 30% among different clinics and surgeons, which cannot be explained by differences in the clinical composition of patient groups and their concomitant diseases. It should have been related, among other things, to peculiarities of the surgeon's technical equipment, and the large scatter of indicators testify that doctors differed significantly in the level of their technical skills [4, 5].

The 20th century enriched surgery with three fundamentally different groups of new instruments: tools for endoscopic manipulations; electrosurgical and ultrasound instruments for tissue dissection and bleeding control; and perfect devices for automatic organ stitching. The first and the second minimize surgical trauma and blood loss, while the third unifies the technique of the most important stages of tissue matching surgery and standardizes its results. Today it is impossible to imagine an oncoproctological operating theatre that would not be equipped with a set of stapling devices (staplers) for various stages of radical surgery for rectal cancer.

The modern rectal suture stapler is ingenious in design and looks simple. However, it is important to pay close attention to the smallest details when using it in clinical practice in order to avoid device-related complications. It is correct both for modern conditions and at the dawn of its creation. The use of stapling devices does not diminish the rare, unique, exceptional, individual merits of a talented surgeon. But it allows raising the level of final results in a significant part of those who rarely (due to the place of their work and the level of their claims) perform technically complex, precision interventions.

The aim of the article is to introduce innovative works of Russian engineers and surgeons in the field of description of the device, test results and clinical application of domestic stapling devices, as well as to assert the Russian priority in the creation of in-demand medical equipment.

FROM SUTURING VESSELS TO GUT STAPLING

The first circular Soviet stapler, which had no analogues in the world, was a vascular stapler (VS) designed in 1945 by the inventor engineer Vasily Gudov. In 1948, V.P. Demikhov performed heart and lung transplantation into the chest of a dog using a circular VS in the USSR; after that Demikhov began to perform all experiments on organ transplantation only with the help of a stapler [6, 7]. The mechanical circular staple suture provided a number of important advantages over the manual Alexis Carrel suture: rapid formation of a standard, ideal in shape, strong and tight vascular anastomosis. At the same time, the quality of mechanical staple suture of blood vessels did not depend on the surgeon's skill.

In 1951, Gudov headed the Research Institute, which was established to develop techniques for automatic or semi-automatic stitching and suturing of organs in order to standardize and simplify surgical procedures and reduce the incidence of postoperative complications. Such devices were supposed to eliminate the correlation between treatment results and surgeon's individual manual skills and dexterity. In accordance with these tasks, the Institute established the following requirements to the device: simplicity of design, speed of application, reliability and non-traumatic mechanical suture.

Soviet vasostaplers were recognized abroad after P. Androsov demonstrated mechanical vascular suturing with VS to the surgical community at the 3rd Congress of the International Angiological Society in Atlantic City (USA) in October 1957. There was also shown a movie about the use of this device for heart transplantation in an experiment, it was filmed by Demikhov. The Soviet achievements looked so innovative and distinctive that they were called "Soviet surgical satellites" based on the analogy with the first artificial satellite recently launched in the USSR. It should be emphasized that the circular VS was successfully used for suturing other tubular hollow organs of small diameter, for example, the ureter, as well as the ends of the esophagus in case of atresia in newborns [8].

The first results of using a linear stapler for “end-to-end”, “side-to-side” and “end-to-side” interintestinal anastomosis in 10 patients (including the colon) were reported by T.V. Kalinina in 1958. [9]. The device was convenient to use; there were no difficulties during the formation of the interintestinal junction; the anastomosis turned out to be airtight in all cases; no postoperative complications were registered. The author believed that the use of the device is reasonable due to the following circumstances: there is no gaping of a lumen of joined ends of intestines, there is no infection of surgeon’s hands and an operating field with intestinal contents, crushing clamps are not applied to an intestinal wall, and suture placement rates are accelerated. Later, the SPN-7 device was created specifically for end-to-end esophageal anastomosis, which was inserted into the esophagus through the mouth [10]. In 1957, the GS (gut stapler) device for forming anastomosis to hollow organs of the gastrointestinal tract and LRS (lung root stapler) were designed, and in 1960, the GIAS (gastrointestinal anastomosis stapler) appeared. Both devices became prototypes of the whole family of modern staplers for thoracic and abdominal surgery.

In 1960–1961, a large line of Soviet staplers designed for use in various fields of surgery, including vessels, nerves, sternum, ribs, bronchus stump, gastrointestinal organs, and functioning arterial (Botall’s) duct were successfully presented in various clinics in the USA [11].

The first circular stapler designed specifically for the anastomosing of GI organs in the USSR was A.N. Burtsev’s device (model of 1957) [12]. In 1963–1966, PKS-25 apparatus was developed on the basis of this device, it was used to form esophageal-intestinal and esophageal-gastric joints, as well as other circular anastomoses [13]. In 1975, A. Burtsev reported on the clinical application of a device designed to create anastomosis on the rectum with two rows of mechanical sutures [14]. The IC (intestinal circular, further a Russian abbreviature KC is used) stapler became a further modification of this device, and then the universal stapler of gastrointestinal tract organs (USGIT) was created. It should be emphasized that the American company USSC produced the first original circular stapler CEEA (analog of the Soviet devices PKS-25, IC-28 and USGIT) only in 1977.

The KC apparatus for circular mechanical suture was created on the principle of the already known PKS-60 apparatus, but it differed by special parameters selected for anastomosis with rectum. Before clinical trials the characteristics of a single-row stapler anastomosis were studied (more than 100 experiments in total): leakage test, dynamics of staple rejection, peculiarities of anastomosis line healing, motor and evacuator function of distal colon sections in the presence of mechanical sutures. It turned out that the anastomosis without violation of tightness withstood the increase of intraintestinal pressure up to very high levels — 200–210 mm Hg. [15]. These results allowed further use of the KC suturer in 22 patients with rectal cancer and ulcerative colitis. The lethality amounted to 9.1%, but the causes of patients’ death were not related to the peculiarities of the operation.

T.V. Kalinina and V.S. Kasulin developed in a pilot trial and then applied (1965–1966) five variants of IC-28 device in clinical conditions, namely in 11 patients with rectal cancer. The outcomes of the device application were favorable in all cases. According to the authors, all techniques of colorectal anastomosis formation developed in the experiment justified themselves in practice, simplified and facilitated the operation [16]. A.N. Ryzhikh, the head of the proctology research laboratory and a clinic of the Ministry of Health of the Russian Federation, founded by him, started using the KC-28 from 1964, and from 1966 he operated on low rectal cancer exclusively with a circular stapler [17]. In 1967, he outlined his personal experience with 110 operations of anterior resection of the rectum (43 — by means of the stapler and 67 — with manual sutures).

The mortality rate was 4.7% after the operations with hardware suture, whereas it was twice as high with manual suture — 9.0%. In the late 1960s and early 1970s, the device IC-28 began to be used not only in Moscow, but also in many other cities of the USSR.

In 1971, the first article was published by Soviet surgeons outside the USSR. It was devoted to the results of using circular mechanical sutures in low sphincter-saving anterior resection of the rectum with a two-row colorectal circular anastomosis with metal staples [18]. It described the experience of more than 100 experimental operations and the results of treatment of 138 patients in the period from 1961 to 1969.

Obvious advantages of the stapler suture were noted: reliability, favorable healing of tissues in the area of the stapled intestines. The use of the apparatus greatly facilitated the work, making it faster (compared to conventional manual suture methods), especially in hard-to-reach areas of rectum sphincters. Healing of the intestinal wound was also more favorable. Functional results in the nearest and distant terms were satisfactory. The development of complications was noted in 3.6% of observations, lethality amounted to 0.7%. The results of the operations were traced for periods from six months to five years, and they corresponded to those in patients with manual anastomosis. By 1983, the USSR medical industry had already produced more than 40 samples of mechanical stapling devices for various fields of surgery.

SOUVENIR FROM RUSSIA

Mark Ravitch (1910–1989) is commonly referred to as the pioneer of surgical staplers. A more precise definition should be as follows: with the help of an industrial model of a linear stapler he brought from the USSR, relying on his unquestionable authority in the United States, he introduced Western medicine to the most advanced Soviet instrument for mechanical suturing of bronchus stumps at that time. In other words, he carried out industrial espionage. And then, under his leadership, this device was modified for various fields of surgery, their mass production was organized, which made such instruments available to surgeons all over the world.

In 1958, Ravitch, who had inherited his father's knowledge of the Russian language, gained respect and favor from Professor Nikolai Amosov, head of the Research Institute of Tuberculosis and Thoracic Surgery in Kiev (USSR), who showed him operated patients and their post-operative chest radiographs. On the radiographs Ravitch saw what struck him most of all: 3- and 4-inch double lines of thin white B-shaped metal brackets. N. Amosov explained that his institute had a special device for placing brackets on a bronchus stump and had already used them in about 200 lung resections and pulmonectomies. The next day Ravitch was admired by the extraordinary simplicity and efficiency of these unique instruments in Amosov's operating theatre and, of course, wanted to purchase them. However, all initial attempts to get a personal gift or make a purchase in Kiev were doomed to failure. Amosov categorically refused his request.

And only by chance (as he described), he bought a bronchial stapler for only 440 rubles ($110 at the 1958 exchange rate), it 33 cm long, weighed 640 g, and was placed in a birch wood box trimmed with black velvet. The stapler was purchased in the Medtekhnika shop in Leningrad. Ravitch himself ironically compared this success to an attempt made in 1939 by a foreign spy to smuggle a bazooka out of the United States [19]. So, returning to this allusion, we can assert that the great American surgeon made an effective attempt to pierce the iron curtain between Russia and the rest of the world with the help of the "Russian bazooka".

Upon his return to the USA, in 1959, M. Ravitch published an article on the use of the bronchus stapling instrument (BSI) in lung resection in experiment and clinic. He enthusiastically spoke about other stapling devices produced in the USSR. He was convinced that such staplers and their modifications will definitely find a permanent place in surgery [20]. The series of successful operations were continued in 1963, when he reported the immediate results of 139 lung resections with the help of the Soviet stapler: bronchial fistula was observed only in 3 (2.2%), and pleural empyema — in 3 cases (2.2%) [21].

Demonstrated capabilities of the Russian stapler were met with disbelief, although manual bronchial suturing required at least a dozen silk sutures and was ten times longer. "The instrument looks terribly big and heavy, and the art of suturing by hand is my vocation", sceptics replied to M. Ravitch. However, the main argument, which required scrupulous justification for many years, was the fact that an automatic instrument could do surgical manipulations not only fast, but also as well as its opponents, and probably even better [19].

Soon, the American businessman L. Hirsch founded the USSC company, which acquired licenses in the USSR for the production of stapling devices. The American analogues of the LRS apparatus were TA series staplers. GIAS was replaced by GIA series staplers, which entered clinical practice in the late 1960s. An important advantage of American staplers was the application of 4 rows of staple sutures (2 rows on the removed part and 2 rows on the left part of the organ). American models also allowed to leave a staple suture without peritonization, with

dosed bending of staples and compression of tissues without crushing them. These devices were equipped with plastic disposable cassettes, which were loaded with staples and sterilized at the manufacturing plant [21]. Further on, the paths of the Soviet and American inventors diverged, and in the following years they saw each other as competitors rather than like-minded people.

FIRST RESULTS OF SOVIET STAPLING DEVICES USE IN LOW ANTERIOR RECTAL RESECTION IN WESTERN COUNTRIES

The first US publication which presented a study on reliability of the Russian USGIT circular stapler in trials and clinical practice was issued in 1975 [22]. One of the authors (S.N. Fine) was the head of the oncological department of the Moscow Institute of Proctology from 1963 to 1973. Apparently, both clinical experience and the stapler itself were brought from the USSR. It was a circular stapling device using tantalum staples that was inserted through the anus to perform an end-to-end intra-abdominal mechanical anastomosis. The method was successfully applied in the USSR, first in experimental trials in 20 dogs and then in 165 human surgeries performed in Russia for carcinoma of the lower rectum from 1967 to 1972; the mortality rate was 2.4% and the incidence of mechanical suture failure was 3.6%.

In 1979 M. Ravitch and F. Steichen reported the successful use of hardware suture in an experiment at a distance of only 2 cm from the anus [23], which was the limit of the surgeon's possibilities to perform with the help of manual suture from the laparotomic access in the bowels of the small pelvis. The results of using the Russian circular suture device KC-28 in 50 patients were published in 1978 for the first time in Western Europe [24]. The authors reported 50 cases of inferior colorectal anastomosis performed for tumors located more than 4 cm above the anorectal fold. They verified that this technique does not compromise the closure function of the anus, reducing operative difficulties and not compromising oncological principles of treatment. The authors were surprised that postoperative complications were less frequent. The first publication on the use of the KC device in Eastern Europe (Hungary) was published in 1976 [25].

The work of D. Golikher et al became the most famous paper popularizing the technique from the USSR. [26]. The authors reported that in two years they were able to use the Soviet circular suture stapler USGIT in 62 patients. The authors concluded that the "Russian suture gun" provides reliable colorectal anastomoses that are at least as safe as those performed manually, and, in addition, it allows anastomosing the colon at a lower level, closer to the anal sphincter, which is impossible with the conventional manual suture technique. It turned out that the principles of the new technique described by M. Ravitch and D. Golicher were so important and simple that very soon they became a sort of obligatory reading for gastroenterology surgeons seeking competent handling of these instruments [27].

The attempt to introduce hardware suture into wide clinical practice in Europe initially met with indifference among specialists. Therefore, special publications by R. Held were required, in which he detailed the objective advantages of the new technology [28]. Initially, USGIT devices from the USSR and EA devices from the USA appeared in the UK as an alternative to manual anastomosis and, thus, did not arouse special interest among surgeons. However, soon it become apparent that the main value of staplers was the opportunity to create a secure anastomosis in the lower pelvis where safe manual anastomosis is difficult. This tool gave a surgeon the opportunity to redefine his surgical approaches and capabilities in rectal cancer.

EMERGENCE OF "RUSSIAN GUN"

The term "suture gun" was first used by D. Golicher in his publications to designate the Soviet circular stapling gun for colorectal surgeries, taking into account the appearance of the device, which resembles a short-barreled firearm. Right after him, R. Held uses the phrase "circular stapling gun" in the specialized literature. The term "Russian gun" was probably used in private conversations with colleagues and friends, most likely in a joking form. In the USA, the term "mechanical suturing apparatus" was usually used [29].

According to R. Held, D. Golicher showed him the "Russian gun" for the first time and encouraged him to think about using it in extremely low anterior resection of the rectum. It took another year to think, prepare and implement this

idea, when R. Held treated a 20-year-old recently divorced patient with a low tumor 5 cm from the anus. If a low anastomosis was not possible, she was facing the alternative of a permanent single-barrel colostomy (unnatural anus) on the anterior abdominal wall. But the "Russian gun fired", allowing the anal sphincter to be preserved [29]. Thus, namely R. Held was the first to perform both the case removal of the regional perirectal tissue with lymph nodes (TME — total mesorectal excision) and stapler anastomosis with a Soviet stapling device during low anterior resection for rectal cancer, which he invented in 1978.

Such successes stimulated interest in the "Soviet gun" by other surgeons. However, during a tour in England, a demonstration of new stapler's capabilities ended when the Russian gun malfunctioned during a demonstration operation. Therefore, "we all rejoiced," writes R. Held, "when the American company Autosuture began to produce disposable, more reliable instruments for stapling" [29].

INTEREST CAME TO REPLACE SKEPTICISM

However, publications in the USA, active educational work of R. Held in England (despite only one negative result), trips of Russian surgeons to European countries gave their results. There appeared interested responses and pioneer works in different Western countries. The so-called "Gun from USSR" and other brands of stapling devices began their triumphal march around the world. Belgium reported the use of Soviet devices PKS-28 and USGIT in 30 patients [30]. Polish oncologists reported the first favorable experience of using the PKC-25 instrument [31]. The new technique was adopted in Germany [32], Sweden [33], England [34], Italy [35], and Finland [36]. Irish surgeons, satisfied with the results of the first 30 operations, noted that gaining experience and a thorough familiarity with the technique resulted in fewer complications [37]. Hardware suture appeared in clinics and hospitals in other continents: in Africa (South Africa) [38], Australia [39] and South America (Brazil) [40].

Obviously, the pendulum of interest in new medical technologies gradually swung in the opposite direction: open rejection and latent indifference were replaced by interest, enthusiasm, passion, inspiration and encouragement. Many surgeons quickly jumped on a "foot of the train" to support its use [41]. R. Held and R. Lester expressed their belief that such operations could become one of the most striking and useful areas of progress in surgical technique, provided, of course, that the risks and dangers were recognized, considered, and mitigated [42].

F. Steichen and M. Ravitch considered that the Soviet instruments had following disadvantages: the necessity to precisely assemble the device during an operation after each preoperative sterilization, obligatory manual filling of the device cartridge with staples, formation of single-row sutures, and the absence of the instrument axis bend (repeating the bend of the rectum). However, the experiment showed that they could successfully perform extremely low rectal anastomoses [43].

However, if we compare the cost of the stapling device and rectal extirpation surgery with a permanent colostomy and lifelong care, the cost of using a stapler is lower than treating a patient after complete organ loss [44]. Hardware suture alone could not reduce the incidence of local tumor recurrence, but this could be achieved if low anterior resection was supplemented with TME (total mesorectumectomy), which created an objective justification for the widespread introduction of this method [45].

In the 1980s, it became clear to most coloproctologists that the use of new disposable American circular staplers saves a significant amount of time, primarily in forming a very low anastomosis. And the anastomosis itself can undoubtedly be performed with much greater ease compared to manual suturing [41].

Thus, the pioneer works of the Soviet Union in the field of tissue stitching and later Russian achievements in the creation of surgical instruments for solving a wide variety of problems pushed the world technologies to a number of improvements, which eventually made the methods of automatic stitching of organs and tissues a standard practice. For first 15–20 years (1966–1985) international experience of using first Soviet reusable stapling devices and then their American disposable modifications had been actively accumulated. It allowed to conclude that stapler colorectal anastomoses are at least as safe as those performed manually; the use of circular stapler allows to perform the reconstructive-restorative stage of low anterior rectal resection at lower levels (closer to the anus) than

in case of manual suturing. As a result, in the 1970s the rectum removal (total proctectomy as an alternative to resection which is concerned as disabling operation) became several times less frequent. The immediate results demonstrated that the use of the new technique in combination with TME did not lead to an increased incidence of local recurrence and decreased survival rate of patients after radical operations; low anterior resection with the formation of a hardware anastomosis became the operation of choice for almost all rectal lesions in which it is possible to safely preserve the sphincter [27], and hence the function of the rectum.

In 1988, R. Held emphasized that during rectal cancer surgery for rectal excision there was only one "high-tech" instrument in the hands of the doctor, which he could afford under these conditions — these were long sharp scissors. At the same time, only millimeters separate the surgeon from a wrong move, and he, like Odysseus — the hero of Homer's poem — can pass between Scylla and Charybdis: both radically remove the tumor with locoregional lymph nodes, without leaving tumor cells in the pelvis, and preserve the full function of urogenital organs without traumatizing their nerves [45].

Continuing R. Held's appeal to the images of Homer's great poem, let us remember that the last test of Odysseus (22nd song) was to draw his marvelous tight bow and release an arrow through the 12 rings set by Telemachus and not to touch a single one. Only then he could assert the right to regain his native island of Ithaca and his wife Penelope. When the operation ends, after the cutting and stitching mechanism of the "Russian gun" is triggered, the surgeon needs to receive only two complete intestinal "rings" (in Anglo-Saxon specialized literature the term "donut" is used), i.e. resected sections of the organs to be stitched together (proximal and distal ones). This is additional evidence in favor of the triumphant completion of tests, which have been finally passed by a modern coloproctologist-surgeon rather than by the hero of Homer.

The widespread use of the Soviet stapling device eventually leveled all the fluctuations of mastery of specialists from different countries of the world regarding the technique of interintestinal suture. An appeal to Samuel Colt's invention allows us to paraphrase it as follows: "God created different surgeons — strong and weak, 'Russian gun' made them equal". One of the most difficult anastomoses — low-lying colonic junction in rectal cancer surgery — has become equally reliable in the hands of a surgeon, regardless of his mastery of manual suture technique. However, it required mastering a new competence.

It is necessary to remember about the Russian priority in the world surgical gastroenterology — the creation of reusable circular stapling devices — since the loss of historical memory may lead to the loss of national identity.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

Funding source. This study was not supported by any external sources of funding.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

REFERENCES

1. Anonymous. Surgical Instruments from Ancient Rome. Available at: http://exhibits.hsl.virginia.edu/romansurgical/ (accessed: 15.11.2023).
2. Dubhashi S.P., Avnish A. Sushruta: Foundation for Surgical Practice. J Krishna Inst Med Sci Univ. 2016;5(2):145–150.
3. Thompson C.J.S. The History And Evolution Of Surgical Instruments. New York; 1942. Available at: https://archive.org/details/in.ernet.dli.2015.64003/page/n1/mode/2up (accessed: 15.11.2023).

4. Sharefkin J., Joffe N., Silen W., Fromm D. Anastomotic dehiscence after low anterior resection of the rectum. Am J Surg. 1978;135:519–23.
5. Tagart R. Colorectal anastomosis: factors influencing success. J R Soc Med. 1981;74:111–118.
6. Gudov V.F. The technique of applying a vascular suture by mechanical means. Khirurgiya. 1950;12:58–60. (In Russian).
7. Kovanov V.V. Mechanical hand suture of blood vessels. Brit Med J. 1956;5:1003–5.
8. Androsov P.I. et al. Suturing of the ureter with a mechanical suture. Urologiya. 1957;5:50–52. (In Russian).
9. Kalinina T.V. The device for stitching the intestines. New Surgical Archive. 1958,2:115–8. (In Russian).
10. Bairov G.A. Emergency surgery for children. Leningrad: Medicine; 1973. (In Russian).
11. Anonymous. Soviet surgical stapler being tested here. Scope. 1960;5(5):1;7.
12. Burcev A.N. Apparatus for the formation of esophageal anastomoses by mechanical double-row suture. Klinicheskaya khirurgiya. 1962;10:80–81. (In Russian).
13. Kalinina T.V. Development and clinical application of crosslinking devices for anastomoses of the digestive tract. In: Khirurgicheskie sshivayushchie apparaty. Moscow; 1967:71–85. (In Russian).
14. Burcev A.N., Lunev V.V., Kovalchuk J. et al. Vnutribrjushinnaja rezekcija prjamoj kishki s formirovaniem anastomoza dvumja rjadami mehanicheskih shvov ustrojstvom sobstvennoj konstrukcii. In.: Materialy Pervoj Vseukrainskoj respublikanskoj proktologicheskoj konferencii. Kiev. 1975;45–146. (In Russian).
15. Gureeva Kh.F. Resection of the rectum with the use of a mechanical suture by the KC-28 apparatus. Pirogov Russian Journal of Surgery. 1966;96(1):60–63. (In Russian).
16. Kalinina T.V., Kasulin V.S. The KC-28 device for stitching the rectum with the colon or small intestine. Voprosy onkologii. 1966;12(1):114–118. (In Russian).
17. Rygyh A.N. Anterior rectal resection. Khirurgiya.1967;43(50):107–112. (In Russian).
18. Alexandrov V.B., Gurejeva Kh.F. Uso de los aparatos soviéticos de sutura en cirugía colorectal. Rev. Esp. Enf. Ap. Digest. 1 junio. 1971;5:489–490. (In Spanish).
19. Vitone E. Mark Ravitch both made and wrote surgical history. Available at: https://www.pittmed.health.pitt.edu/Spring_2013/curmudgeon.pdf (accessed: 01.11.2023).
20. Ravitch M.M., Brown I.W., Daviglus G.F. et al. Experimental and clinical use of the Soviet bronchus stapling instrument. Surgery. 1959:46:(1):97–108.
21. Scierski A. From ant to stapler – 100 years of mechanical suturing in surgery. Videosurgery and other Miniinvasive Techniques. 2010;5(2):76–81.
22. Fain S.N., Patin S., Morgenstern L. Use of mechanical suturing apparatus in low colorectal anastomosis. Arch. Surg. 1975;110:1079–1082.
23. Ravitch M.M., Steichen F.M. A stapling instrument for end-to-end inverting anastomosis in the gastrointestinal tract. Ann. Surg. 1979;189:791–797.
24. Beckers J., Deldime P. A propos de 50 anastomoses colorectales basses par suture mécanique. Acta Chir Belg. 1978;77(5):327–333. (In French).
25. Németh L., Löblovic I. Verwendung der KZ-Nähmaschine in der Rektalchirurgie. Zentralbl Chir. 1976;101(13):815–817. (In Hungarian).
26. Goligher J.C., Lee P.W., Macfie J. et al. Experience with the Russian model 249 suture gun for anastomosis of the rectum. Surg Gynecol Obstet. 1979;148(4):516-524.
27. Knight Ch.D., Griffen F.D. Techiques of low rectal reconstruction. Cur Probl Surg. 1983;20(7):387–456.
28. Heald R.J. Towards fewer colostomies-the impact of circular stapling devices on the surgery of rectal cancer in a district hospital. Br J Surg. 1980;67(3):198–200.
29. Heald R.J. The evolution of a concept: the total mesorectal excision story. In: Manual of Total Mesorectal Excision. Ed. B.Moran, R.J. Heald. 2013; Taylor & Francis Group: 1–30.
30. Gauthier-Benoît C.,Prat A. Mechanical suturing during resection directum through the Abdomen. Acta Chir Belg. Jul-Aug. 1979;78(4):259-264.(In French).
31. Bogacki W. et al. Mechanical Intestinal Anastomosis With the Use of the PKS 25 Apparatus in Rectal Cancer. Tumors. 1981;31(1):75–80. (In Polish).
32. Becker H., Probst M., Ungelheuer E. Mechanical anastomosis after anterior rectal resection. Surgeon. 1980;51(5):341–343. (In German).
33. Devlin H.B. Stapling guns. Br J Surg. 1980;67(6):456. DOI: 10.1002/bjs.1800670634.
34. Bolton R.A., Britton D.C. Restorative surgery of the rectum with a circumferential stapler. Lancet. 1980;1(8173):850–851. DOI:10.1016/s0140-6736(80)91355-0.
35. Bezzi M., Tucci G., De Angelis R. et al. Experience and results in low colo-rectal mechanical anastomosis in surgery of cancer of the rectum. Minerva Chir. 1982;37(5):363–366. (In Italian).
36. Laitinen S., Huttunen R., Ståhlberg M. et al. Experiences with the EEA stapling instrument for colorectal anastomosis. Ann Chir Gynaecol. 1980;69(3):102–105.
37. Kirwan W.O. Integrity of low colorectal EEA-Stapled anastomosis. Br J Surg. 1981;68(8):539–540. DOI: 10.1002/bjs.1800680806.
38. Brown A.A., Gasson J.E., Brown R.A. Experience with the EEA stapler in carcinoma of the lower rectum. S Afr Med J. 1981;59(8):258–261.
39. Polglase A.L., Hughes E.S., Masterton J.P., Waxman B.P. The autosuture surgical stapling instruments: preliminary experience. Aust N Z J Surg. 1979;49(1):111–116.
40. Cutait D.E., Cutait R., da Silva J.H. et al. Stapled anastomosis in colorectal surgery. Dis Colon Rectum. 1981;24(3):155–160. DOI: 10.1007/bf02962325.

41. Beart R.W., Wolff B.G. The use of staplers for anterior anastomoses. World J Surg. 1982;6(5):525–530.
42. Heald R.J., Leicester R.J. The low stapled anastomosis. Dis Colon Rect. 1981;24:437–444.
43. Steichen F.M., Ravitch M.M. History of mechanical devices and instruments for suturing. Curr Probl Surg. 1982;19(1):3–52. DOI: 10.1016/0011-3840(82)90004-1.
44. Parrott N.R., Devlin H.B. An alternative to colostomy. Br Med J. 1979;1(6178):1630.
45. Heald R.J. The 'Holy Plane' of rectal surgery. J R Soc Med. 1988;81:503–508.

ЛИТЕРАТУРА

1. Anonymous. Surgical Instruments from Ancient Rome. Доступно по: http://exhibits.hsl.virginia.edu/romansurgical/ (дата обращения: 15.11.2023).
2. Dubhashi S.P., Avnish A. Sushruta: Foundation for Surgical Practice. J Krishna Inst Med Sci Univ. 2016;5(2):145–150.
3. Thompson C.J.S. The History And Evolution Of Surgical Instruments. New York, 1942. Доступно по: https://archive.org/details/in.ernet.dli.2015.64003/page/n1/mode/2up (дата обращения: 15.11.2023).
4. Sharefkin J., Joffe N., Silen W., Fromm D. Anastomotic dehiscence after low anterior resection of the rectum. Am J Surg. 1978;135:519–23.
5. Tagart R. Colorectal anastomosis: factors influencing success. J R Soc Med. 1981;74:111–118.
6. Гудов В.Ф. Техника наложения сосудистого шва механическим способом. Хирургия. 1950; 12:58–60.
7. Kovanov V.V. Mechanical hand suture of blood vessels. Brit Med J. 1956;5:1003–5.
8. Андросов Р.И. Сшивание мочеточника механическим швом. Урология. 1957;5:50–52.
9. Калинина Т.В. Аппарат для сшивания кишок. Новый хирургический архив. 1958;2:115–8.
10. Баиров Г.А. Неотложная хирургия у детей. Л.: Медицина; 1973.
11. Anonymous. Soviet surgical stapler being tested here. Scope. 1960;5(5):1,7.
12. Бурцев А.Н. Устройство для формирования пищеводных анастомозов механическим двухрядным швом. Клиническая хирургия. 1962;10:80–81.
13. Калинина Т.В. Разработка и клиническое применение сшивающих устройств для анастомозов пищеварительного тракта. В кн.: Хирургические сшивающие устройства. М.;1967:71–85.
14. Бурцев А.Н., Лунев А.Н., Ковальчук Г. и др. Внутрибрюшинная резекция прямой кишки с формированием анастомоза двумя рядами механических швов устройством собственной конструкции. В кн.: Материалы Первой Всеукраинской республиканской проктологической конференции. Киев. 1975;45–146.
15. Гуреева Х.Ф. Резекция прямой кишки с применением механического шва аппаратом КЦ-28. Вестник хирургии имени И.И. Грекова. 1966;96(1):60–63.
16. Калинина Т.В., Касулин В.С. Аппарат КЦ-28 для сшивания прямой кишки с толстой или тонкой кишкой. Вопросы онкологии. 1966;12(1):114–118.
17. Рыжих А.Н. Передняя резекция прямой кишки. Хирургия. 1967;43(5):107–112.
18. Alexandrov V.B., Gurejeva Kh.F. Uso de los aparatos soviéticos de sutura en cirugía colorectal. Rev. Esp. Enf. Ap. Digest. 1 junio 1971;5:489–490.
19. Vitone E. Mark Ravitch both made and wrote surgical history. Доступно по: https://www.pittmed.health.pitt.edu/Spring_2013/curmudgeon.pdf (дата обращения: 01.11.2023).
20. Ravitch M.M., Brown I.W., Daviglus G.F. et al. Experimental and clinical use of the Soviet bronchus stapling instrument. Surgery. 1959:46:(1):97–108.
21. Scierski A. From ant to stapler – 100 years of mechanical suturing in surgery. Videosurgery and other Miniinvasive Techniques. 2010;5(2):76–81.
22. Fain S.N., Patin S., Morgenstern L. Use of mechanical suturing apparatus in low colorectal anastomosis. Arch. Surg. 1975;110:1079–1082.
23. Ravitch M.M., Steichen F.M. A stapling instrument for end-to-end inverting anastomosis in the gastrointestinal tract. Ann. Surg. 1979;189:791–797.
24. Beckers J., Deldime P. A propos de 50 anastomoses colorectales basses par suture mécanique. Acta Chir Belg. 1978;77(5):327–333.
25. Németh L, Löblovic I. Verwendung der KZ-Nähmaschine in der Rektalchirurgie. Zentralbl Chir. 1976;101(13):815–817.
26. Goligher J.C., Lee P.W., Macfie J. et al. Experience with the Russian model 249 suture gun for anastomosis of the rectum. Surg Gynecol Obstet. 1979;148(4):516–524.
27. Knight Ch.D., Griffen F.D. Techiques of low rectal reconstruction. Cur Probl Surg. 1983;20(7):387–456.
28. Heald R.J. Towards fewer colostomies-the impact of circular stapling devices on the surgery of rectal cancer in a district hospital. Br J Surg. 1980;67(3):198–200.
29. Heald R.J. The evolution of a concept: the total mesorectal excision story. In: Manual of Total Mesorectal Excision. Ed. B.Moran, R.J. Heald. 2013;Taylor & Francis Group:1–30.
30. Gauthier-Benoît C.,Prat A. Mechanical suturing during resection directum through the Abdomen. Acta Chir Belg. Jul-Aug. 1979;78(4):259–264.
31. Bogacki W. et al. Mechanical Intestinal Anastomosis With the Use of the PKS 25 Apparatus in Rectal Cancer. Tumors. 1981;31(1):75–80.
32. Becker H., Probst M., Ungelheuer E. Mechanical anastomosis after anterior rectal resection. Surgeon. 1980;51(5):341–343.

33. Devlin H.B. Stapling guns. Br J Surg. 1980;67(6):456. DOI:10.1002/bjs.1800670634.
34. Bolton R.A., Britton D.C. Restorative surgery of the rectum with a circumferential stapler. Lancet. 1980;1(8173):850–851. DOI: 10.1016/s0140-6736(80)91355-0.
35. Bezzi M., Tucci G., De Angelis R. et al. Experience and results in low colo-rectal mechanical anastomosis in surgery of cancer of the rectum. Minerva Chir. 1982;37(5):363–366.
36. Laitinen S., Huttunen R., Ståhlberg M. et al. Experiences with the EEA stapling instrument for colorectal anastomosis. Ann Chir Gynaecol. 1980;69(3):102–105.
37. Kirwan W.O. Integrity of low colorectal EEA-Stapled anastomosis. Br J Surg. 1981;68(8):539–540. DOI: 10.1002/bjs.1800680806.
38. Brown A.A., Gasson J.E., Brown R.A. Experience with the EEA stapler in carcinoma of the lower rectum. S Afr Med J. 1981;59(8):258–261.
39. Polglase A.L., Hughes E.S., Masterton J.P., Waxman B.P. The autosuture surgical stapling instruments: preliminary experience. Aust N Z J Surg. 1979;49(1):111–116.
40. Cutait D.E., Cutait R., da Silva J.H. et al. Stapled anastomosis in colorectal surgery. Dis Colon Rectum. 1981;24(3):155–160. DOI: 10.1007/bf02962325.
41. Beart R.W., Wolff B.G. The use of staplers for anterior anastomoses. World J Surg. 1982;6(5):525–530.
42. Heald R.J., Leicester R.J. The low stapled anastomosis. Dis Colon Rect. 1981;24:437–444.
43. Steichen F.M., Ravitch M.M. History of mechanical devices and instruments for suturing. Curr Probl Surg. 1982;19(1):3–52. DOI: 10.1016/0011-3840(82)90004-1.
44. Parrott N.R., Devlin H.B. An alternative to colostomy. Br Med J. 1979;1(6178):1630.
45. Heald R.J. The “Holy Plane” of rectal surgery. J R Soc Med. 1988;81:503–508.