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History of surgery: the evolution of views on the formation of intestinal stoma

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Abstract

The history of intestinal stoma surgery spans more than one century. Awareness of the possible benefits of creating an intestinal stoma came to the medical community long before the practical possibilities of its safe formation. At the same time, the evolution of the attitude towards the intestinal stoma has passed the stages of understanding the possibility of creating an artificial anus, understanding the need and expediency of such an intervention through the search for optimal techniques and the type of the stoma itself. Its connotation as the final stage of treatment of various coloproctological diseases has been formed amid the emergence of modern asepsis and antiseptics. And as a result of improving the operational technique of the main stage of the operation, the colo-(ileo-)stoma became only a temporary companion of a significant part of patients. The improvement of care methods has led to a significant improvement in the quality of life, even in life-long stoma patients.

The analysis of the content of works on the description of the use of intestinal stomas in surgery of the abdomen allows us to formulate ideas about the evolution of views on the role and importance of an unnatural anus, in the treatment of diseases and injuries of the intestine. Until the 18th century, professional physicians accumulated isolated personal experience and came to the realization of the possibility of excretion of feces bypassing the rectum. In the 18th century, the fatalism of passive observation of the patient is replaced by active tactics of struggle for their life. In the 19th century, surgeons in Europe are searching for the optimal localization of intestinal stoma and expand the indications for its formation. Since the beginning of the 20th century, there is a variety of kinds of stomas, expanding the range of indications for it. In the second half of the 20th century, the passion for technical aspects of stoma-surgery is replaced by stoma-therapy to improve the quality of life patients with a permanent stoma.

Keywords

history of medicine, history of surgery, coloproctological diseases, intestinal stoma

An intestinal stoma is an anastomosis (link) between the intestines and the skin surface, created by a surgeon (artificially) or which is a complication of a wound or the natural course of a pathological process (for example, a tumour). When literally translated "stoma" is Greek for "mouth". Stoma surgery relates to the field of coloproctology, which morphed into a separate area of surgery in the middle of the last century.

Surgery evolved from a craft into medical science and became an art after the emergence of anaesthesia (general and local), the emergence of topographic anatomy, the emergence of ideas about asepsis and antiseptics, as well as transfusion medicine. Until then, i.e., before the second half of the 19th century and the early 20th century, the development of surgery was haphazard and empirical, and usually boiled down to the accumulation and sharing of isolated facts and personal experiences. Against this backdrop, the evolution of views on the intestinal stoma, in our opinion, went through five stages.

First stage: realization of the possibility of excretion of faeces

In the early days of the advent of medical knowledge and skills, people had to rely on folk medicine and professional healers. However, for a long time, diseases and injuries of internal organs of the chest and abdo-

men remained *terra incognita*. In case of a penetrating abdominal wound with the opening of a bowel lumen, ancient physicians (Hippocrates, Celsus, Galen) could only rely on the demarcation of the wound from the vacant abdominal cavity and the natural formation of an intestinal stoma (Graney and Graney 1980), which in rare cases could close on its own. More often than not, until the 19th century inclusively, most penetrating abdominal wounds were considered fatal (Adams 1983).

Celsus is said to have tried to sew up abdominal wall wounds, but usually witnessed a fatal outcome. He, therefore, came to the idea that nothing could be done once the small intestines are injured. However, if the large intestine was attached to the abdominal wall at the point of the wound, the patient would survive. Furthermore, he noted that constricted hernia sometimes formed its own outlet through the intestinal stoma (Dinnick 1934).

However, Caelius Aurelianus (the 2nd century B.C.) cited Praxagoras (the 4th century B.C.) – the mentor of Herophilos and the cousin of Hippocrates – who argued that, in the absence of the effect of medical treatment of intestinal obstruction, an abdominal incision had to be made in the pubic region, the large intestine had to be opened, its contents removed and the would sewn up (Caelius Aurelianus… 1950, Wu 2012).

More reliable is the account of the first attempt at suturing an intestinal defect after injury and interrupting the natural course of events, made in the late 15th century by Hieronymus Brunschwygk (Loria 1948). Still, in the 16th century, the father of military medicine, Ambroise Paré, kept with tradition and recommended to only stick to the elimination of the present eventration without colorrhaphy (Dunphy 1970, Paré 1951). Only Paracelsus suggested creating an artificial path into the intestines after observing the self-healing of intestinal stomas after abdominal injury. In 1701, Jean Méry, a surgeon at the Hôtel-Dieu hospital in Paris, probably for the first time in the world, was forced to form an "*anus contre nature*" in a female patient with a strangulated inguinal hernia. He cut out the necrotised portion of the strangulated intestine, and a colic stoma was formed in the pubic region.

In 1710, French surgeon Alexis Littré for the first time described the death of a six-day-old infant with an imperforate anus as a result of rectal atresia and suggested the formation of an intestinal stoma as a method of treating this birth defect (Littre 1710). The idea was too revolutionary and it was only in 1757 that German anatomist and surgeon, Lorenz Heister, returned to the idea of the need and the possibility of creating an intestinal stoma in the event intestinal injury or disease (Tebala 2015, Heister 1743). He argued that, since the edge of the intestinal wound can spontaneously fuse with the edge of abdominal wall wound, this tip from nature had to be utilised. Colleagues argued that the exteriorisation of the intestines was extremely unpleasant for the patient. His argument was that it was better to give up one of the conveniences of life than life itself (Cataldo 1999).

The names of the first few patients whose treatment comprised the forced creation of an intestinal fistula are known. The first among them was George Deppy, who had sustained an abdominal wound during the Battle of Ramilles on 23 May 1706, after which he had a colostomy formed, which functioned for the remaining 14 years of his life. In 1737, the Queen of Great Britain, Caroline of Brandenburg-Ansbach, the wife of George II, had a spontaneous intestinal stoma ("Royal stoma") after rupturing the membrane of strangulated umbilical hernia. Because the strangulation led not only to obstruction, but bowel gangrene as well, she died three days later. In 1750, William Cheselden operated on 73-year old Margaret White for strangulated umbilical hernia related to incoercible vomiting and cut out 55 cm of the intestine, which was fixed at the level of the hernial orifice. Despite the horrible hygiene conditions, she survived and for a long time cared for the peristomal skin with a towel and a rag (Wu 2012, Cromar 1968 Kingsnorth 2006, Cheselden 1750).

Second stage: fatalism replaced by active tactics

Until the early 18th century, in case of intestinal injury, a wait and see tactic was used with respect to the natural course of a pathological process. The first attempts of active intervention in the course of intestinal diseases and injuries - the purposeful formation of an intestinal stoma – relate to this period only. These attempts comprised the pulling out and fixation of the edges of the opening in the intestine on the anterior abdominal wall, which facilitated the discharge of faecal matter. The ideas of passionary physicians gradually came into fruition.

In France, in 1776, following his plan rather than relying on the long arm of coincidence, H. Pillore was able to form the first ever colostomy. Until then, attempts had been made to resolve the intestinal obstruction of his patient by administering a large amount of laxatives and mercury, which turned out to be ineffective. During digital examination, Pillore detected stricture mimicking rectal cancer and created a cecostoma on the wine merchant, Morel, by sewing the edge of the opening in the caecum to the anterior abdominal wall. The patient died on the 28th day due to complications caused by taking a large amount of mercury. The autopsy showed that the stoma was tightly fixed to the skin (Dinnick 1934).

In 1783, A. Dubois unsuccessfully attempted to realise Littré's idea: his three-day old patient lived just 10 days after the colostomy (Amussat 1839, p. 88). It was only three years later, in 1793, when a newborn with proctatresia was successfully operated on for the first time. C. Duret created a colostomy in the left iliac region of a four-day-old infant, who went on to live with the colostomy for 45 years (until his death). Duret initially used this technique on a deceased 15-year old patient, and then decided to use the experience in clinical practice (Duret 1798).

Double-barrel colostomy was formed for the first time in 1797 by P. Fine in Geneva on a 63-year old woman with an obstructive tumour of the rectosigmoid junction. The patient lived for 3.5 months after the operation. During the autopsy, it turned out that the surgeon had created a transverse colostoma instead of an ileostomy as intended (Amussat 1839, p. 109, 114). During the Battle of Abukir in 1799, Dominique Larrey fixed the damaged intestines that were lying freely in the abdominal cavity of a soldier that had sustained an abdominal gunshot wound. He sutured the edges of the intestinal wound to the anterior abdominal wall and left the patient until full recovery (Cataldo 1999, Larrey 1823).

The first reference to special-purpose faecal collectors was made in 1795. Through an operation, M. Daguesceau formed an intestinal stoma in the pelvic area of a farmer who had sustained injury with damage to the intestines. The farmer was subsequently fitted with a small leather bag for collecting faeces, with which he lived until the age of 81 (Daguesceau 1844). Almost nothing is known about how other patients coped with the sanitation of the stoma and peristomial area.

Individual and collective experience in this field was gradually accumulated. Despite the risks, it became clear that colostomy prolongs the life of patients with intestinal obstruction caused by colon cancer, with abnormal development of the rectum, as well as with penetrating abdominal wounds, at a time when the creation of an intestinal anastomosis was not yet possible. In cases with cancerous diseases, the formation of a stoma could certainly not prolong the life of patients, since no radical surgery was performed and the tumour was not removed from the patient. At this stage of the development of medicine, the formation of an intestinal fistula was a forced measure in cases when non-surgery treatment was impossible. Furthermore, there were no special techniques for caring for the stoma and the risk of complications was high due to the rudimentary equipment, as a result of which surgeons themselves opted not to perform the operation. Among physicians, attitude towards this technique was rather negative. One would agree with S.S. Yudin's opinion of the surgery of that time: "In those old days, the determination of surgeons had to contend with the inflexible will to live of the patients themselves" (Iudin 1955, p. 16).

Third stage: the search for the optimal localization of intestinal stoma (analysis of alternatives) and expansion of indications for it

In 1800, H. Callisen from Copenhagen insisted on the need for translumbar approach when performing colostomy since he considered the transabdominal approach dangerous due to the high risk of peritonitis. He explained that access to the caecum or descending colon through an incision in the lumbar region near the edge of the lumbar quadrate muscle and the formation of an artificial anus at that point was a questionable solution. However, it was easier to reach the large intestine particularly at that point than in the pelvic area (Callisen 1800).

Abdominal gunshot wounds with intestinal injury were associated with an unfavourable outcome. Hopes for the spontaneous formation of a stoma or the Larrey operation were still considered less feasible. L. J.-B. Baudens performed probably the first laparotomy in the history of surgery for a gunshot wound with suture of the intestinal wound during the French conquest of Algeria in 1830. One of the two patients survived (Baudens 1836). Encouraged by this success, with increasing frequency, the surgeon performed digital exploration of wounds during the Crimean War (1853–1856). And upon detecting faeces and gases, he insisted on laparotomy under anaesthesia, arguing that celiotomy would be used more frequently in case of injury to internal organs of the abdomen (Baudens 1858).

In the first half of the 19th century, the formation of a colostomy during disease and not intestinal wounds, gradually transformed from one-off interventions into a category of operations familiar to a wider circle of physicians. However, due to the risk of peritonitis, not all surgeons were willing to perform it. In 1839, French surgeon Jean Zùlema Amussat analysed 29 case studies of the formation of a colostomy from 1776 (i.e., descriptions of the first cases of colostomy by H. Pillore), where only four patients survived. In all cases, the operation was performed using abdominal approach (Amussat 1839, p. 204). Shaken by the death of his friend from obstructive rectal cancer, J.Z. Amussat set out to find a way to treat colorectal cancer: "I was well prepared to no longer remain a passive spectator of death by obstruction of the rectum..."[1] (Magill 1895, p. 34).

In order to eliminate the risk of peritonitis, he elaborated the idea of the extraperitoneal formation of a colostomy via a transverse cut in the lumbar region.[2] The change of approach enabled to expand indications for the formation of a stoma. Although, J.Z. Amussat did not put forward a method of treating colorectal cancer, he considered the easing of the suffering of patients with acute intestinal obstruction (Amussat 1856) to be his main achievement.

In England in 1841, independent of the French surgeon's work, J. Erichsen, based on previously published data, articulated the expanded indications for the formation of a colostomy: rectal atresia, treatment-resistant constipation, colon obstruction and rectal cancer with severe pain (Erichsen 1841). These indications in particular were taken into account by T. Billroth, who opera-

[1] Translated by N.N. Krylov.

[2] Stages of J.Z. Amussat's operation: https://commons.wikimedia.org/wiki/File:Amassat%27s_lumber_colostomy,_stages_in_the_operation._Wellcome_L0010081.jpg

ted on N.A. Nekrasov on 12 April 1879 for progressive rectal obstruction, caused by stricture mimicking cancer. Colostomy under chloroform anaesthesia (Belogolovy 1878) was conducted in the poet's apartment (36 Liteyny Prospect, Saint Petersburg) by retroperitoneal approach as required by J.Z. Amussat.

The general atmosphere in those days was vividly described by German surgeon G. Wegner in 1876, who stressed that, like himself, his contemporaries were brought up in fear of God and peritonitis. This fear would loom over surgeons, right until the advent of antibiotics.

In 1879, obstructive resection of the colon with a tumour was performed for the first time in Austria: colonic – T. Billroth, and sigmoid – Carl Gussenbauer, with suture of the peripheral end, its sinking into the abdominal cavity and the pulling out of the proximal end onto the abdominal wall in the form of an end colostomy. Due to the absence of an entero-entero anastomosis and the possible risk of failure of its suture, this way of ending the operation enabled to drastically reduce postoperative lethality (Billroth 1879, Magill 1895, Maydl 1888).

A non-radical analogue of this operation, but simpler in terms of technical execution, was the formation of an end colostomy in 1884 by O. Madelung from Rostock and M. Polloson from Lyon for treating rectal cancer. It was performed through laparotomy with complete cut-off of the sigmoid colon loop, where the afferent end was pulled into the wound onto the anterior abdominal wall, leaving the lumen open, and the distal end was sewn tightly and sunk into the abdominal cavity. The creation of such a colostomy marked a new stage in the development of colon surgery, since it enabled to avoid the creation of an intestinal anastomosis after its cutting. It also prevented contents of the intestines from entering the distal segment directly above tumour, and it could be a palliative alternative to emergency surgery for an inextricable tumour (Madelung 1884, Polloson 1884).

An alternative to single-barrel colostomy was proposed for the first time in 1885 by Russian surgeon A. Kni from Moscow. He suggested that double-barrel colostomy, which removes faeces, had to be performed, since the spurs separating the two parts of the intestines are enough to prevent faeces from entering the distal efferent limb. The surgeon tested his ideas during experiments on animals (Knie 1885). In 1888, K. Maydl published the description of a new technique of forming a loop stoma in clinical practice. The intestine loop was pulled out of the abdominal cavity and, through the mesentery; a support rod was placed underneath it. Even a goose quill was used emergency situations (Maydl 1888). The idea was also used by H.W. Allingham in 1887. He described the formation of a colostomy using a glass rod which was passed underneath a middle intestine loop, which prevented its retraction into the abdominal cavity until the edge of the intestines were fused with the edge of the wound of the abdominal wall. The use of such a rod enabled to create an artificial anus which protrudes above the surface of the body, which enabled complete discharge of the contents of the intestines and became the next stage in the evolution of the quest for the most effective and safest intestinal stoma (Allingham 1887).

The first ileostomy was formed nearly 150 years after the first colostomy, in 1879, by German surgeon W.G. Baum. A patient with intestinal obstruction during proximal colon cancer had an ileostomy formed as the first stage of treatment. After 8 weeks, resection of the ileocecal segment with ileocolostomy was performed. Unfortunately, the patient died on the 9th day after the operation due to the failure of anastomosis sutures and peritonitis (Cataldo 1999, Baum 1879).

Fourth stage: variety of kinds of stomas, wide range of indications

The first half of the 20th century is associated with the rapid development of new areas of surgery, including colorectal surgery. By that time, results (successes and failures) of the use of the intestinal stoma had been accumulated, which enabled to develop a new tactic.

The alternative radical operations for colon cancer that had been developed required the formation of a colostomy for temporary or permanent removal of faeces in the postoperative period. The established position was to perform as the first stage, in the most severely stricken, debilitated patients, preliminary intestinal decompression with a preventive (discharge) stoma – cecostoma (according to G.F. Zeidler, 1897) or transversosigmostomy (according to H. Schloffer, 1903). This enabled to plan and implement the two- or three-stage tactic for treating tumorous intestinal obstruction in the approaching 20th century. The second stage comprised resection of the intestine carrying the tumour, after which the safety intestinal fistula was removed at the third stage. The creation of a temporary intestinal stoma prevented intestinal contents from entering the distal segment of the intestines during the healing of the intestinal anastomosis sutures (Tebala 2015, Cataldo 1999).

The colostomy played the same role during J. Mikulicz's multi-stage treatment of colon cancer. Not satisfied with the results of single-step resection with formation of a primary anastomosis, he described three-stage treatment of colon cancer in 1903. The first stage comprised pulling out part of the intestines with the tumour and creating a colostomy from the proximal end. The pulled loop with the tumour was cut out and the two limbs of the intestines (proximal and distal) were sewn together with the subsequent extended restoration of the continuity of the intestines. J. Mikulicz published material on 16 cases of this operation (one fatal case) in 1903 (Mikulicz 1903).

With time, the relative advantages and shortcomings of extraperitoneal resection with colostomy became clear, since the main operation becomes shorter, the likelihood of infectious complications is lower and the probability of the patient recovering quickly is higher. He argued that all this outweighs the inconvenience of a colostomy on the anterior abdominal cavity. The creation of a preventive stoma enabled him to reduce the frequency of lethal complications associated with single-step resection from 50% to 12.5% – based on the results of the first 100 operations (Mikulicz 1937).

Successes in the surgery of rectal and colon cancer occurred concurrently with the improvement of the technique of creating stomas. C.H. Mayo in 1904 (Mayo and Dixon 1928) and W.E. Miles in 1908 (Miles 1908) explained the creation of a terminal colostomy when completing abdominoperineal extirpation of the rectum. It enabled to perform the operation as much radically as possible, which in turn reduced the frequency of tumour recurrence and improved the long-term outcome. Thus, colostomy gained its place in the treatment of rectal cancer. J.P. Lockhart-Mummery in 1907 developed a technique for two-stage intermediate resection of the rectum: a loop colostomy was created 10 days prior to the intermediate resection of the rectum (Lockhart-Mummery 1923).

In 1921 H. Hartmann proposed a modification of the radical treatment of pelvic colon cancer, which includes the resection of the rectosigmoid segment, tightly sewing the distal end, placing the rectal stump below the pelvic peritoneum and creating a terminal colostomy from the proximal end. This operation essentially embodied the previous idea put forward by T. Billroth and C. Gussenbauer, albeit in an area more difficult for manoeuvre. This operation was proposed as an alternative to abdominoperineal rectum resection. H. Hartmann followed the concept of delayed formation of an entero-entero anastomosis with elimination of the stoma. However, he admitted the extremely high technical difficulty of restoring faecal flow. As a result, nearly a hundred years from the description of the operation, Hartmann allows for the formation of the continent colostomy, since later on up to 30–50% of patients do not return to have the stoma closed (Hartmann 1931).

The use of indications to ileostomy became widespread in the 20th century. Ileostomy could be temporary during aggravation of ulcerative colitis, and the natural flow of the faecal stream was restored after the onset of remission. The technique was proposed in 1913 by J.Y. Brown (Brown 1913). After the publication of the work of C.C. Miller et al in 1949, with increasing frequency surgeons resorted to total colproctectomy with permanent ileostomy for radical treatment of severe ulcerative colitis (Miller et al. 1949).

The lack or temporary bypass of the colon in such patients normally led to complications (uncontrolled dehydration, peristomal dermatitis), which hampered widespread use of this technique. This turned out to be critical in patients with pancolitis, the removal of which required the life-long presence of an ileostomy. However, after A. Parks proposed the creation of an ileal pouch ("neorectum" from the ileum) with preservation of the anal sphincter, ileostomy evolved into a category of a temporary measure for removal of faeces (Parks et al. 1980).

The widespread use of temporary intestinal stoma facilitated the accumulation of data on the nature, severity and frequency of complications which significantly influence mortality rate. D. Patey (1951) and C. Butler (1952) offered to perform abdominoperineal extirpation of the rectum during cancerous diseases with the formation of a skin-intestinal suture. The introduction of this technology into practice and the extraperitoneal location of the colostomy enabled to lower the risk of such dangerous complications as prolapse and stenosis. In 1952, B. Brooke proposed pulling out the mucous lining of the stump of the ileum and attaching it to the anterior abdominal wall by suture, thereby reducing the probability of the common dilatation of the stenosed "column" of the ileum (Brooke 1952).

Caring for the stoma was extremely difficult until the 1950s, when R. Turnbull introduced the concept of the rehabilitation of stoma patients (Turnbull and Turnbull 1991). Various modifications of the creation of intestinal stomas were subsequently proposed, although from the second half of the 20th century the basic concept of their use did not change significantly. Technical innovations (particularly the now commonplace mechanical, staple, intestinal suture) enabled to standardise the results of operations performed by surgeons worldwide, reduce the risk of postoperative complications associated with both the presence of the stoma and the possible failure of anastomosis sutures, which undoubtedly considerably improved the overall results, length and quality of life of patients.

Fifth stage: stoma surgery gives rise to stoma therapy

The creation of temporary or permanent intestinal stomas became a common operation in the 20th century. However, right up to the 1970–1980s, there were no special tools for caring for stomas. In 1924, a proposal was made to wash the colostomy, which was the only way of looking after stomas. The attachable colostomy bag was invented by Danish nurse Elise Sørensen in 1954. Norma Gill, a patient with an ileostomy, who had been operated on by American surgeon Turnbull for ulcerative colitis, became the first professional in providing care to stoma patients in 1958. The first device for collecting intestinal contents with odour containment was invented in the 1980s. Stoma patients now had a choice between the standard procedure of

washing the stoma or a tool for collecting intestinal contents (Cataldo 1999).

Attempts were made to create an alternative to colostomy bags by creating reservoirs and continent stomas. The technique of creating a "containment" ileostomy was first proposed by N. Kock in 1969 (Kock 1969). Numerous attempts were subsequently made to create the so-called continent stoma. However, most of the attempts were unsuccessful. New complications emerged and the degree of containment left a lot to be desired. The proposed techniques did not grain widespread currency.

In the early 21st century, with the emergence of sphincter-saving operations, the need for intestinal stomas dropped drastically; operations are increasingly performed with the primary creation of an intestinal anastomosis. However, due to its "low" position, the frequency of failure of its mechanical sutures is relatively high. Hence the creation of a preventive stoma became the cornerstone of success in preventing this complication. Thanks to the development of new treatment techniques, today a permanent stoma is necessary in just 15–25% of rectal cancer patients that have undergone radical surgical treatment.

Therefore, the history of intestinal stoma surgery spans more than one century. The recognition of the possible benefits of creating an intestinal stoma came to the medical community long before the practical possibilities of its safe formation. At the same time, the evolution of the attitude towards the intestinal stoma has passed the stages of understanding the possibility of creating an artificial anus, understanding the need and expediency of such an intervention through the search for optimal techniques and the type of the stoma itself. Its connotation as the final stage of treatment of various coloproctological diseases was formed amid the emergence of modern asepsis and antiseptics. And as a result of improving the operational technique of the main stage of the operation, the colo-(ileo-)stoma became only a temporary companion of a significant part of patients. The improvement of care methods has led to a significant improvement in the quality of life, even in life-long stoma patients.

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