

Anatomical Considerations on Sudeck's Critical Point and Its Relevance to Colorectal Surgery

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Sudeck's critical point at the rectosigmoid junction is described as the point of origin of the last sigmoid arterial branch, originating from the inferior mesenteric artery (IMA). There is controversy on the importance of Sudeck's point, and the frequency in which the anastomosis is found. Furthermore, the diameter of the anastomosis, if present, may also impact on the viability of the caudal stump. This study aimed to determine the frequency in which a macroscopic anastomosis occurs, between the superior rectal artery and the last sigmoidal branch, in a cadaver population; the diameter of this anastomosis and the distance from the origin of the IMA to Sudeck's point. Sixty-four cadavers were included in the study, excluding those with previous surgery to the rectosigmoid junction. Sudeck's point was carefully identified and dissected to establish the presence of an anastomosis. Subsequent measurements were performed using a digital caliper (accuracy $\frac{1}{4}$ 0.01 mm). A macroscopic anastomosis was absent in three cases (4.7%). The mean diameter of the anastomosis when present was 1.9 mm (SD: 0.5 mm), and the distance from the origin of the IMA to Sudeck's point was 55.5 mm (SD: 14.6 mm). Although an anastomosis is present in the majority of cases, the vessel is very small in diameter, and may not be sufficient to meet the demands of the caudal stump. The distance from the origin of the IMA to Sudeck's point is sufficient enough to allow for ligation of the IMA proximal to Sudeck's point.

INTRODUCTION

In 1907 Sudeck described his "critical" point as the point of origin of the last sigmoid arterial branch, originating from the inferior mesenteric artery (IMA) (Fig. 1) (Sudeck, 1907; Yamazaki et al., 1997b). Sudeck (1907) concluded that it is essential to retain this critical point during colorectal surgery, as removal may lead to ischemia of the distal colon.

The colonic blood supply contains various weak points known as watershed areas (Siddharth and Ravo, 1988), such as Griffiths' point at the splenic flexure (Griffith, 1956; Michels et al., 1965, 1968; Siddharth and Ravo, 1988; Yamazaki et al., 1997b) and Sudeck's point (Sudeck, 1907; Griffith, 1956; Michels et al., 1965, 1968; Siddharth and Ravo, 1988; Yamazaki et al., 1997b) at the rectosigmoid junction. Therefore, ligation of the IMA proximal or distal to Sudeck's point, during resection of the sigmoid colon, can be crucial in terms of postoperative blood supply to the caudal stump, depending on whether the anastomosis between the superior rectal artery (SRA) and the last sigmoid branch is present, and sufficient to meet the demands of the caudal stump.

If the anastomosis is absent, blood will have to flow up the SRA, through Sudeck's point and down the last sigmoid artery to supply the proximal part of the caudal stump when a sigmoid resection is performed. This is not possible if the SRA has been ligated as the part of the intestine supplied by the last sigmoid branch may have an insufficient blood supply in the absence of an anastomosis and may lead to postoperative ischemic colitis and necrosis, and later ischemic stricture.



Fig. 1. Dissection of the IMA (5) with the last sigmoidal branch (2) and SRA (1) with the presence of a macroscopic anastomosis (3). Sudeck's point is indicated by the arrow (abdominal aorta $\frac{1}{4}$ 6; rectosigmoid junction $\frac{1}{4}$ 4).

In 1918, Bacon and Smith (1918) first questioned the validity of Sudeck's point. They advocated transillumination of the mesentery in all patients prior to ligation of any vessel to identify an anastomosis.

Pope and Judd (1929) called Sudeck's point a misnomer with no surgical importance. Griffiths (1956, 1961) later affirmed this. He showed that even after ligation of the IMA in 100 patients, no adverse effects were observed in the distal portion of the colon and rectum, after resection.

It is clear that confusion exists regarding the presence of an anastomosis and whether this anastomosis if present is sufficient to meet the demands of the caudal stump. It also begs the question whether a mural anastomosis between the sigmoid colon and rectum is at most times physically present and physiologically functional to act as an adequate collateral blood supply to the stump remaining in the light of the low percentage of stump necrosis found.

Two other factors that should also be taken into consideration when the IMA is going to be ligated proximal to Sudeck's point. The first is the distance between the origin of the IMA at the aorta, and the second the diameter of the artery that forms the rectosigmoid anastomosis.

AIMS

The aims of this study was therefore to determine the incidence of the presence of a macroscopic anastomosis between the SRA and the last sigmoidal branch in a cadaver sample by means of macroscopic dissection, to measure the length of the IMA from its origin from the abdominal aorta to Sudeck's point, and to determine the diameter of the anastomotic artery, if present.

MATERIALS AND METHODS

Sixty-four cadavers were dissected in this study, of which 48 were obtained from the University of Pretoria and 16 were obtained from the Medical University of South Africa (Act 65 of 1983, Human Tissues Act).

Cadavers with previous colorectal surgery were excluded from the study. The cadavers were carefully dissected using standard dissection methods and instruments. The method included opening the anterior abdominal wall, reflection of the parietal peritoneum overlying the posterior abdominal wall, and identification of the origin of the IMA. The IMA was then followed inferiorly to Sudeck's point at the bifurcation of the last sigmoid artery and SRA. The SRA and last sigmoid arteries were carefully dissected up to the gut wall. The area between the SRA and last sigmoid arteries was subsequently carefully dissected to determine the presence of an anastomosis.

Subsequently, the length of the IMA from its origin to Sudeck's point was measured, as well as the diameter of the anastomotic artery when present. A digital caliper, with an accuracy of 0.01 mm, was used for all the measurements.

RESULTS

A sample of 64 cadavers (43 males, 21 females) was used in this study; the sample had a mean age of 62 years, a mean height of 1.66 m and a mean weight of 51.3 kg.

A macroscopic anastomosis between the SRA and last sigmoid artery was absent in 3 (4.7%) of the 64 cadavers (Fig. 2). A mean length of 55.5 mm (SD: 14.6 mm) was found from the origin of the IMA to Sudeck's point, and a mean diameter of 1.9 mm (SD: 0.5 mm) for the anastomosis between the SRA and last sigmoid artery in 95.3% where it was present.



Fig. 2. Dissection of the IMA (4) with the last sig-moidal branch (2) and SRA (1) with the absence of a macroscopic anastomosis. Sudeck's point is indicated by the arrow (abdominal aorta ¼ 5; rectosigmoid junction ¼ 3).

DISCUSSION

Drummond (1914) found that the anastomosis between the last sigmoidal and SRA to be poor or absent, and supported Sudeck that his point is critical and should be taken into serious consideration by surgeons when removing part of the sigmoid colon, for example, during vaginoplasty the removed part of the sigmoid colon is used for reconstruction of the vagina (Franz, 1996).

In his experiments, Sudeck (1907) injected a radio-opaque substance into the relevant part of the arterial circulation, in order to see, by means of roentgenograms, if the anastomosis between the SRA and last sigmoid branch exists and found that it is absent in most cases. Apart from Sudeck (1907), Drummond (1914) investigated the sigmoid vessels by injection techniques. All illustrated a critical point between the last sigmoid artery and SRA.

On the other hand, many authors (Griffiths, 1956, 1961; Michels et al., 1965, 1968) believe that Sudeck's point is not at all critical. They argue that Sudeck's experimental technique was not always reliable, because it did not take into account that the arteries do not always fill up with fluid properly because of postmortem spasm. Griffiths (1956) rightly pointed out that injecting radio-opaque material with subsequent roentgenograms taken of the cadaver is not a satisfactory method of investigating the presence of an anastomosis, unless being verified by dissection.

Griffiths (1965) used 60 necropsy subjects to study the anatomy of the IMA. A barium and gelatine mixture was injected into the abdominal aorta, after which the abdominal organs were removed in one block and then radiographed. He found that there were an adequate anastomosis between the SRA and last sigmoid artery. He suggested that the conclusions made by Sudeck (1907) and Drummond (1914) were false conclusions, which were made using an inadequate injection technique on a small sample. He found an anastomosis in almost all cases continuing on the margin of the rectosigmoid junction, anastomosing directly with the SRA or forming an arcade supplemented by rectosigmoid branches of the SRA.

Other factors that may also have influenced Sudeck's experiments are the viscosity of the fluid injected and blockages that may have been present in the arteries themselves. Complete filling of the anastomosis can therefore never be guaranteed (Siddharth and Ravo, 1988). A number of studies have shown that there is in fact a macroscopic anastomosis between the SRA and last sigmoid artery. Michels et al. (1965) found that the anastomosis between the last sigmoid artery and SRA was present in 39 of 75 specimens (52%). He took the study further and ligated 10 random specimens, from his sample ($n = 75$), distal to Sudeck's point, and injected a latex and India ink solution into the aorta. The SRA filled up with the injected solution in all 10 specimens, even though a macroscopic anastomosis was absent in four of the specimens. He concluded that an anatomical bypass does exist despite the presence of a critical point.

Recent studies suggest that ischemic colitis is more likely to occur in the so-called watershed areas, (Bower, 1993; Landreneau and Fry, 1990; Farman, 1995; Shoji and Becker, 1994). Longo et al. (1992) reported in a retrospective study that the rectosigmoid region was involved in 40% of a series of 47 patients with nonocclusive ischemia. Diagnoses were made either during surgery, by means of endoscopy or a barium enema. In another retrospective study Guttormson and Bubrick (1989) found the sigmoid colon to be involved in 25.6% of colonic ischemia. Again the diagnosis was made during surgery, by means of endoscopy or a barium enema.

Michels et al. (1965) stated that their cadaveric dissection study and autopsy cases examined confirmed that

Sudeck's point existed from a gross anatomical point; however, experimental ligation studies, arteriograms, roentgenograms, and surgical procedures deny its functional importance.

In a case reported by Yamazaki et al. (1997a,b), a patient underwent a sigmoidectomy to remove cancerous tissue in the distal colon. The patient had no anastomosis between the SRA and last sigmoid branch, and the surgeon ligated the SRA. The result was deficient blood supply to the proximal part of the caudal stump, and the patient developed postoperative ischemic stricture (Yamazaki et al., 1997). This case study alluded to the importance of retaining Sudeck's point during colorectal surgery.

A macroscopic anastomosis was absent in 3 of the 64 cadavers (4.7%). These findings correspond to studies conducted by Griffiths (1956, 1961). It therefore seems that although a macroscopic anastomosis exists in most cases, surgeons need to be aware of a small percentage of cases where the anastomosis is absent and where it is of great importance to retain Sudeck's point during colorectal surgery.

Although the anastomotic artery was present in 95.3% of cases, the mean diameter of 1.9 mm (SD: 0.5 mm) may be insufficient to supply the demands of the proximal part of the caudal stump. On the other hand, the artery may be able to dilate acutely at the time of ligation or adapt over time to be able to carry the increased load. Farman (1995) has alluded to the tenuous and deficient blood supply to the sigmoid colon in times of vascular need. Atheromatous change has been shown to occur more frequently and with greater severity in the IMA than in the superior mesenteric artery (Demos et al., 1962).

There are limitations that should be considered regarding the measurement of the diameter of the anastomosis. In our study, our sample consisted of an embalmed cadaver population. Embalmed tissue present some disadvantages, including slight shrinkage, deformation, especially of muscular tissue, and other artifacts, because of processing of the specimen. Therefore, the measurements reported might differ to some extent from the in vivo diameter. Further studies on in vivo samples as well as the relation between vessel diameter and colonic necrosis postsurgically need to be performed.

The possible extent of the submucosal anastomoses in supplying the proximal part of the caudal stump needs to be investigated as well. Griffiths (1961) and Michels et al. (1968) have described plexuses in the wall of the colon, including a rich submucosal plexus extending throughout the colon, a smaller mucosal plexus under the mucosa from where the arterioles supplying the mucosa originate, and a muscular and subserous plexus.

To avoid the risk of postoperative ischemic necrosis, colitis, and delayed stricture, it is desirable to ligate proximal to Sudeck's point, for those cases where an anastomosis might be absent or where the present anastomosis is insufficient.

One might consider establishing during surgery, if possible, whether an anastomosis exists or not, which may then inform the decision to retain Sudeck's point or not. However, the presence of an anastomosis may not imply that it is of sufficient diameter to meet the demands of the caudal stump.

In this study, it was found that the length of the IMA from its origin at the aorta to Sudeck's point is of ample measure for ligation proximal to Sudeck's point ($55.5 \text{ mm} \pm 14.6 \text{ mm}$), without harming any of the autonomic nerve plexuses running on the great vessels, regardless of the presence of an anastomosis.

From an anatomical point of view, Sudeck's point should not be considered as a critical point, but rather an important consideration during colorectal surgery. This is due to the fact that the macroscopic anastomosis is absent in a small sample of the population. Furthermore, due to uncertainty whether the diameter of the anastomosis, if present, is sufficient to meet the demands of the caudal stump, ligation proximal to Sudeck's point is suggested to be in the best interest of the patient.

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