Clinical and experimental studies on treatment of acute mesenteric ischemia
Schoots, I.G.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Chapter 4

Riolan’s anastomosis revisited

Thomas M. van Gulik\textsuperscript{1} and Ivo G. Schoots\textsuperscript{1}.

Department of \textsuperscript{1}Surgery and Surgical Laboratory, Academic Medical Center, University of Amsterdam, Amsterdam, the Netherlands

\textit{A tribute to Riolan "the prince of the anatomists"}

Submitted
Riolan’s anastomosis revisited

Abstract

Riolan’s anastomosis or arc is eponymously used to indicate the arterial anastomosis between the superior and inferior mesenteric arteries. Vascular as well as gastro-intestinal surgeons are well-acquainted with this collateral mesenteric pathway for retrograde perfusion of the superior mesenteric artery when the origin of the latter is occluded. The eponym suggests that Jean Riolan (1580-1657), a famous 17th century French anatomist, was the first to describe this arterial anastomosis. Riolan was a strong defender of traditional Galenic doctrine in medicine and therefore, proved a vigorous opponent of the new concept of the circulation of the blood as exposed by William Harvey (1578-1657). This makes it unlikely that Riolan would have conceived an arterial collateral pathway in the mesocolon, a notion confirmed by examining his anatomy book published in 1649. He probably had observed vascular arcades running along the inner border of the colon which later associated him with the collateral circulation of the mesentery. Other, well-known anatomical textbooks of his era show that mesenteric circulation was only poorly defined. It was not until 1743, that Albrecht von Haller (1708-1777) gave a detailed description of the anatomy of the mesenteric arteries, referring to the arterial collateral connection between the superior and inferior mesenteric arteries, as the “Arcus Riolani”, in honour of an old master of anatomy.
Introduction

The name of Riolan is eponymously attached to the arterial anastomosis between the superior and inferior mesenteric arteries. Eponyms in medical nomenclature usually bear reference to the author who first described an anatomical structure or functional concept. Hence, the eponym Riolan’s anastomosis suggests that Jean Riolan (1580-1657), a French anatomist, was the first to demonstrate the collateral arterial arcade that may occur in the colonic mesentery in the presence of occlusive abdominal arterial disease. It is paradoxical that this collateral anastomosis of the mesenteric arteries is named after Riolan, since Riolan was famous for his opposition to Harvey’s discovery of the circulation of the blood. This historical note focuses on Jean Riolan, a prominent but controversial 17th century anatomist, and concludes that this anatomist probably never observed the vessel that carries his name.

The “meandering mesenteric artery”

The collateral “meandering mesenteric artery” was described by Moskowitz as a thick wide vessel of uniform caliber with a tortuous course through the mesentery of the left colon, running more or less parallel to the mesenteric border of the colon. Besides Riolan’s anastomosis or arc, a variety of terms have been used to indicate this collateral pathway, including marginal artery, meso-mesenteric artery, middle colic-left colic collateral, artery of Drummond and arc of Treves.

Figure 1. Riolan’s anastomosis constituting the collateral arterial connection between the inferior mesenteric artery and the superior mesenteric artery in the event of occlusion of the origin of the superior mesenteric artery.

(Department of Radiology, Academic Medical Center, Amsterdam, the Netherlands)
The “meandering mesenteric artery” that arises from the inferior mesenteric artery for retrograde perfusion of the superior mesenteric artery in the event of occlusion of the origin of the superior mesenteric artery is readily recognized on intestinal arteriograms and is the enlarged branch of the left colic artery connecting centrally with the middle colic artery (Figure 1). Both vascular and gastro-intestinal surgeons are aware of this collateral mesenteric pathway since inadvertent ligation of Riolan’s anastomosis may have disastrous consequences during operative procedures. In the presence of this collateral, reimplantation of the inferior mesenteric artery is recommended during surgery for aortic aneurysm lest blood supply of the superior mesenteric artery is jeopardized. For the same reason, Riolan’s anastomosis should be preserved or reconstructed during left colonic resection.

Jean Riolan, the anatomist.

Jean Riolan was born in 1580 in Paris. His father, Jean Riolan the elder (1538-1605), was a famous medical doctor who at one time was the dean of the Faculty of Medicine in Paris. Like his father, Jean Riolan was a rigorous defender of traditional medicine and a strong proponent of Galen’s views. He became a professor of anatomy and botany at the University of Paris and was appointed physician to the kings Henry IV and Louis XIII, and for 10 years was the physician of Marie de Medici. He was one of the most authoritative anatomists of his time and as a skilled dissector, added much to anatomical and embryological knowledge (Figure 2).

In anatomical nomenclature, Riolan’s marginal bundle of the orbicularis palpebrarum muscle, Riolan’s cremaster muscle and Riolan’s bouquet (muscles and ligaments arising...
from the styloid process) testify to his many contributions to human anatomy. His opus magnum was the *Anthropographia et osteologia*, published in 1618, and with the second edition of this work, Jean Riolan established his fame as a scholar and anatomist. In this book, Jean Riolan tried to reconcile new discoveries with the traditional medical framework as was dictated by Galen. In 1649, Jean Riolan published an anatomical textbook entitled *Encheiridium anatomicum et pathologicum*, famed for its concise presentation of normal and morbid anatomy (Figure 3).

![Figure 3. Title page of Riolan’s *Encheiridium anatomicum et pathologicum*, published in 1649 in Leiden, the Netherlands.](image)

In the fourth edition of this work, published in 1658 in Paris, a chapter is included (*Tractatus de anatome pneumatica*, p603-609) in which he used air injections to explore the topography of blood vessels. While injecting air through the umbilical vein of a fetus, he noticed that all the organs, arteries and veins swelled with air, from which observation he concluded that all arteries anastomosed with the veins. In this connection, he probably described the mesenteric vascular arcades running along the inner border of the colon, associating his name with the collateral circulation of the mesentery. It was also in this work that Jean Riolan for the first time reacted to the discovery of the circulation of the blood by William Harvey (1578-1657).

Jean Riolan who suffered from troublesome asthma and bladder stones, died at the age of 77, of urinary obstruction. Although reactionary, he was a great anatomist and was remembered as the last humanist and Galenist of the Paris medical school.
Riolan’s concept of the circulation of the blood

Galen of Pergamon in the second century (AD) was the first to describe arteries as carriers of blood. According to Galen, whose doctrine dictated medical thought for the next 14 centuries, blood passed from the right ventricle through the pulmonary artery to the lungs.

Figure 4. Tabula XII of Riolan’s *Encheiridium anatomicum et pathologicum*, showing the venous system (I) and arterial system (IV). Y = celiac trunk, g = inferior mesenteric artery, y = superior mesenteric artery.
in which it mixed with air and became completely purified. It then passed through the pulmonary vein to reach the left chamber of the heart. Blood from the right ventricle passed through pores in the septum to the left ventricle in which blood and air elaborated into the "vital spirit". The spirituous blood was then distributed throughout the body by the own pulsific properties of aorta and arteries. Riolan almost religiously continued the medicine taught by Galen, as all the philosophers, naturalists and physicians of ancient Greece and Rome governed his thinking. In the context of mesenteric circulation, it is noteworthy that according to Riolan's views, the blood in the abdomen, whether in the portal vein, the splenic, celiac, or other arteries did not circulate at all. It is therefore unlikely, that Riolan would ever have conceived the presence of a collateral arterial pathway in the mesentery of the colon.

Jean Riolan, Harvey's foremost adversary.

Jean Riolan was a contemporary of William Harvey, who in his seminal treatise on the circulation of the blood, De motu cordis published in 1628, contradicted Galen's view on the movement of air and blood to the heart. Riolan was strongly opposed to the principle of the circulation of blood disclosed by Harvey, which according to the latter stemmed from his fear of destroying traditional medicine. Riolan was the only opponent of the new concept of the circulation of blood, whom Harvey deemed worthy of an answer and who he referred to as the "prince of anatomists".

Figure 5. Tabula IX-I of Riolan's *Encheiridium anatomicum et pathologicum*, showing the mesentery. d = rami arteriarum mesentericarum, c = rami venae portae meseraicae.
Even Thomas Bartholin, the Danish anatomist who favored the new ideas on the circulation of the blood, dedicated his book on the discovery of the lymphatic vessels to Riolan, whom he referred to as “the greatest anatomist on earth and in Paris”. In response to the theory proposed by Harvey, Riolan came up with his own concept of the circulation of the blood, which he named “circulatio Riolana” as opposed to the “circulatio Harveiana”. Riolan’s circulation maintained the Galenic vessels, as the arterio-venous anastomoses and the passages through the cardiac septum. Being a true Galenist, his main concern was to preserve the ancient art of healing while publicly disagreeing with Harvey’s doctrine. The concept of circulation had developed over two millennia, according to Riolan: Hippocrates conceived, Harvey discovered, and Riolan corrected the circulation.

The mesenteric arterial blood supply according to Jean Riolan.

Examination of Riolan’s anatomy textbook, Encheiridium anatomicum, tells us more about Riolan’s perception of the mesenteric vasculature. Figure 4 depicts the venous and arterial system in Riolan’s Encheiridium, showing schematically but very clearly, the celiac trunk, the superior mesenteric artery and the inferior mesenteric artery. These three main intestinal arterial trunks are shown as separate arterial trees, without any arterial interconnection whatsoever. His description of the mesentery is, however, more elaborate than most of the other anatomy textbooks available in the 17th century. Riolan distinguished four types of vessels in the mesentery, i.e. tributaries of the portal vein, lacteals, arteries and nerves. Again there is no mention of any collateral circulation between the superior mesenteric artery and the inferior mesenteric artery.

In the beginning of the 18th century, Galenism had further lost ground in favor of pathological anatomy and physiology. In The Netherlands, the University of Leiden had become one of the leading medical centers in Europe owing to the reputation of the world famous physician and scientist, Herman Boerhaeve (1668-1738). The most important anatomy textbooks of that era were written by the Dutch anatomists Adriaen van der Spiegel (1578-1625), Govert Bidloo (1649-1713) and Bernard Siegfried Albinus (1697-1770). Examination of these anatomy books learns that even in that time of new medical enlightenment, vascularization of the mesentery was only poorly defined, and no reference is made to a collateral arterial pathway in the mesentery of the colon (Figure 6 and 7). (The anatomy book of Albinus only depicts the muscles and bones of the human body.)

Haller’s “arcus magnus mesentericus”

It eventually was a pupil of Herman Boerhaeve, Albrecht von Haller (1708-1777), who would precisely disclose the blood supply of the colon. After Harvey’s principles on the circulation of the blood had become widely accepted, Albrecht von Haller was the first to produce a detailed account of the anatomy of the mesenteric arteries in his monumental work, Icones Anatomicae, published in 1743. Albrecht von Haller, a famous Swiss anatomist and the greatest physiologist in his time, showed that the primary blood supply of the colon is from branches of the superior and inferior mesenteric arteries. He described that both arterial mesenteric trunks were connected by an anastomotic artery, termed the “arcus magnus mesentericus” (Figure 8).
Figure 6. Tabula II (Lib.V) of Adriaan van der Spiegel’s (Adrianus Spigelius) anatomy book De humani corporis fabrica, 1627, showing the greater omentum, the colon and mesocolon held up. The vascular loop (D) with radiating branches depicted in the mesocolon is referred to in the accompanying text as “tributaries of the portal vein, derived from the whole colon” (Venae portae ramus, per totum colum derivatus).
Figure 7. Illustration ("Veertigste aftekenings") from the anatomy book of Govard Bidloo's *Ontleding des menschelijken lichaams* (Dissection of the human body), 1690, showing the mesentery of the colon reflected open. The capital letters (K, L, M) inserted in the mesocolon refer to fatty and lymphatic structures.
It is assumed that to honor the old anatomist Riolan, who previously pointed out the arterio-venous anastomoses in the mesentery, Haller preferred to use an alternative name, i.e. "Arcus Riolani" to indicate the arterial collateral connection between the superior mesenteric and inferior mesenteric artery, via the middle colic artery. In English nomenclature, this arc is referred to as Riolan’s arc whereas in German and Dutch nomenclature, the arc is usually referred to as Riolan’s anastomosis.

**Figure 8.** The “arcus magnus mesentericus” as depicted by Albrecht von Haller in his *Icones Anatomicae* (Tabula arteriarum mesentericarum), published in Leiden in 1743. Note the detailed representation of the middle colic artery, the left colic artery and the collateral vessels that follow the mesenteric border of the colon to interconnect both arterial vessels.
Epilogue

From the aforesaid, it can be concluded that Jean Riolan could not have perceived an arterial collateral arcade in the mesentery of the colon, such as the mesenteric anastomosis named after him. An anastomosis of that kind did not fit with his strong Galenic and anti-Harveian views of the circulation of the blood. He did describe arterio-venous anastomoses in the mesentery and probably noted vascular arcades running along the inner border of the colon. Albrecht von Haller who was the first to establish the arterial collateral pathway between the superior mesenteric and inferior mesenteric artery, being familiar with all the works of Riolan, dedicated this collateral anastomosis to Jean Riolan, who he once called the “prince of anatomists”, in honour of this remarkable old master of anatomy.
Chapter 4

References

17. Albinus, Bernard Siegfried. Tabulae sceleti et musculorum corporis humani. Apud Joannem et Hermannum Verbeek, Leiden, 1747 Collection University Library Amsterdam