Anastomosis: an important clinical term with multiple non-standardized definitions and no formal classification

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Abstract

Introduction

Anastomosis is a frequently used and important clinical term with multiple meanings and no obvious standardized definition or classification. Anastomosis differs in meaning depending on whether the context is anatomical, physiological or surgical, which leads to confusion. Few textbooks offer a complete or working definition of 'anastomosis' even though the term is used ubiquitously. This review investigated the definition of 'anastomosis'.

Materials and methods

A literature search was conducted on the most commonly used texts: anatomical, physiological and surgical along with common web-based resources to examine the use of 'anastomosis' and to determine the completeness of the definition.

Results

The literature search revealed that the most common definition, when presented, was 'a communication of one vessel to another'. Collectively, three separate definitions were identified. Surprisingly, many textbooks did not offer a definition of anastomosis; those that did provided a single and limited definition.

Conclusion

Our suggested definition is: 'The communication of a luminal vessel with another region of itself or branch of itself with another luminal vessel from a separate origin, or when capillary beds from separate origins interact to maintain tissue viability'. Due to its clinical importance, the results of our review suggest the term anastomosis could be defined comprehensively and classified.

Introduction

Anastomosis is a term that has existed since classical antiquity. The term can be traced back in recorded history to Erasistratus (Figure 1) and Galen (Figure 2), who both believed that the arteries are linked to the veins at their extremities by extremely fine, imperceptibly small, connecting channels1.

This single definition has evolved into several distinct variations. At least three groups (anatomists, physiologists and clinicians) have variations on the term anastomosis and all are different. Some anatomists on the topic of the Circle of Willis may state that the Circle of Willis is an anastomosis amongst cerebral arterial vessels. They may further clarify that the Circle of Willis fails to provide adequate blood to an obstructed area, thus leading to a cerebrovascular accident (Figure 3).

Therefore, this type of definition is a structural, rather than a functional arterial anastomosis. Some physiologists may describe an anastomosis as the sharing of two sets of capillary beds and may note the importance of including an anastomosis to ensure tissue viability.

This would represent a functional tissue viability anastomosis (Figure 4). A surgeon might give an example of an anastomosis using a procedure referred to as an end-to-end bowel anastomosis (Figure 5);

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Figure 1: Erasistratus, the father of physiology.

Figure 2: Galen.

Figure 3: Circle of Willis: an example of a structural anastomosis.

Figure 4: Capillary as an example of functional tissue viability anastomosis.

Figure 5: End-to-end bowel anastomosis.

Figure 6: Frequency of the term anastomosis.
Table 1  Chronological account of the usage of the term anastomosis.

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-in- A Physical Dictionary, Expounding Such Words, as Being Terms of Art, or Otherwise Derived From the Greek and Latin, Are Dark to the English Reader⁴.</td>
<td></td>
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<tr>
<td>1715</td>
<td>The Physical Dictionary. Wherein The Terms of Anatomy, the Names and Causes of Diseases, Chyrurgical Instruments, and their Use, are accurately describ’d³.</td>
<td>An Effluxion of the Blood, the Lympha or Chyle, at the meeting of Vessels that close not narrowly. It is also taken for the mutual opening of Veins and Arteries into one another, as some long ago falslyimagin’d; for this were to offer Violence to the Laws of Circulation, yet it is not impossible neither, since Veins open into Veins, and Arteries into Arteries; as is plain in the Spermatick Vessels, the Plexus Choroides, Rete mirabile, &amp;c.</td>
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<tr>
<td>1787</td>
<td>Lexicon Physico-Medicum; or, a New Medicinal Dictionary. Explaining the Difficult Terms Used in the Several Branches of the Profession, And in Such Parts of Natural Philosophy, As are Introductory thereto⁴.</td>
<td>From ανα, through, and ςσμα, the mouth. To relax, or open the mouths of the vessels. This sometimes expresses such an aperture of the mouths of the vessels as lets out their contents: but more commonly a unison between the arteries and veins, where the former open into the latter; or where an artery ceases any longer to be so, and begins to be a vein.</td>
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<tr>
<td>1819</td>
<td>The London Medical Dictionary; Including, Under Distinct Heads, Every Branch of Medicine, Viz. Anatomy, Physiology, and Pathology, the Practice of Physic and Surgery, Therapeutics, and MateriaMedica; With Whatever Relates to Medicine in Natural Philosophy, Chemistry, and Natural History⁵.</td>
<td>Anatomists use the word to express the inosculoation of the arteries and veins, or their running into one another. The menses, discharged, are said to be discharged by anastomosis, i.e. by the opening the mouths of the vessels into the uterus.</td>
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<tr>
<td>1832</td>
<td>A Dictionary of Practical Surgery: Comprehending All the Most Interesting Improvements, Form the Earliest Times Down to the Present Period; An Account of the Instruments and Remedies Employed in Surgery; the Etymology and Signification of the Principal Terms; and Numerous References to Ancient and Modern Works: Forming a 'Catalogue Raisonné' or Surgical Literature⁶.</td>
<td>(From ανα, through, and στομα, a mouth.) Anatomists and surgeons imply by this term the communications of the blood-vessels with each other, or their running and opening into each other, by which the continuance of a free circulation of the blood is greatly ensured, and the danger of mortification lessened. The immense importance of this part of our structure in all cases in which the main artery or veins of a limb are obliterated, is particularly conspicuous in the disease called aneurism.</td>
</tr>
<tr>
<td>1833</td>
<td>Lexicon Medicum; or Medical Dictionary; Containing an Explanation of the Terms in Anatomy, Botany, Chemistry, MateriaMedica, Midwifery, Mineralogy, Pharmacy, Physiology, Practice of Physic, Surgery, and the Various Branches of Natural Philosophy Connected with Medicine⁷.</td>
<td>(From ανα, through, and στομα, a mouth.) The communication of vessels with one another.</td>
</tr>
<tr>
<td>1846</td>
<td>A Dictionary of Terms Used in Medicine and the Collateral Sciences⁸.</td>
<td>(στόμα, a mouth). The communication of vessels with each other, as of the arteries with the veins, which by touching at numerous points, form a network of reticulation. See Inosculation.</td>
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Table 1 (continued)

<table>
<thead>
<tr>
<th>Year</th>
<th>Book Title</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1874</td>
<td>A Dictionary of Medical Science: Containing a Concise Explanation of the Various Subjects and Terms of Anatomy, Physiology, Pathology, Hygiene, Therapeutics, Medical Chemistry, Pharmacology, Pharmacy, Surgery, Obstetrics, Medical Jurisprudence, and Dentisty; Notices of Climate, and of Mineral Waters; Formulae for Officinal, Empirical, and Dietetic Preparations; with the Accentuation and Etymology of the Terms, and the French and Other Synonyms8.</td>
<td>(αναστομώσις, from ana, στόμα, ‘a mouth’, and osis.) InosculatioReu'niavosia' – rum, Exanastomosisis, Concur'sus, Inosculatio,(F.) Anastomose, Aboucement. Communication between two vessels. By considering the nerves to be channels, in which a nervous fluid circulates, their communication has been called Anastomosis. By means of anastomoses, if the course of a fluid be arrested in one vessel, it can proceed along others.</td>
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<td>1888</td>
<td>A Complete Pronouncing Medical Dictionary: Embracing the Terminology of Medicine and the Kindred Sciences, with Their Signification, Etymology, and Pronunciation13.</td>
<td>(From the Gr. ανά, ‘by’, ‘through’, and στόμα, a ‘mouth’.) The communication of branches of vessels with one another.</td>
</tr>
<tr>
<td>1890</td>
<td>A New Medical Dictionary: Including all the Words and Phrases Used in Medicine, with Their Proper Pronunciation and Definitions13.</td>
<td>(αναστομοω, to bring to a mouth). The junction or intercommunication of vessels. Anastomotic arteries of the thigh, etc., branches of the brachial, femoral, etc., whereby the collateral circulation is established after ligature for aneurysm, etc. The term has been inaccurately used of the junction of nerve-filaments.</td>
</tr>
<tr>
<td>1890</td>
<td>The National Medical Dictionary: Including English, French, German, Italian, and Latin Technical Terms Used in Medicine and the Collateral Sciences, and a Series of Tables of Useful Data12.</td>
<td>1. Union of two vessels by which their canals become continuous. 2. Union or conjunction between two nerves.</td>
</tr>
<tr>
<td>1896</td>
<td>An Illustrated Dictionary of Medicine Biology and Allied Sciences Including the Pronunciation, Accentuation, Derivation, and Definition of the Terms Used in Medicine, Anatomy, Surgery, Obstetrics, Gynecology, Therapeutics, Materia Medica, Pathology, Dermatology, Pediatrics, Ophthalmology, Otolaryngology, Physiology, Neurology, Histology, Toxicology, Dietetics, Legal Medicine, Psychology, Climatology, Etc., Etc.13.</td>
<td>(ἀναστομώσεως, to bring to a mouth). The intercommunication of vessels. Anastomotic arteries of the thigh, etc., branches of the brachial, femoral, etc., whereby the collateral circulation is established after ligature for aneurysm, etc. The term has been inaccurately used of the junction of nerve-filaments. A., Crucial, an arterial anastomosis in the upper part of the thigh, formed by the anastomatic branch of the sciatic, the first perforating, the internal circumflex, and the transverse branch of the external circumflex. A., Intestinal, an operation consisting in establishing a communication between the intestine above and that below the obstruction, in cases of intestinal obstruction. In this way the impermeable portion of the bowel is excluded from the fecal circulation.</td>
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Discussion
The objective of this review was to identify the definition of anastomosis and to evaluate and provide a universal definition with or without sub-classifications for clarity in healthcare education. Anastomosis was first coined by Erasistratus, the father of physiology. Erasistratus’ early definition of anastomosis as imperceptibly small transitions from arteries to veins would best be described in modern terms as capillaries. This definition of anastomosis remained fairly consistent for more than two millennia. The definition began to change around 1830, incorporating the general term ‘communication’ to define anastomosis. In modern textbooks, our review found the term anastomosis present in 58% of textbooks, yet a definition is provided in only 32% of textbooks. This meant that anastomosis was used in just over one-quarter of the textbooks without a definition given and the definitions presented varied widely. Some were quite basic, simply stating that anastomosis is 'the joining of branches of arteries'14. Others offered a more qualified definition, ‘Arteriovenous anastomoses..."
are direct connections between smaller arteries and veins\textsuperscript{15}. Some definitions described anastomosis as a convergence or joining of arteries\textsuperscript{16,17}; others described it as a network\textsuperscript{18}. None of the six common definitions found in textbooks offered a comprehensive definition. In clinical and didactic settings, this term is voiced frequently with varied meanings with which the learner is unlikely to be familiar. For example, the term anastomosis implies a different outcome when it is used by the following experts:

- Surgeons—bowel anastomosis, femoral—popliteal anastomosis
- Anatomists—cerebral circulation—Circle of Willis (nonviable tissue)
- Physiologists—the sharing of two sets of capillary beds (viable tissue).

The difference in clinical relevance is significant enough to create a comprehensive definition, which would include a table of subcategories (Table 2). Our suggested definition is: ‘The communication of a luminal vessel with another region of itself, or branch of itself, or with another luminal vessel from a separate origin with or without the sharing of capillary beds’.

**Conclusion**

This review found that the term anastomosis was generally undefined in many modern texts. In the few instances where a definition is given, the definitions were inconsistent and no comprehensive universal definition could be identified. This review suggests a universal definition, ‘The communication of a luminal vessel with another region of itself, or branch of itself, or with another luminal vessel from a separate origin with or without the sharing of capillary beds’.

**Table 2 Suggested comprehensive medical classification of anastomosis.**

<table>
<thead>
<tr>
<th>Classifications of Anastomosis</th>
<th>Explanation</th>
<th>Example</th>
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<tbody>
<tr>
<td><strong>Type I</strong></td>
<td>The connection of one luminal vessel to another. Surgically created to circumvent or remove an obstruction.</td>
<td>End-to-end bowel anastomosis is, Femoral-popliteal bypass.</td>
</tr>
<tr>
<td><strong>Type II</strong></td>
<td>Non-viable anatomical anastomosis is.</td>
<td>Circle of Willis.</td>
</tr>
<tr>
<td><strong>Type III</strong></td>
<td>The overlap of capillary beds that ensures tissue viability even if one of the prominent feeders into the capillary beds is obstructed.</td>
<td>Capillary beds of the face.</td>
</tr>
</tbody>
</table>

**References**

3. Blanck S. The physical dictionary. Wherein the terms of anatomy, the names and causes of diseases, chyrurgical instruments, and their use, are accurately describ’d. London; 1715.
4. Quincy J. Lexicon physico-medicum; or, a new medicinal dictionary. Explaining the difficult terms used in the several branches of the profession, and in such parts of natural philosophy, as are introductory thereto. With an account of the things signified by such terms. Collected from the most eminent authors. London; 1787.
6. Cooper S. A dictionary of practical surgery: Comprehending all the most interesting improvements, form the earliest times down to the present period; an account of the instruments and remedies employed in surgery; the etymology and signification of the principal terms; and numerous references to ancient and...
9. Dunglison R. A dictionary of medical science: Containing a concise explanation of the various subjects and terms of anatomy, physiology, pathology, hygiene, therapeutics, medical chemistry, pharmacology, pharmacy, surgery, obstetrics, medical jurisprudence, and dentistry; notices of climate, and of mineral waters; formulae for official, empirical, and dietetic preparations; with the accentuation and etymology of the terms, and the french and other synonyms. Philadelphia, PA: Henry C. Lea; 1874.
10. Thomas J. A complete pronouncing medical dictionary: Embracing the terminology of medicine and the kindred sciences, with their signification, etymology, and pronunciation. With an appendix, comprising an explanation of the latin terms and phrases occurring in medicine, anatomy, pharmacy, etc.; together with the necessary directions for writing latin prescriptions, etc. London: J.B. Lippincott Company; 1888.
13. Gould GM. An illustrated dictionary of medicine biology and allied sciences including the pronunciation, accentuation, derivation, and definition of the terms used in medicine, anatomy, surgery, obstetrics, gynecology, therapeutics, materia medica, pathology, dermatology, pediatrics, ophthalmology, otology, laryngology, physiology, neurology, histology, toxicology, dietetics, legal medicine, psychology, climatology, etc. And the various sciences closely related to medicine bacteriology, parasitology, microscopy, botany, zoology, dentistry, pharmacy, chemistry, hygiene, electricity, veterinary medicine, etc. Philadelphia, PA: P. Blakiston, Son & Co.; 1896.

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