Anatomical traps for arteriovenous fistula creation

Author: Z. M. Ziętek

DOI: 10.5603/FM.a2020.0076

Article type: CASE REPORTS

Submitted: 2020-05-07

Accepted: 2020-06-16

Published online: 2020-07-09

This article has been peer reviewed and published immediately upon acceptance. It is an open access article, which means that it can be downloaded, printed, and distributed freely, provided the work is properly cited.

Articles in "Folia Morphologica" are listed in PubMed.
Anatomical traps for arteriovenous fistula creation

Running head: Anatomical variability and complications

Z.M. Ziętek¹,²

¹Department of General Surgery and Transplantology, Pomeranian Medical University, Szczecin, Poland
²Department of Normal and Clinical Anatomy, Pomeranian Medical University, Szczecin, Poland

Address for correspondence: Z. Ziętek, Department of General Surgery and Transplantology, Pomeranian Medical University, Al. Powstańców Wielkopolskich 72, 70–111 Szczecin, Poland, tel: 914661480, mobile: 503502735, e-mail: zzietek@poczta.onet.pl

Abstract

Background: The risk of complications in undisclosed vascular variability appears relatively likely. Therefore, it is important to assess the probability of encountering anatomical-topographic variability in the venous system of the upper limb. The catalog of patterns of the upper limb venous system seems to be unlimited and should therefore be constantly updated. The aim of the study was to explore of venous system of upper extremity and discuss some problems that would be encountered with the formation of an arteriovenous fistula.

Results: In 17 (85%) explored of upper limbs, the venous system shown a pattern similar to the reports already described. But in 3 of them (15%), the venous system showed a certain differences in relation to the accepted anatomical textbooks. Especially in one of them the anatomical variant of basilic and cephalic vein contrasted distinctly with the other veins. Based on the revealed anomalies, a statistical analysis of the probability of occurrence of any anatomical variant and the risk of complications associated with fistula creation was conducted. Even on such small group an assessed probability of anatomical variability of the upper limb venous system was statistically significant at p < 0.0244 (Odds Ratio - 0.0828; 95% CI: 0.0095 to 0.7252).

Conclusions: The probability of any anatomical-topographic variability in the venous system of the upper limb should be considered as a statistically significant. Only intense anatomical dissections would undoubtedly help to avoid some anatomical traps and then minimize some complications in the creation of arteriovenous fistulas.

Key words: veins, upper limb, anatomy variant, arteriovenous fistula, complications
INTRODUCTION

Since the development of the first arteriovenous access, many reports have appeared, not always flattering it (1, 2, 3, 4, 5, 6). Particularly risky is an undisclosed variability of vascular system of the upper limb which could discourage surgeons from a classic approach (2, 7, 9, 11).

In many published reports, rates of arteriovenous fistula complications were assessed (7). Most of them included aneurysm, infection, terminal ischemia syndrome, thrombosis or venous hypertension (7, 8). It seems that all of this could have contributed to the collapse of an interest in the creation of arteriovenous fistulas (11). So at the end of the 70s, other alternative vascular access approaches began to be used (1, 8, 9, 10). However, longer observations of the results revealed them as more dangerous with even more severe complications (1, 7, 8, 9, 10, 11).

Many authors emphasized that complications associated with fistula formation started the first with technical problems, related to vascular topography (5, 11). The traditional anatomy texts offer little description of the upper limb veins and are particularly silent in regards to their variations. The number of patterns seems to be unlimited and therefore should be constant updating. Continuous updating and, more importantly, a permanent reminder of those already discovered would be particularly useful in vascular procedures, including arteriovenous fistulas (5, 12, 13). Arteriovenous fistula is again becoming a popular vascular access procedure (12). There are many reasons, and one of them is an intensive anatomical work that broadens knowledge about the vascular system of the upper limb (4, 5, 6, 12, 13, 14, 15). Classic arteriovenous fistula still seems to be a good method associated with a lower rate of complications compared to other methods (7, 10). That all have been resulted in a slow return to classic arteriovenous fistulas (7, 12).

Despite of our modest anatomical material of the upper limbs, we would like to present some revealed variants of the venous system. In addition, some possible anatomical traps in the creation of an arteriovenous fistula were analyzed.

MATERIALS AND METHODS

The material was consisted of 20 preparations of the upper limb taken from 10 deceased (6 men and 4 women). The anatomical explorations were conducted at the Faculty of Normal and
Clinical Anatomy of the Pomeranian Medical University in Szczecin. The cadavers preserved and stored in a solution of formalin, glycerin and ethyl alcohol. Among the cadavers were 6 males and 4 females. The registered age on the day of their death was 67–81 years. The body storage period was 10-20 years. The upper limbs were without visible genetic deformities or previous surgery. Apart from typical sectional instruments such as scalpels, pincettes and raspators, a magnifying camera was also used, which was particularly useful in the exploration of small blood vessels. For clarity of photographic documentation, the dissected blood vessels have been colored. Then the dissected upper limbs were photographed for the scientific purposes and then allocated to for educational program.

RESULTS

The main intention of this exploration was to educate students. But during the preparation of the upper limbs, some variants of the venous system were discovered, which have not yet been described in anatomy textbooks.

In 17 (85% of all) upper limbs the venous system shown a pattern similar to the reports already described (Fig. 1). But in 3 of them (15%), the venous system showed a certain dissimilarities in relation to the accepted anatomical textbooks.

Especially in one of them the topography of the basilic and cephalic vein contrasted significantly with the others (Fig. 2). At the beginning the both veins ran along both sides of the forearm, but instead of climbing on the arm, they both approached the cubital fossa, where they connected to the deep venous system. The next unusual thing was the brachial vein. Usually in the cubital fossa can be found two brachial veins, but unexpected there was only one. Only this one brachial vein was formed from the connection of the superficial and deep veins. Which was finally confirmed by further exploration of the upper limb. To the surprise, the estimated probability of occurrence of anatomical variability of the venous system of the upper limb was statistically significant at p< 0.0244 (Odds Ratio - 0.0828; 95% CI: 0.0095 to 0.7252). In extrapolation analysis it can be stated that about 90% of fistulas would not have encountered any topographic diversity during surgery, but every tenth may already occur. This would mean that
there may really be topographic difficulties with the venous system in creating an arteriovenous fistula.

**DISCUSSION**

The knowledge about anatomical variabilities of upper limb venous system is intensive updating but in clinical practice still encounters some limits (5, 6, 12, 13, 14, 16, 17, 18, 19).

Anatomical exploration of human body is a challenge for both anatomists and clinicians. Especially for clinicians because undiscovered variations can cause many problems in their daily medical practice (2, 5, 7, 9, 10).

In addition to updates, it should be reminded about already discovered patterns. It seems to be crucial for the successful treatment (5, 12, 13).

Although anatomy departments all over the world suffer from a body deficiency, intensive anatomical dissections have been conducting and undoubtedly contributed to restored priorities of arteriovenous fistula (6, 12, 15, 17).

We did not expect that in our very small group of limbs we will encounter some anomalies of deep and superficial veins. Indeed, in 17 preparations of the upper limbs, the topography of venous vessels has an approach to the classic descriptions of textbooks. The basilic and cephalic vein runs up along both side of forearm. The basilic one comes into arm on the medial side of it, and in half of arm diving more proximally to join with one of two brachial veins near the axilla. But cephalic vein runs higher to join the axillar vein in the deltopectoral triangle. It can be supposed that in theses anatomical variations the creation of an arteriovenous fistula would not encounter any anatomical or topographic difficulties. But in three of them (15%) the topography of brachial, basilic and cephalic vein did not coincide with the descriptions of textbooks and literary reports. Especially in one it was completely different, which is the subject of this case report. Searching the literature data, a similar variant was found, which has already been described and classified as very rare (18). This prompted us to re-present this variant, but in the aspect of creating arteriovenous fistulas. The accidental ligation of such an unpaired brachial vein would stop the outflow of blood and develop some complications such as oedema or even
phlegmasia cerulea dolens. Therefore, we would like to remind of this and anticipate some problems in creating of fistula (7, 8, 18).

Our variant could be described as the second case report. However, in our opinion, more important than report numbering is whether a particular case is really rare, as is supposed. The disclosure of a similar variety on our small anatomical material may indicate that this variant should not be considered very rare. Especially it is important in creation of arteriovenous fistula in the middle arm (MAF - Middle Arm Fistula). This method (MAF) is rapidly becoming a more common vascular access procedure, especially in so called difficult arteriovenous fistulas (16).

This should remind surgeons to this topography pattern when they plan to form an arteriovenous fistula in the arm with basilic vein transposition (4, 12, 14, 15). The presented variability seems particularly interesting in the context of possible complications after the creation of MAF (7, 8). The clinical report of Kaiser et al. confirms the possibility of occurrence of some complications with MAF creation in atypical junction to the basilic vein with the unpaired brachial vein. (19).

CONCLUSIONS

Because of the likelihood of variability in the venous system of the upper limb, examining it before surgery would avoid some difficulties and pitfalls. These preliminary results of the upper limb venous system require further investigations.

REFERENCES

1. Wijeyaratne S.M., Kannangara L. Safety and efficacy of electrospun polycarbonate-urethane vascular graft for early hemodialysis access: first clinical results in man. J. Vasc. Access 2011; 12: 28–35.
2. Quinton W, Dillard D, Scribner BH. Cannulation of blood vessels for prolonged hemodialysis. Trans Am Soc Artif Intern Organs. 1960;6:104–13.
3. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. N Engl J Med 1966; 275: 1089–1092
4. Sandhu NP, Sidhu DS. Mid-arm approach to basilic and cephalic vein cannulation using ultrasound guidance. Br J Anaesth. 2004;93:292-4.
5. Kaiser CL, Anaya-Ayala JE, Ismail N, Davies NMG, Peden EK. Unrecognized Basilic Vein Variation Leading to Complication during Basilic Vein Transposition Arteriovenous Fistula Creation: Case Report and Implications for Access Planning. Eur J Vasc Endovasc Surg 2010;39:627-629
6. Lee H, Lee SH, Kim SJ, Choi WI, Lee JH, Choi IJ, et al. The clinical anatomy of the cephalic vein in the deltopectoral triangle. Folia Morphol 2008;67:72-7.

7. Al-Jaishi AA, Liu AR, Lok CE, Zhang JC, Moist LM. Complications of the Arteriovenous Fistula: A Systematic Review. J Am Soc Nephrol 28: 1839–1850, 2017. doi: https://doi.org/10.1681/ASN.2016040412.

8. Tellis V.A., Veith F.J., Soberman R.J. i wsp. Internal arteriovenous fistula for hemodialysis. Surg. Gynecol. Obstet. 1971; 132: 866–870.

9. Miller A., Holzenbein T.J., Gottlieb M.N. i wsp. Strategies to increase the use of autogenous arteriovenous fistula in end- stage renal disease. Ann. Vasc. Surg. 1997; 11: 397–405.

10. Astor B.C., Eustace J.A., Powe N.R. i wsp. Type of vascular access and survival among incident hemodialysis patients: the Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study. J. Am. Soc. Nephrol. 2005; 16: 1449–1455.

11. Lemson M.S., Tordoir J.H., Daemen M.J., Kitslaar P.J. Intimal hyperplasia in vascular grafts. Eur. J. Vasc. Endovasc. Surg. 2000; 19: 336–350.

12. Anaya-Ayala JE, Younes HK, Kaiser CL., Syed O, Ismail N, Naoum JJ, Davies MG, EPeden EK. Prevalence of variant brachial-basilic vein anatomy and implications for vascular access planning. J Vasc Surg. 2011;53:720-4.

13. Griffioen FMM, Drukker J, Hoogland PVJM and Godschalk M. General plan anatomy, objectives of the teaching of the anatomy/embryology in medical curricula in the Netherlands. Eur J Morphol, 1999; 37: 288-325.

14. Altıparmak B, Korkmaz Toker M, Uysal Al, Gümüş Demirbilek S. Double axillary vein variation diagnosed with ultrasound guidance during infraclavicular nerve block intervention. BMJ Case Rep. 2019 Jan 28;12(1). pii: bcr-2018-227495. doi: 10.1136/bcr-2018-227495.

15. Fontaine CH. Some help for literature study in anatomical variations reports. Surg Radiol Anat, 2001;23: 293-294

16. Sanudo J.R., Vazquez R., Puerta J. Meaning and clinical interest of the anatomical variations in the 21st century. Eur J Anat, 7 (S1): 1-3 (2003).

17. Jones DG, Dias GJ, Mercer S, Zhang M and Nicholson HD. Clinical anatomy research in a research-driven anatomy department. Clin Anat, 2002;15: 228-232.

18. Sadeghi A, Setayeshmehr M, Esfandiari E, Mohamadi S, Baharmian H. Variation of the cephalic and basilic veins: A case report. J Cardiovasc Thorac Res, 2017, 9(4), 232-234

19. Kaiser CL, Anaya-Ayala JE, Ismail N, Davies MG, Peden EK. Unrecognized basilic vein variation leading to complication during basilic vein transposition arteriovenous fistula creation: case report and implications for access planning. Eur J Vasc Endovasc Surg. 2010;39:627-9. doi: 10.1016/j.ejvs.2010.01.011. Epub 2010 Feb 20.

**Figure 1.** The photograph shows the correct picture of the cephalic vein (1) and the basilic vein (2).

**Figure 2.** The photograph shows the correct picture of the cephalic vein (1) and the basilic vein (2) and brachial vein (3).
Phot. 1.
Phot. 2.