Brachial Plexus Vascularization – a Preliminary Study

Unaczynienie splotu ramiennego – doniesienie wstępne

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Streszczenie
Rozwój technik mikrochirurgicznych wymaga drobiazgowej znajomości anatomii chirurgicznej. Zagadnienie unaczynienia splotu ramiennego nie jest wyczerpująco opracowane określone w dostępnej literaturze. Celem naszej pracy było ustalenie źródła unaczynienia poszczególnych elementów splotu ramiennego. Badania przeprowadzono na materiale 12 splotów ramiennych. Naczynia perfundowano roztworem soli fizjologicznej a następnie nastrzyknięto żelatyną z tuszem chińskim. Materiał utrwalono w 10% roztworze formaldehydu. Po utrwaleniu preparowano przy pomocy mikroskopu operacyjnego i narzędzi mikrochirurgicznych. Stwierdzono, że głównym źródłem unaczynienia splotu ramiennego są gałęzie tętnicy podobojczykowej i pachowej. Korzenie splotu zaopatrywane są w większości przez naczynia pochodzące od tętnicy kręgowej i tętnicy szyjnej wstępującej. Unaczynienie pni i pęczków pochodzi od gałęzi tętnicy poprzecznej szyi, bezpośrednich gałęzi od tętnicy pachowej i podobojczykowej.
[Acta Clinica 2001 2:111-116]

Słowa kluczowe: splot ramienny, tętnica podobojczykowa, tętnica kręgowa

Summary
The rapid development of microsurgical techniques demands detailed knowledge of the surgical anatomy. The vascular pattern of supply to the brachial plexus has not been clearly described in the published literatures. The purpose of the study was to define the vessels supplying the plexus and, as a second step, to determine the pattern of vascularization of particular structures within the plexus. The study was performed on 12 specimens. The vessels were injected with the mixture of gelatine and ink. The materials were fixed in 10% formaldehyde solution and subsequently dissected under magnification of surgical microscope. The main sources of blood supply are the branches of subclavian and axillary arteries. The nerve Roots of the brachial plexus are supplied mainly by the vessels from minor branches arising from the vertebral artery and ascending cervical artery. The vessels supplying the trunks and cords arise from the transverse cervical, subclavian and axillary arteries. [Acta Clinica 2001 2:111-116]

Key words: brachial plexus, subclavian artery, vertebral artery

Introduction

The brachial plexus is formed by the ventral branches of the cervical spinal nerves from C5 – C8 and the first thoracic spinal nerve. During development the plexus consists of anastomoses between spinal nerves, then it develops into a solid plate that finally divides into separate trunks. At early developmental stage the plexus is rectangular, then trapezoidal and finally it forms a triangular shape (3). Due to developmen-

tal conditions there are some possible structural variations of the brachial plexus. Generally two plexus types can be found: the two trunk type (C5+C6+C7; C8+Th1) and classical three trunk type (C5+C6; C7; C8+Th1).

In the classical type which is, the most common type, the roots C5 and C6 form the upper trunk, roots C7 – the middle trunk and C8 – Th1 – the lower trunk. Then the trunks divide to two parts; anterior and posterior. The posterior divisions of all trunks form the posterior cord. Anterior divisions of upper and middle trunks form lateral cord and anterior division of lower trunk form the medial cord. The lateral cord gives musculocutaneous and lateral head of the median nerve. Medial cord divides into medial head of median nerve, the ulnar nerve, medial cutaneous nerve of forearm and medial cutaneous nerve of the arm. The posterior cord gives radial and axillary nerves. Except the long branches, the brachial plexus gives several short branches that innervate the pectoral girdle muscles.

There are only a few papers concerning the vascularization of the brachial plexus. The blood supply of the brachial plexus comes from several sources such as vertebral artery, thyrocervical trunk, and costocervical trunk, (from subclavian artery) and single small branches from axillary artery. The purpose of the study was to describe the sources of vascularization of the brachial plexus and to define the types of vascular pattern.

Material and methods

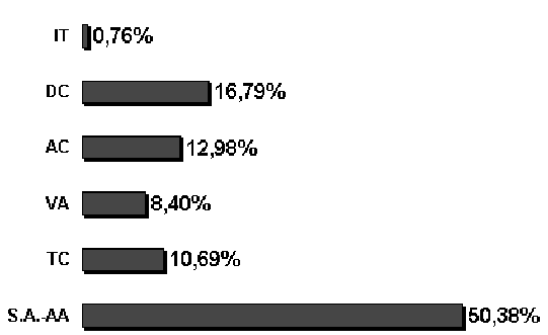
The study was performed on 12 specimens. The brachial plexuses with the spinal cords were obtained from unfixed cadavers during autopsy. The vessels were perfused with saline solution and then filled with gelatine with ink. Then the specimens were fixed with 10% formaldehyde solution for a period of 3 months. The vessels and nerves were dissected with the aid of surgical microscope using standard microsurgical instruments. After dissecting the back muscles we removed the vertebral arch lamina to visualise the roots of the cervical spinal nerves and the vessels supplying them. To identify the origin of vessels supplying the roots we've dissected them along their course to the point of their origin. Next the dissection of the brachial plexus was performed step by step anteriorly to find the vessels originating from thyrocervical and costocervical trunks and also the vessels arising from subclavian-axillary artery.

Results

Twelve brachial plexuses were examined: 6 right and 6 left. Totally 131 vessels supplying particular brachial plexus structures were found. On the base of our study we've identified five sources supplying the brachial plexus: subclavian – axillary trunk (according to the terminology of Gouaze et al. (4)), deep, ascending and transverse cervical arteries and vertebral artery. The majority of all vessels (50,38%) originated from the subclavian – axillary trunk which could be divided into two groups. The first group includes the small ascending branches from subclavian artery which supply roots and trunks of the brachial plexus. The second group is consisted of the vessels originating from axillary artery and then running along the cords supplying them. The branches from deep cervical artery are the second source of the brachial plexus vascularization, there were 22 branches found (16,79% of all number of vessels). The branches originating from ascending cervical artery consisted approximately 12,98% of the all branches. Vertebral artery was found to give 11branches

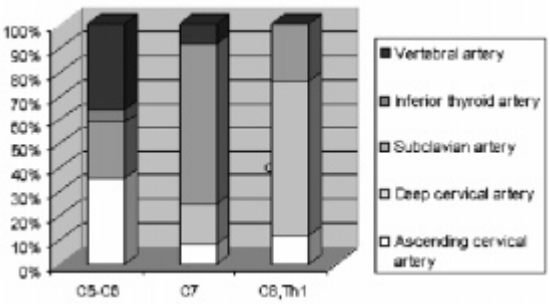
usually to C5 – C6 roots. The detail percentage of the branches supplying the brachial plexus is shown in the diagram 1. The majority of branches supplying the C5-C6 roots originated from two sources: ascending cervical artery and vertebral artery (35,29%). The main blood supply to the C7 roots comes from small ascending branches of subclavian artery trunk known in literature as Soemmering's arteries (4). In the majority of cases (64,71%) branches from deep cervical artery supply C8 – Th1 roots. The percentage contribution of the vessels to roots is shown in the diagram 2. The trunks of the brachial plexus are mostly supplied by the branches from subclavian artery (diagram 3). The medial and posterior cords receive branches usually from axillary artery trunk. The lateral cord is supplied by the branches from transverse cervical artery (52,94%) and also from axillary artery branches (diagram 4). The diagram 5 shows that there were no statistically significant differences between the number of branches originating from particular arteries on the left side comparing to the right side.

Diagram 1
Percentage contribution of the vessels supplying the brachial plexus



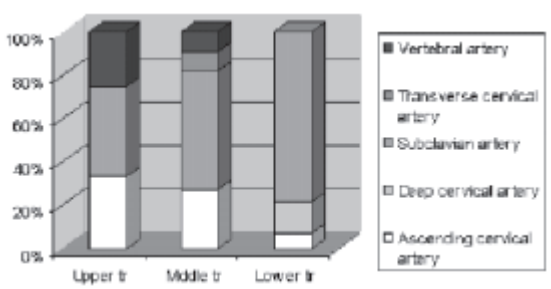
AC – ascending cervical artery, DC – deep cervical artery, S.A. – subclavian artery, IT – inferior thyroid artery, VA – vertebral artery AA – axillary artery TC – transverse cervical artery

Diagram 2
Contribution of the vessels supplying the roots



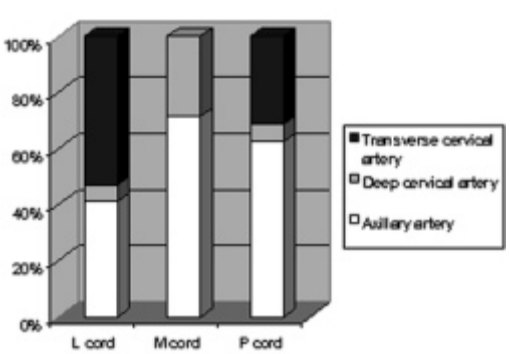
	Vessels				
Roots	AC	DC	SA	IT	VA
C5-C6	35,29%	0,00%	23,53%	5,88%	35,29%
C7	8,33%	16,67%	66,67%	0,00%	8,33%
C8,,Th1	11,76%	64,71%	23,53%	0,00%	0,00%

Diagram 3
Contribution of the vessels supplying the trunks



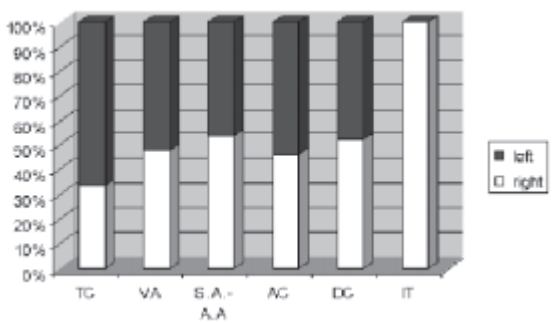
	Vessels				
Trunk	AC	DC	SA.	TC	VA
Upper tr	33,33%	0,00%	41,67%	0,00%	25,00%
Middle tr	27,27%	0,00%	54,55%	9,09%	9,09%
Lower tr	7,14%	14,29%	78,57%	0,00%	0,00%

Diagram 4
Contribution of the vessels supplying the cords



	Vessels		
Cord	AA	DC	TC
L cord	41,18%	5,88%	52,94%
M cord	71,43%	28,57%	0,00%
P cord	62,50%	6,25%	31,25%

Diagram 5
Percentage contribution
of the vessels supplying
the brachial plexus L/R side



	Vessels					
Side	TC	VA	SA-AA	AC	DC	IT
right	8,00%	8,00%	53,33%	12,00%	17,33%	1,33%
left	15,79%	8,77%	45,61%	14,04%	15,79%	0,00%

Discussion

In the literature the brachial plexus was described many times in aspect of clinical implications of its variations.

Yan J. Horiguchi M (8) – investigated twenty-four adult cadavers (48 sides) to get knowledge about the incidence of a branch

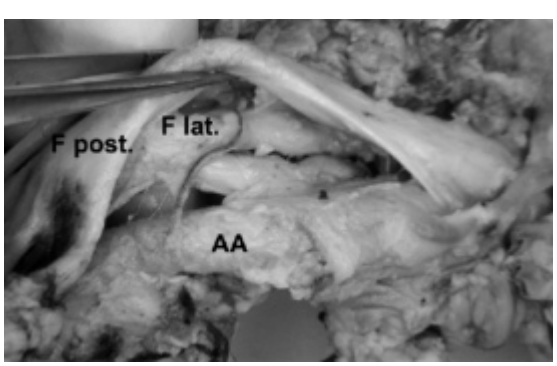


Fig. 1 A branch from the axillary artery to the lateral cord of the brachial plexus. F lat. – *fasciculus lateralis*, F post. – *fasciculus posterior*, AA – *arteria axillaris*.

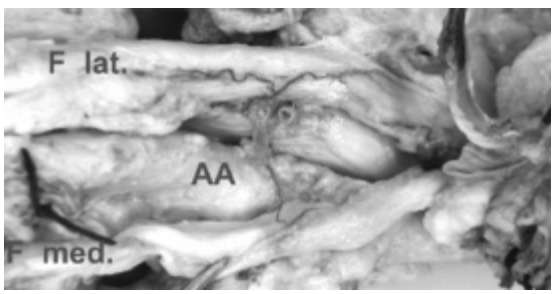


Fig. 2 Branches from the axillary artery to lateral and medial cords of the brachial plexus. F lat. – *fasciculus lateralis*, F med. – *fasciculus medialis*, AA – *arteria axillaris*.

arising from the ventral ramus of the fourth cervical nerve (C4) with the phrenic nerve and subsequently joining the brachial plexus. The incidence of the C4 branch was 23% (11/48 sides), but in our material such variability existed only in 1 case. Such kind of variation of brachial plexus is known as „prefixed" type.

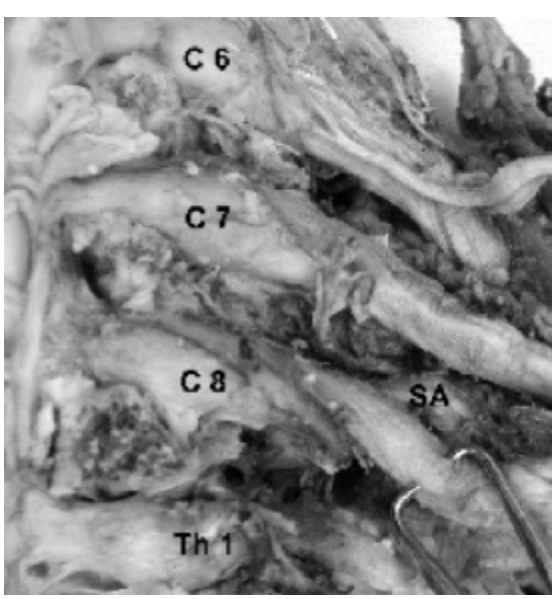


Fig. 3. Branches from the subclavian artery trunk to C7 roots. SA – *arteria subclavia*

O'Rourke MG at all (6) described the occurrence of the intercostobrachial nerve that has a connection to the medial cord of the brachial plexus in the axilla. In all dissections the nerve originated from the second intercostal space, with contributions

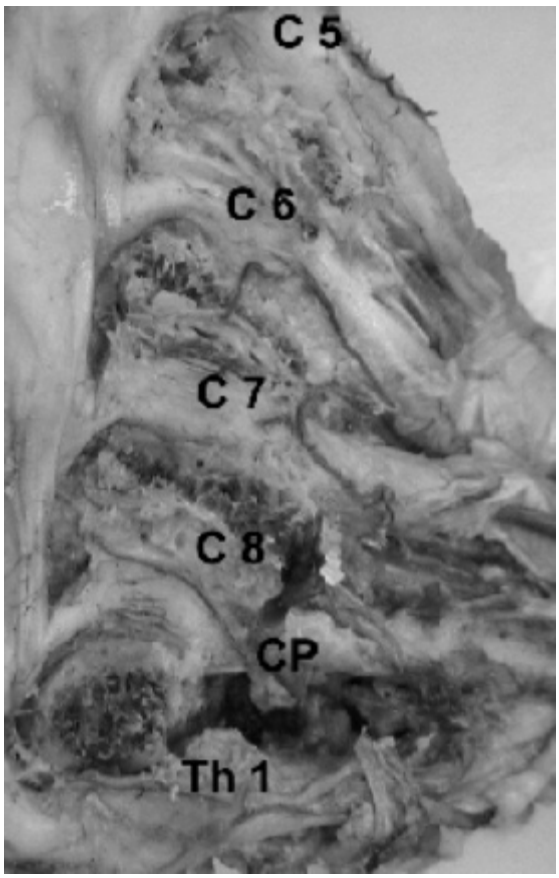


Fig. 4. Branches from the subclavian artery trunk to C6 and C7 roots and branch from the deep cervical artery to C8. CP-*arteria cervicalis profunda*

from the first and third intercostals spaces, this variation of the brachial plexus is known in literatures as „postfixed" type. In our material such pattern was not observed. A detailed knowledge of the anatomy of the brachial plexus is required not only for surgeons but also for anaesthesiologists to gain proper access for interscalene block during operation of the shoulder and proximal upper extremity.

All available papers concerning the arterial blood supply of the brachial plexus were published from 1897 to 1967 (1,4,5,7,8). Abdullach et all (1) described branches from the vertebral artery that supplied the roots of cervical spinal nerves. The trunks of the plexus were supplied directly by muscular branches of the ascending and deep cervical arteries and superior intercostalis and occasionally from the subclavian artery. The cords received small direct branches from the subclavian, axillary and subscapular vessels. They stated that there was no vasa nervorum from the transverse cervical artery.

Gouaze et all (4) described two groups of vessels supplying the brachial plexus, the first group consisted of the branches from deep, ascending and transverse cervical arteries and the second group were long and short vessels which arise from the subclavian and axillary arteries along their course. This group of vessels were earlier described by Paturet (4) and were called small ascending cervical arteries, such vessels in our materials were also present.

Lazorthes et all (5) described the vessels supplying the cervical medulla and cervical spinal nerves from vertebral, supreme intercostal and the ascending cervical arteries. In all papers mentioned above there was no statistical data concerning for example number of vessels or their occurrence or their statistical contribution in blood supply of each structures of the brachial plexus.

Conclusions

1. The vessels supplying the structures of the brachial plexus; originate anteriorly and/or posteriorly to the plexus..

2. The roots C5-C6 are mainly supplied by the branches of ascending cervical artery (35,29%) and vertebral artery (35,29%); C7 receives direct branches from subclavian artery trunk (66,67%), and C8-Th1 from the branches of deep cervical artery (64,71%).

3. The trunks are supplied by the subclavian artery branches.

4. The lateral cord is mainly supplied by transverse cervical artery and the medial and posterior cords by the branches from axillary artery.

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