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Vascular relationship of the infratemporal fossa: age-related aspect

U.N.Vovk, M.A.Kornieieva, D.A.Tkachenko

University of Jordan, Department of Anatomy and Histology, Faculty of Medicine,
Lugansk State Medical University, Department of Clinical Anatomy with Operative Surgery
Amman, Jordan, Lugansk, Ukraine

Topography of the trunk and branches of maxillary artery, feature of the structure of pterygoid venous plexus, and also their relationship in age aspect were studied. It was established that superficial part of the pterygoid plexus has intimate morphological and functional relations with the maxillary artery, while the deep part accompanies the extracranial segment of middle meningeal artery along the three fourth of its length. Vessels of the deep part of the pterygoid venous plexus are partly reducing with age, but in some cases the deep venous network still permanent in adults. Morphofunctional and applied aspects of the received results are discussed.

Key words: maxillary artery, pterygoid venous plexus, human ontogeny.

INTRODUCTION

The infratemporal fossa is characterized by complex topography with numerous arterial and venous interrelations. The maxillary artery (MA) that extends here gives off a number of functionally important branches to supply face and dura mater. The pterygoid venous plexus (PVP) braiding the main trunk of MA communicates with the lumen of the cavernous sinus via oval foramen emissary vein of skull base. The knowledge of normal topography of MA and its branches is useful for angiography interpretation. Some of these vessels can be used as an endovascular access for embolization of hemangiomas and bleeding vessels, as well as for selective intravascular chemotherapy in modern oncology [1, **9, 10, 11**].

The aim of present work was to study topography of the maxillary artery and pterygoid venous plexus and peculiarities of their relations in different age-groups.

MATERIALS AND METHODS

The vessels of infratemporal fossa were examined on 12 of fetus (32-38 weeks of gestation) and 6 of adult corrosive specimens. Method includes injection of colored dental plastic «Redont-03» into head arterial bed through the ascending aorta and into venous system of head through the superior vena cava. After complete plastics polymerization and thorough soaking in formalin the specimens were dissected. Layer-by-layer the skin, parotid fascia with parotid gland, the masseter muscle, the superficial temporal fascia and the fat pad were removed. The zygomatic arch and coronoid process of the mandible with the temporal muscle tendon were cut and taken out. After resection of mandible from its neck to angle, the MA and PVP were exposed on the surface of the lateral pterygoid muscle. For study of the deep vessels division the soft tissues were destructed by hydrochloric acid and thoroughly washed with running water. Then, the corrosion samples were studied with biological light microscope with 10-fold magnification.

RESULTS AND DISCUSSION

The study shows that complex topography of MA is determined by the features of intrauterine development. Definitive structure of MA was formed to 32nd week of gestation and generally accepted segments (mandibular, pterygoid and pterygopalatine) of its trunk were defined.

The points of view on the borders of MA segments differ [2, 5, 7] but in presented study the main demarcating sign was a change of MA course. According this conception the mandibular segment is located on the level of mandible neck and temporomandibular joint, the pterygoid segment passes within infratemporal fossa between later-

al and medial pterygoid muscle, and the pterygopalatine segment is limited by the borders of same named fossa.

Mandibular segment of MA has an arch-shape and it is directed medially in both fetuses and adults (Fig. 1, A), but degree and extension of this arch becomes more pronounced with age. An average length of the mandibular segment gradually enlarges from 6-12 mm in fetuses to 18-23 mm in adults and its diameter increases from 1,4-2,6 mm to 2,8-4,2 mm respectively. The first branch of MA mandibular segment is the deep auricular artery with diameter from 1,4 to 1,9 mm. In adults, it arises from the main MA trunk at distance of 7-9 mm from its beginning. Then deep auricular artery goes upwards — backwards and participates in blood supply of the temporomandibular joint with its capsule, lower wall of the outer ear canal and the eardrum by number of its branches. The alveolar branch to the lower jaw arises at 2-3 mm distance from the deep auricular artery, then it runs downward and entering the mandibular canal together with both alveolar vein and nerve. Diameter of this branch in adults varies from 2,6 to 2,8 mm.

The middle meningeal artery (MMA) arises from the mandibular segment in the most prominent point of its arch. An extracranial part of MMA has average diameter from 0,74 to 0,86 mm in newborns and from 1.4 to 1.6 mm in adults. This artery runs upwards and medially along inner surface of the lateral pterygoid muscle to foramen spinosum by which enter the cranial cavity. Intra-osseous segment of MMA has vertical direction with slight back-deviation. Its length gradually increases from 2,25-2,68 mm in fetuses to 6,2 mm in adults. Beginning of MMA intracranial part curves laterally.

The pterygoid segment of MA runs obliquely forward and upward in the sagittal plane and superficially of the lateral pterygoid muscle (Fig 1, A). The angle between its beginning and ending varied from 10 to 45 and defining shape of the pterygoid segment as an «arch» (22,2%) or a «staple» (27,7%). The «staple» variant is more characteristic for adult. Its length varied from 8-16 mm in fetus to 28-44 mm in adults and diameter was up 0,6-1,4 mm to 2,5-3,7 mm respectively.

There are many authors who tried to classify the variable patterns of the pterygopalatine segment [7], but the variability of the pterygoid segment has never been described. The pterygopalatine segment has a loop-shape and it is situated strictly in the frontal plane (Fig. 1, B). It is characterized by deep location and occupies most of the pterygopalatine fossa, reaching the zygomatic bone and lateral surface of the maxilla body, where it ends by branching that supply nasal cavity and the palate. The length of the third segment of MA varies from 17 to 24 mm, diameter runs up 1,8 to 2,5 mm in adults. The terminal branches of MA — the descending palatine and pterygopalatine arteries — widely anastomose each with other. It is especially true for fetal period, then various modes of anastomoses of the terminations of MA with the terminal portion of the greater palatine artery, or with the end of the sphenopalatine artery, or with its counterpart on the opposite side, etc. were described.

MA is closely related to the lower head of lateral pterygoid muscle. It runs either superficially or deep to the lateral pterygoid accompanied by vessels of superficial part of PVP. According to observations of Dennison J, et al. (2009), the pterygoid segment of MA lies deeper than the lateral pterygoid predominately in females, and superficially — in males. We have found the second part of the maxillary artery superficial to the pterygoid muscle in all the specimens.

The pterygoid plexus is a venous structure that accompanies the first and second segments of the MA and is closely associated with the lateral pterygoid muscle. The superficial and deep variants of the plexus are described in literature: the superficial variant usually accompanied with wide connections of PVP vessels with superficial facial veins, while the deep type is characterized by a major communication with the venous plexuses placed at the cranial base [8]. Our study showed, that superficial and deep parts of PVP is clearly distinguished on all fetal specimens, and both these parts still recognizable in adults.

The superficial part of the plexus is represented by a dense flattened network with diameter of vessels from 0,1 to 0,2 mm oriented primarily along the fibers of lateral pterygoid muscle (Fig. 2, A). On the lateral aspect, these vessels converge together to form some main efferent vessels up 3,2 to 0,5 mm in diameter. They pass both in front and behind of the neck of mandible and empty to the external jugular vein.

Deep part of the plexus has a loop-shaped structure gaining a cone form. Its vessels run towards the skull base and without clear boundaries extend as a venous network of foramen ovale. Contrariwise they pour together to form 3-4 main veins with diameter from 0,3 to 0,5 mm that empty to the efferent vessels of superficial part of PVP (Fig. 2, B). A tendency to reduction of small vessels both superficial and deep parts of PVP and formation some large trunks among network of the plexus, with diameter of lumen from 1,8 to 2,3 mm,

are traced in adults. Residual veins accompanying MMA described as «middle meningeal vein» [4]. However, in 33% cases the loop-shaped extended structure of PVP was preserving in adults that coincided with extended pattern of the whole head's venous system.

On the arterial-venous corrosive specimens we can see that main direction of MA corresponds with general direction of vessel of the superficial part of PVP. Small muscular branches of the pterygoid segment of MA branch out between the superficial vessels of PVP, forming a dense arterial-venous network (Fig. 3). The efferent vessels accompany main trunk of MA till the place of its derivation from the external carotid artery, where the veins themselves empty into the external jugular vein.

Extracranial part of MMA is surrounded by loop-shaped vessels of deep part of PVP along the three fourth of its length. Only the proximal one fourth of its extension is free from the venous accompaniment, as in close proximity to the base of the skull deep branches of PVP run in the medial direction to the foramen ovale. Few venous vessels penetrate cranial cavity together with MMA via the foramen spinosum.

In adults, a proximal half of extracranial segment of MMA hasn't its venous braiding in connection with significant reduction of deep PVP vessels. At 6-8 mm away from the proximal part of MMA the emissary vein of foramen ovale was rejected medially to enter the same named foramen. In some cases on front-medial aspect of MMA were remained some venous vessels with diameter from 2.1 to 1.0 mm accompanying the artery into cranial cavity.

CONCLUSION

1. The obtained results make it possible to suggest the surface marking for mandibular and pterygoid segments of the maxillary artery. In adults, the projection line of the mandibular part of maxillary artery is a horizontal line starting on a level with neck of the mandible, then runs forward over the 18-23 mm to its endpoint. The projection of the pterygoid segment is a triangular area with apex in the endpoint of the first segment, and with angles of base at the outer corner of the orbit and 20 mm below it. Thus, trauma to the face near this projection line and the three-cornered zone may be accompanied by profuse bleeding from maxillary artery or its branches.

2. Availability of extracranial part of middle meningeal artery must be taken into consideration for designing the new methods of its extracranial ligation to stop bleeding from the intracranial part of the artery in case of the blunt injuries of the temporal region.

3. Dense venous plexus surrounding the maxillary artery and its branches, especially the middle meningeal artery, suggest an active participation of the pterygoid venous plexus to regulate the blood circulation in this area by lessening the impacts of pulse-wave and stabilization of blood flow in the maxillary artery, which is a main terminal branch of the external carotid artery. This effect is especially important in the antenatal period because of incomplete maturation of autoregulatory mechanisms of blood circulation in the dura mater and the brain.

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Ю.Н.Вовк, М.А.Корнеева, Д.А.Ткаченко. Возрастной аспект сосудистых взаимоотношений подвисочной ямки человека. Амман, Иордания; Луганск, Украина.

Ключевые слова: верхнечелюстная артерия, крыловидное венозное сплетение, онтогенез человека.

Изучены топография ствола и ветвей верхнечелюстной артерии, особенности строения крыловидного венозного сплетения, а также их взаимоотношения в возрастном аспекте. Установлено, что поверхностно расположенные сосуды крыловидного венозного сплетения формируют густую сеть по ходу основного ствола верхнечелюстной артерии, в то время как сосуды глубокого отдела сплетения сопровождают внечерепной сегмент средней оболочечной артерии на протяжении 3/4 ее длины. Сосуды глубокой части крыловидного венозного сплетения частично редуцируются с возрастом, однако в ряде случаев рассыпная форма сплетения сохранялась и у взрослых. Обсуждены морфофункциональные и прикладные аспекты полученных результатов.

Ю.М.Вовк, М.О.Корнєєва, Д.О.Ткаченко. Віковий аспект судинних відносин підскроневої ямки людини. Амман, Йорданія; Луганськ, Україна.

Ключові слова: верхньощелепна артерія, крилоподібне венозне сплетіння, онтогенез людини.

Вивчено топографію верхньощелепної артерії та її гілок, особливості будови крилоподібного венозного сплетіння та їх взаємовідношення у віковому аспекті. Встановлено, що судини поверхневого відділу крилоподібного венозного сплетіння формують щільну венозну сітку по ходу головного стовбура верхньощелепної артерії, в той час як судини глибокого відділу сплетіння супроводжують позачерепний сегмент середньої оболонкової артерії протяжгом 3/4 її довжини. Судини глибокої частини крилоподібного венозного сплетіння з віком частково редукуються, але в деяких випадках і у дорослих сплетіння зберігає розсипну форму. Обговорені морфофункціональні та прикладні аспекти отриманих результатів.

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