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Macroanatomical Investigation of Superficial Veins of Head in the Egyptian Red Fox "Nile Fox-Vulpes vulpes".

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ABSTRACT

The current study was carried out on two adult apparently healthy red foxes of both sexes and nearly at the same age. Before exsanguinations, the jugular vein was cannulated and flushed with warm normal saline solution (0.9%) then injected with gum milk latex colored red to study the superficial venous drainage of head and neck of the red fox. The origin, the course and the venous drainage of the jugular vein tributaries were studied. The external jugular vein drained blood from two main tributaries, the maxillary and the lingofacial veins. The tributaries of maxillary vein were only the caudal auricular and the superficial temporal veins while those of lingofacial vein were the lingual vein which forming the arcus hyoideus and the facial vein which received the masseter vein in addition to drainage of the face.

Keywords: Venous Drainage, Head, Jugular Vein, Red Fox.

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INTRODUCTION

The red fox is the largest of the true foxes, as well as being the most geographically spread member of the carnivora belonging to family canidae as dogs. Throughout its range, the red fox is widely perceived as a major predator of rabbits, pheasants and mice *(Sargeant et al., 1984, Saunders et al., 1995, White et al., 2003* and *Baker et al., 2006).* The red fox subspecies occurring in Egypt is the *Vulpes vulpes aegyptia*, known in Arabic as "Tha'lab Ahmar". It typically has a length from 76.7 to 105 cm, weighing between 2.8 and 5.8 kg; with a tail ranging from 30.2 to 40.1 cm. it is not red, but having a ruddy to gray-brown coloration above, and is darker on the back of the neck. The flanks are grayer, tinged with a buff color, while the throat and belly are dark to the point of being almost black. The aim of this study was to anatomically investigate the main superficial venous drainage of the head and neck however; the anatomical data on the fox was few and nearly neglected by anatomists.

MATERIAL AND METHODS

The present investigation was conducted on two adult apparently healthy red foxes of both sexes. Before exsanguinations, foxes were anaesthetized by IM injection of 1 cc of 2% xylazine HCL to provide muscle relaxation and to prevent vasoconstriction, followed by the injection of heparin ampoule (5000 I.U.) into the subcutaneous region of thorax to prevent blood clotting. Each fox was then exsanguinated through the common carotid arteries and left to bleed for five minutes. The jugular vein was exposed and cannulated using a suitable venous catheter then injected with 60% gum milk latex colored red with Rotring® ink. The foxes were left in a mixture of 10% formalin and 2% phenol for three days before dissection. The obtained results were photographed using a digital photo camera Nikon COOLPIX L310 14.1 Megapixels in nine photos. The nomenclature used was that recommended by the *Nomina Anatomica Veterinaria*, 5th edition by *(Frewein and Habel, 2012).*

RESULTS

V. jugularis externa:

The external jugular vein (fig.1-5/1) was found to be the main venous drainage of the superficial structures of cephalic and cervical regions located on the ventral border of bracheocephalicus muscle and covered by cutaneous coli muscle in fox. In cervical region, it received ventrally muscular tributaries, small veins from lymph nodes and ascending veins (fig.1-4/5) while dorsally it received superficial cervical vein (fig.1-4/4) that collecting blood returning from the occipital region and superficial portion of dorsal aspect of the neck. At the angle between head and neck, the external jugular vein received two main tributaries draining the head, the maxillary and the lingofacial veins.

V. maxillaris:

The maxillary vein **(fig.1-5/2)** was one of the main two tributaries forming the external jugular vein through conjugation with the lingofacial vein **(fig.1,3,4,5,9/3)**. It is located in the retromandibular fossa under the base of ear immediately ventral to the tympanic cavity and caudal to the mandibular angle coursing over the mandibular (fig.1-4/38) and parotid (fig.1-4/37) salivary glands and in between the corresponding lymph nodes (fig.1,2/39,40). The main tributaries participating in the formation of the maxillary vein were glandular veins *(ramus glandularis)* (fig.1-4/6) which collecting blood returning from parotid and mandibular glands and the associated lymph nodes, the caudal auricular vein (fig.1-4/7) and the superficial temporal vein (fig.1-4/11). It was observed that the base of ear was lodged in the bifurcation formed by the caudal auricular vein caudally and the superficial temporal vein rostrally.

V. auricularis caudalis:

The caudal auricular vein (fig.1-4/7) was found to be formed by the conjunction of three smaller veins, from rostral to caudal, the lateral auricular, the intermediate auricular and the deep auricular veins. The lateral auricular vein *(v. auricularis lateralis)* (fig.1-4/8) originated from the apex of the auricula and coursing along the cranial rim towards the base of ear. The intermediate auricular vein *(v. auricularis intermedia)* (fig.1-4/9) originated at the caudal convex border of ear and before opening into the caudal auricular vein, forming a

common trunk with the lateral auricular vein. The deep auricular vein *(v. auricularis profunda)* (fig.1-4/10) originated from the caudomedial rim of the auricula coursing rostroventrally and opening separated from the lateral and intermediate ones into the caudal auricular vein. Finally, along its way before opening into the maxillary vein, the caudal auricular vein received one or two smaller radicles coming out of the parotid gland then enter the maxillary vein at the level of the dorsal border of mandibular salivary gland.

V. temporalis superficialis:

The superficial temporal vein (fig.1-4/11) was found to be formed on the rostral side of the external auditory meatus by conjunction of two main tributaries forming V-shape, one coming from the caudal side but rostral to base of the ear called rostral auricular vein (fig.1-4/14) *(v. auricularis rostralis)*, was the continuation of the stylomastoid vein which leave the cranial cavity through the stylomastoid foramen also it received a small vein from the medial aspect of auricula, the medial auricular vein (fig.1/15) *(v. auricularis medialis)* while the other one coming from rostral side called lateral auricular vein (fig.1-4/13) *(v. auricularis lateralis)*, was the continuation of the dorsal external ophthalmic vein and forming a network of venous drainage (fig.8/yellow arrow) with the lateral superior palpebral vein coming from the angular vein of the eye. These two main tributaries united together forming the superficial temporal vein which continued ventrally and before reaching to open into the maxillary vein, received a third vein coming transversally, called transverse facial vein (fig.1-4/12) *(v. transversa faciei)* which continued as two parallel tributaries dorsal and ventral to facial crest on the masseter muscle which joined caudally to open into the superficial temporal vein but rostrally the ventral one descending rostroventrally and joined on the cranial border of masseter muscle with the facial vein (fig.1-3,9/black arrow).

V. linguofacialis:

The lingofacial vein **(fig.1,3,4,5,9/3)** was found to be the principal venous drainage of the more superficial and more rostral structures of the head, forming the external jugular vein through its conjunction with the maxillary vein below the ventral border of the mandibular salivary gland (fig.1-4/38). The main tributaries forming the lingofacial vein were the lingual vein (fig.3,5,9/16) ventrally under cover of mandibular lymph nodes and the facial vein (fig.1-9/17) laterally descending on the face which coursing caudoventrally crossing over the mandibular lymph nodes.

V. lingualis:

The lingual vein (fig.3,5,9/16) was arised from the lingofacial vein in the intermandibular space. It was found to be united with the vein of the other side at the level of the basihyoid forming a transverse venous connection called the hyoid venous arch *(arcus hyoideus)* (fig.3,5/28), prior to this connection, the lingual vein received glandular veins (fig.1-4/6) especially from mandibular salivary gland and ascending pharyngeal vein *(v. pharyngea ascendens)* (fig.9/36). The hyoid venous arch received the deep lingual vein *(v. profunda linguae)* (fig.5/30) and *ramus submentalis* (fig.3/29) which drained each mylohyoideus muscle and clearly communicated through small radicles with the submental vein (fig.3,5/18) of the facial vein.

V. facialis:

The facial vein (fig.1-9/17) was found to be originated dorsal to the orbit and passed ventrally at the medial angle of the eye in front of the rostral border of masseter muscle, crossing over the mandibular lymph nodes till reaching the lingofacial vein. The facial vein began as the angular vein of eye *(v. angularis oculi)* (fig.1,2,4,6,7,8/25) which receiving *v. palpebralis superior medialis* (fig.8/32) from the upper eyelid, *v. palpebralis superior lateralis* (fig.8/33) which forming a venous network lateral to eye with the lateral auricular vein (fig.1-4/13) of superficial temporal vein and finally, the *v. angularis oculi* continued to communicate with the dorsal external ophthalmic vein (fig.6,8/31). Along the course of the facial vein on face it received:

V. dosalis nasi:

The dorsal nasal vein (fig.6/24) in fox was found to be formed of dorsal and ventral divisions. The dorsal division was about 3-4 smaller corrugated radicles dorsal to nasal bone draining the dorsal part of nasal plate and communicated with radicles of the other side (fig.6/34). While the ventral division was located

lateral to nasal bone at the nasoincisive notch and draining the lateral part of nasal plate as well as the associated structures of nose. Finally, the two divisions united and directed caudally as a dorsal nasal vein which was found to be connected with the facial vein at the more convex portion and was clearly seen to be on the same level with the angular vein of the eye.

V. lateralis nasi:

The lateral nasal vein (fig.7/22) was originated at the lateral aspect of face, draining and covered by the *levator nasolabialis* muscle. It received blood coming from dorsal and ventral small radicles along its course caudally parallel to the dorsal nasal vein (fig.6,7/24) before opening into the facial vein.

V. malaris:

The malar vein (fig.7,8/27) was aroused from the medial angle of the eye and collecting blood from the *malaris* muscle and lower eyelid and opened into the facial vein from behind, just before entrance of the superior labial vein (fig.7/21).

V. labialis superior:

The superior labial vein (fig.7/21) was originated from the maxillary lip and coursing caudally and laterally where it received about 5-8 small radicles coming from the lip border. These latter radicles, after the end of superior labial vein, were found to open into the facial vein itself.

V. profunda faciei:

It was found that there was a large communication between the ophthalmic plexus and the facial vein via the deep facial vein (fig.8,9/35) which was ventral to the zygomatic bone and under cover of rostral margin of masseter muscle. It received the ventral external ophthalmic vein; pterygoid plexus, vessels of soft and hard palate then descend to open into the facial vein at the level of mouth commissure.

V. angularis oris:

The angular vein of mouth (fig.9/20) was formed from about 8-10 small veins like a tree distributed and radiated into the *orbicularis oris* muscle then collected together caudal to the mouth angle forming one vein, the *v. angularis oris* which ended caudally into the facial vein.

V. labialis inferior:

The inferior labial vein (fig.1-5,9/19) drained the blood returning from the mandibular lip and chin resembling to the *v. labialis superior* through small radicles along the course of the lip border but differed than the *v. labialis superior* in that the inferior labial vein ended indirectly into the facial vein through another vein called *v. submentalis* (fig.3,5/18) of the facial vein.

V. masseterica:

It was found that in fox, the massetric vein (fig.1-4,9/26) originated by small radicles coming from layers of the masseter muscle and directed rostroventrally and opening into the caudal aspect of facial vein at the opposite side of submental vein entrance.

V. submentalis:

The submental vein (fig.3,5/18) was originated ventrally at the chin and communicated dorsally with *v. labialis inferior*, directed caudally in the intermandibular space parallel to the other one of the other side between the mandibular body and the mylohyoideus muscle till reaching the vascular notch of the mandible then turning lateral to the face and before ending at the facial vein, it received the *v. labialis inferior*. It was found from the first impression through naked eyes that the facial vein collecting three main tributaries only

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due to the connection between the facial, inferior labial and submental veins which giving appearance of three large veins forming the facial vein.

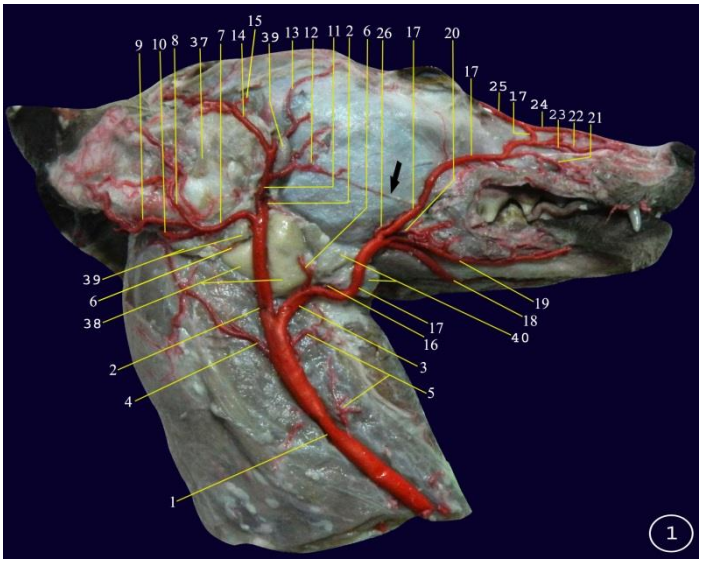

Fig 1: A photograph showing the superficial venous drainage of head & neck in red fox injected with red colored gum milk latex (Lateral view).

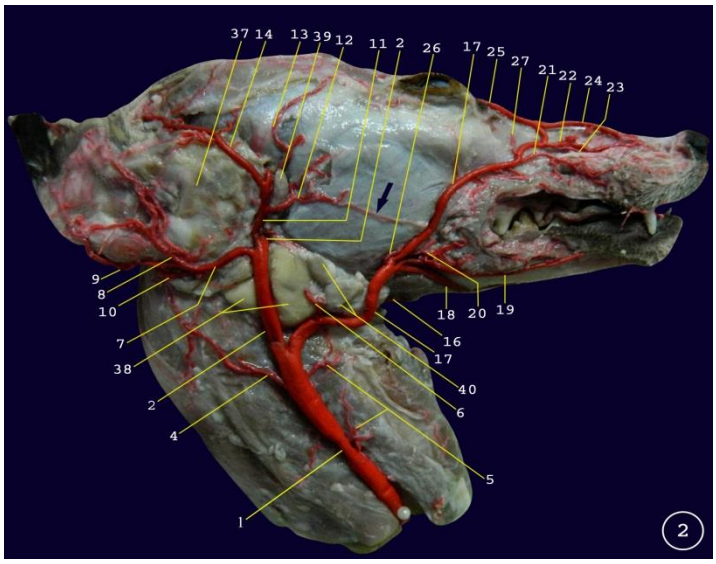

Fig 2: A photograph showing the superficial venous drainage of head & neck in red fox injected with red colored gum milk latex (Lateral view).

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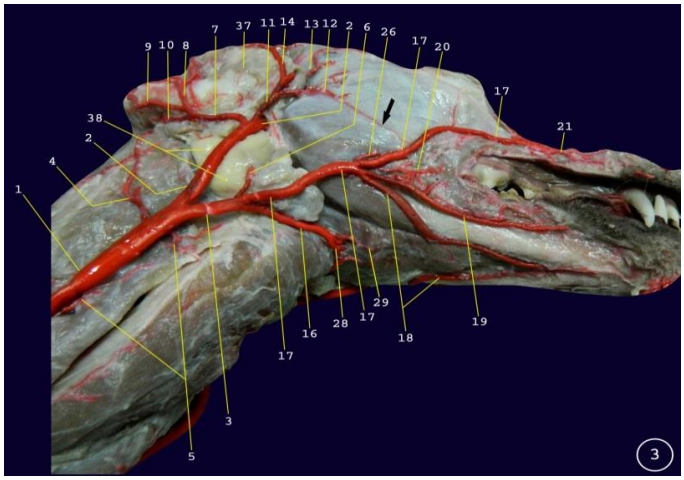

Fig 3: A photograph showing the superficial venous drainage of head & neck in red fox injected with red colored gum milk latex (Ventrolateral view).

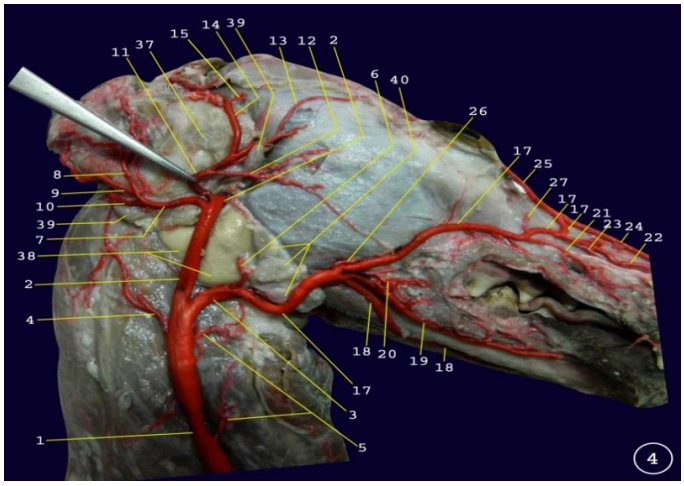

Fig 4: A photograph showing the superficial venous drainage of head & neck in red fox injected with red colored gum milk latex (Lateral view).

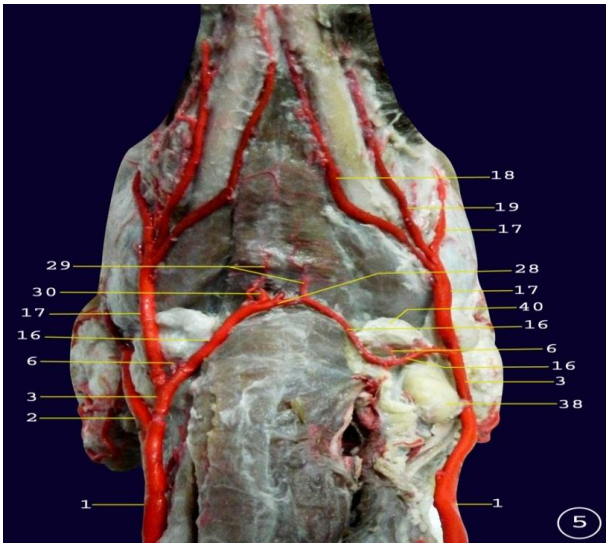

Fig 5: A photograph showing the superficial venous drainage of head & neck in red fox injected with red colored gum milk latex (Ventral view).

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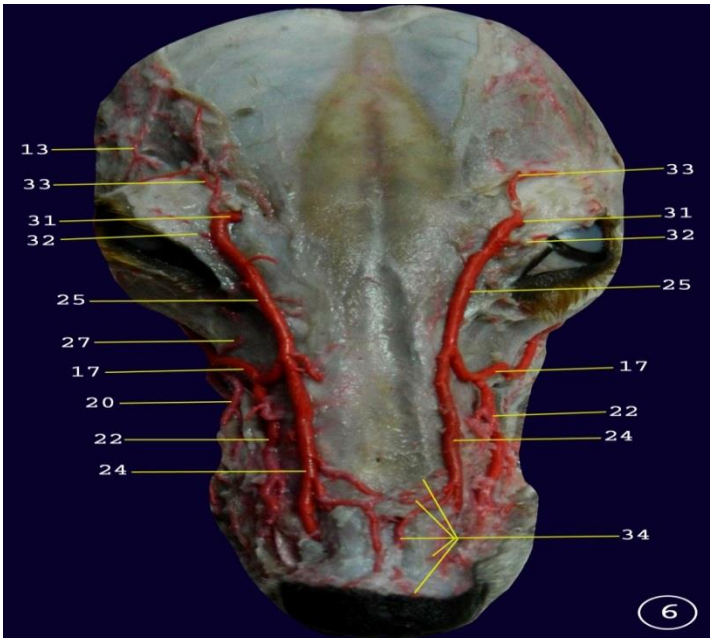

Fig 6: A photograph showing the facial venous drainage of head in red fox injected with red colored gum milk latex (Dorsal view).

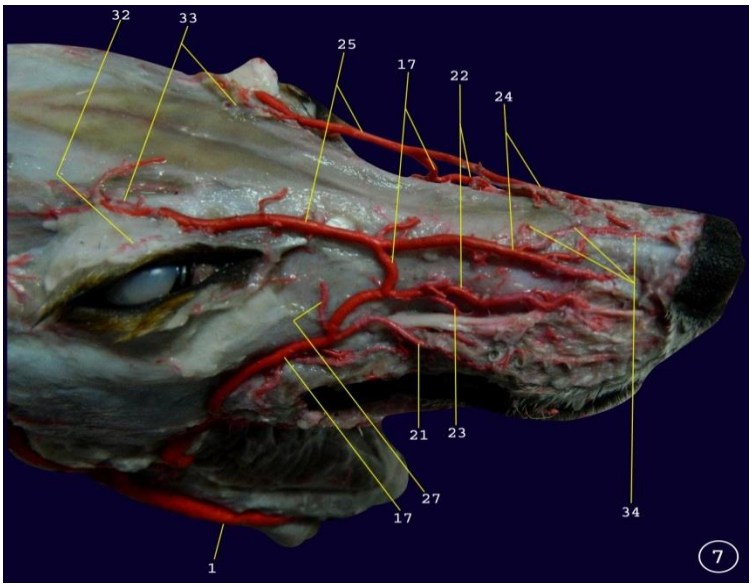

Fig 7: A photograph showing the facial venous drainage of red fox injected with red colored gum milk latex (Dorsolateral view).

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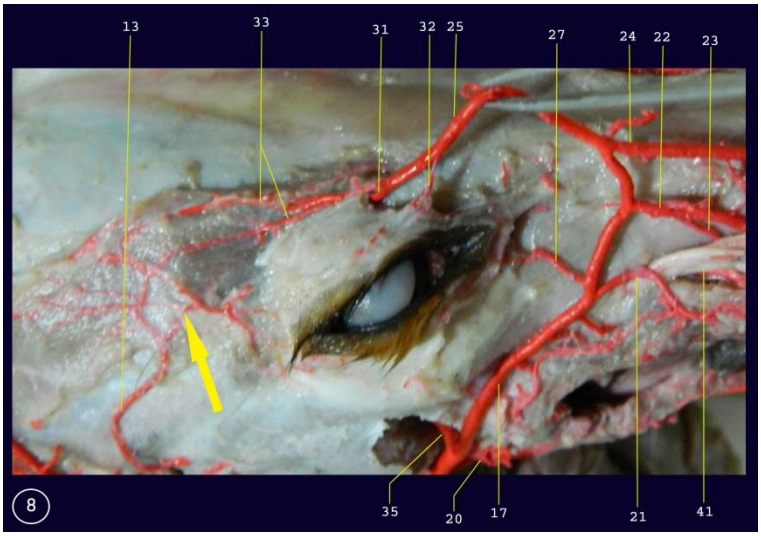

Fig 8: A photograph showing the facial venous drainage of red fox injected with red colored gum milk latex (Dorsolateral view).

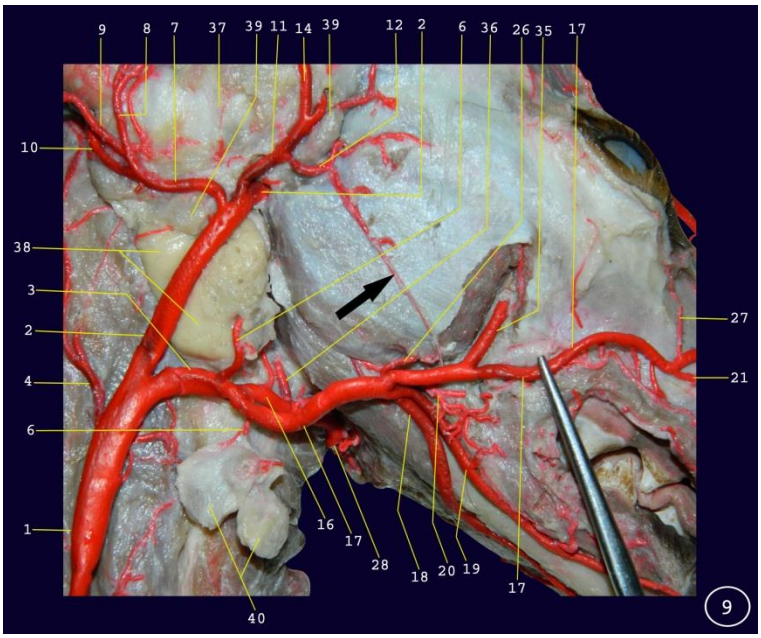

Fig 9: A photograph showing the superficial venous drainage of head & neck in red fox injected with red colored gum milk latex (Lateral view).

1. V. jugularisexterna
2. V. maxillaris
3. V. linguofacialis
4. V. cervicalissuperficialis
5. Ramus ascendens
6. Ramus glandularis
7. V. auriculariscaudalis
8. V. auricularislateralis
9. V. auricularisintermedia
10. V. auricularisprofunda
11. V. temporalis superficialis
12. V. transversafaciei
13. V. auricularislateralis

14. **V. auricularisrostralis**
15. **V. auricularismedialis**
16. **V. lingualis**
17. **V. facialis**
18. **V. submentalis**
19. **V. labialis inferior**
20. **V. angularisoris**
21. **V. labialis superior**
22. **V. lateralisnasi**
23. **V. infraorbitalis**
24. **V. dorsalisnasi**
25. **V. angularis oculi**
26. **V. masseterica**
27. **V. malaris**
28. **Arcushyoideus**
29. **Ramus submentalis**
30. **V. profunda linguae**
31. **Ramus anastomoticus cum v. ophthalmicaexternadorsalis**
32. **V. palpebralis superior medialis**
33. **V. palpebralis superior lateralis**
34. **Rami dorsalisnasi**
35. **V. profundafaciei**
36. **V. pharyngeaascendens**
37. **Gl. Parotis**
38. **Gl. Mandibularis**
39. **Lnn. Parotideisuperficialis**
40. **Lnn. Mandibulares**
41. **N. infraorbitalis**

DISCUSSION

The current investigation revealed that the external jugular vein in fox was formed mainly by two main tributaries draining the head, the maxillary vein and the lingofacial vein, a result which was in accordance with that reported by *(Nickel et al., 1981; Dyce et al., 2002* and *Evans* and *DeLahunta, 2004)* in dogs. On the other hand, *Dom et al. (1970)* in opossum observed that the external jugular vein was formed, in most instances, by the junction of the facial vein and the maxillary vein.

Our investigations were in agreement with that found by *Dom et al. (1970)* in opossum and *Nickel et al. (1981)* in dogs that the external jugular vein received, near the thoracic inlet, the *v. cervicalis superficialis*, a small vein from the submandibular gland and an even smaller vein from the prominent lymph nodes located posterior to the submandibular gland. They also added that the *v. cervicalis superficialis* return blood from the superficial portion of the dorsal aspect of the neck. In addition, *McClure (1905)* reported that a vein drained blood from superficial muscles of ventral aspect of neck and one draining blood from the side of larynx entered the external jugular vein.

Unlike our results*, (Bertolini* and *Zotti, 2006* and *Specchi et al., 2012)* observed that in cats, the left external jugular vein and both internal jugular veins might be absent. They also added that this case was common and should not be interpreted as an abnormality. A result which not found in any of our specimens ever. *Niiyama et al. (1985)*

Our current investigations and that of *Smeak* and *Inpanbutr (2005)* in dogs found that the maxillary vein located immediately ventral to the tympanic cavity and must be safely retracted away from the tips of the rongeurs while the ventral aspect of the bulla was being removed and the base of ear was lodged in the bifurcation formed by the caudal auricular vein caudally and the superficial temporal vein rostrally. In addition, in pigs was applied that the caudal auricular vein flows into the maxillary vein which joined with linguofacial vein and runs into the external jugular vein at the cross point of the caudal margin of the mandibular gland.

Our results were in agreement with that observed by *Mutuş (2001)* in rabbits that the intermediate auricular vein forming a common trunk with the lateral auricular vein while the deep auricular vein entered separated from the lateral and intermediate ones and caudal to them into the caudal auricular vein. These results were not similar to that reported by *Evans* and *DeLahunta (2004)* in dogs who illustrated that the deep auricular vein entered directly into the maxillary vein in the midway between the origin of entrance of both the caudal auricular and superficial temporal veins.

Mutuş (2001) in rabbit reported that the transverse facial vein continued as two parallel branches on the ventral and the dorsal sides of the crista facialis over the masseteric muscle and the two branches joined together before opening to the rostral section of the superficial temporal vein. It formed an anastomosis on the front side over the masseteric muscle with a branch originating from the facial vein. A result which was similar to our investigations in fox.

The present investigation and that of *(Frenzel, 1967; Ghosal et al., 1981; Nickel et al., 1981; Ari, 2000 and Ari et al., 2011)* in dogs, were agreed that the lingual vein was aroused from the lingofacial vein in the intermandibular space. It was found that the lingual vein united with the vein of the other side at the level of the basihyoid forming a transverse venous connection called the hyoid venous arch; this venous arch formed by union of the right and left lingofacial veins in cats. In addition, *Dom et al. (1970)* recorded that the *v. lingualis* in opossum was formed by the union of the *v. profunda linguae* with the *v. submentalis*.

During the course of facial vein on the border of the masseter, it gave off the inferior labial vein, the angular vein of the mouth and the deep facial vein and under the *levator nasolabialis*, it gave off the superior labial vein, the lateral nasal vein and the dorsal nasal vein. These results were in agreement with that reported by *(Frenzel, 1967; Ghosal et al., 1981; Nickel et al., 1981; Ari, 2000; Konig* and *Liebich, 2004* and *Ari et al., 2011)* in dogs.

Our results were in accordance with *(Frenzel, 1967* and *Nickel et al., 1981)* who reported that the masseter vein was given by the facial vein at the level of the masseter in dogs. They also added that the submental vein originated from the lingual vein in cats while originated from facial vein in dogs. This explained that the fox was similar to dog in the origin of the submental vein.

Ari et al. (2011) observed that the dorsal nasal vein in cats originated from the facial vein at the medial angle of the eye. It ramified into dorsal branch and ventral branch, after its origin. The dorsal branch anastomosed with the same branch on the opposite side on the dorsal of the nose. The ventral branch anastomosed with the same branch on the opposite side after coursing rostroventrally on the lateral wall of the nose. A result which was similar to our investigation but in fox the dorsal division was more ramified into 3-4 radicles than in dogs and cats.

The present investigation revealed that the angular vein of eye received *v. palpebralis superior medialis* from the upper eyelid, *v. palpebralis superior lateralis* which forming a venous network lateral to eye with the lateral auricular vein of superficial temporal vein and continued to communicate with the dorsal external ophthalmic vein. On the other hand, *(Frenzel, 1967; Ari, 2000* and *Ari et al., 2011)* in cats reported that the angular vein of the eye gave rise to anastomotic branch to the rostral auricular vein.

CONCLUSION

This investigation provided an anatomical guide to the superficial venous drainage of the head and neck of the red fox that was to some extent similar and differed from other domestic mammals even carnivores as dogs and cats. The jugular vein was located on the ventral border of bracheocephalicus muscle. The lateral auricular and intermediate auricular veins united together before entering the caudal auricular vein while the deep auricular one opened separated into the caudal auricular vein. The lateral auricular vein of the superficial temporal formed a network of venous drainage with the lateral superior palpebral vein coming from the angular vein of the eye at the lateral angle of eye. The lingual vein in fox formed with the opposite one, the arcus hyoideus at the level of the basihyoid. The dorsal division of dorsal nasal vein was more ramified dorsal to the nose. The dorsal nasal vein and the angular vein of eye were at the same level but draining from more opposite sites. The angular vein of mouth was formed from about 8-10 small veins like a

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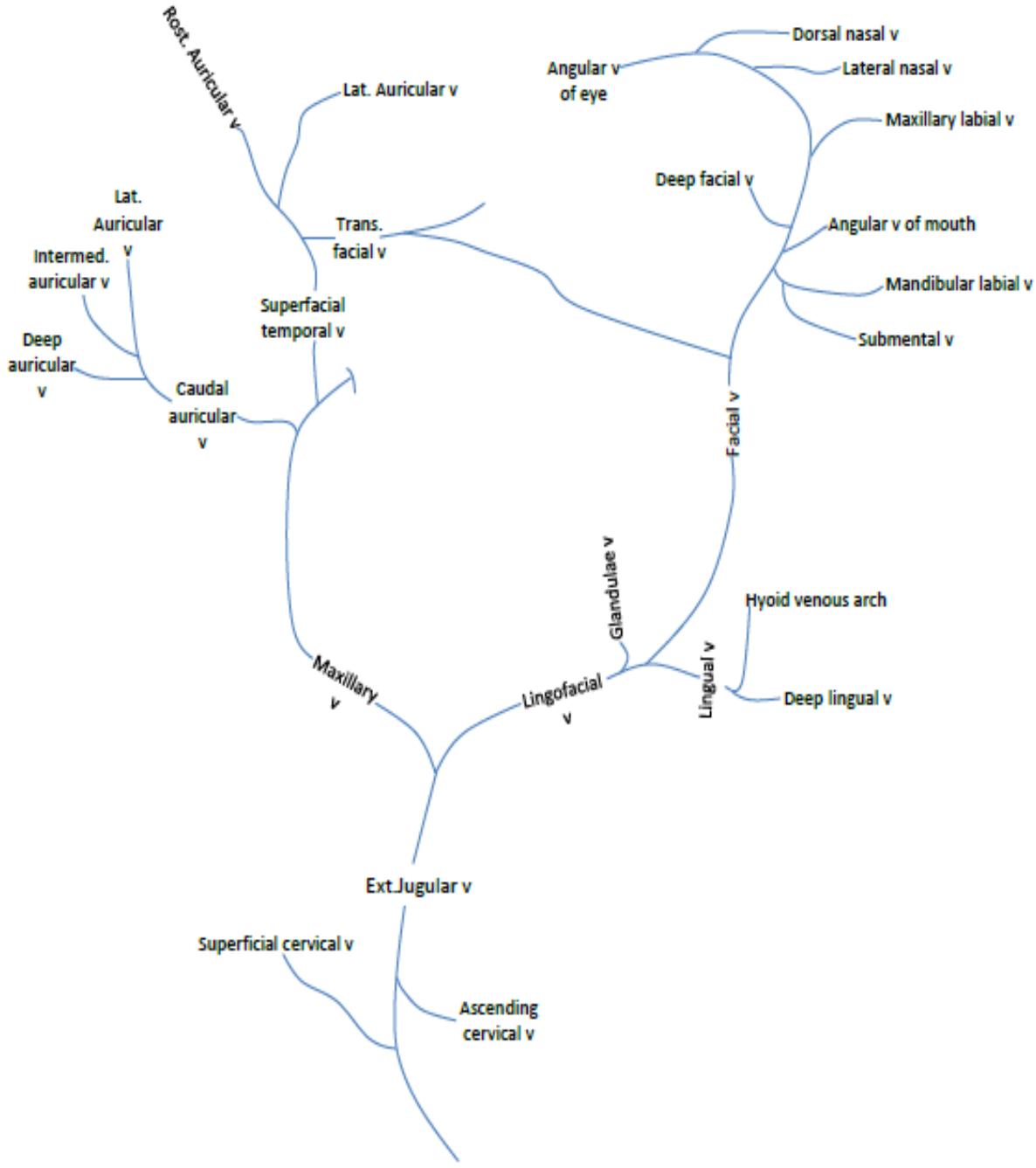
tree. The masseteric vein in fox drained into the facial vein and the submental vein received the inferior labial vein before entering the facial vein.

Diagram illustrating the superficial veins of head:



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