International Journal of Current Research and Academic Review
ISSN: 2347-3215 Volume 3 Number 4 (April-2015) pp. 45-58
www.ijcrar.com

Applied anatomy of the head region of donkey (*Equius asinus*) in Egypt and its clinical value during regional anesthesia

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KEYWORDS

Applied anatomy, Head region, Donkey, Regional anesthesia

A B S T R A C T

The study involved the anatomical landmarks measurements for regional anesthesia in head region of thirteen adult donkeys in Egypt. The Applied anatomical measurements for 21 parts of the skull were made for this study were tabled. The results were of clinical importance and used in regional nerve blocks of the supra-orbital, infra-orbital and mental nerves which are useful during surgical operations in head region and dental extraction. The application of local anesthetic agent was easier for the maxillary and mandibular nerve blocks through the injection of local anesthetic agent via infra-orbital foramen and mental foramen respectively. These data were discussed with regard their application to clinical maneuvers around the head of donkey, horse and camel.

Introduction

Donkeys belong to the family Equidae and they play an important role in people and goods transporting in urban areas in Egypt. The applied anatomy of donkey's head is very important as it is the location of vital organs as the lips, eyes, nose, teeth, tongue and brain. The head is thus needed for coordinating the body as well as for deglutition and olfaction (Dyce *et al.*, 2002). The cranial nerves and their passages from different foramina in the skull have clinical importance in regional anesthesia (Olopade, 2003) and anesthesia around the head (Hall *et al.*, 2001). Regional nerve block used for all painful procedures including dental removals via Buccotomy, rasping of maxillary and mandibular molar teeth in case of sharp teeth, treatment of upper eyelid entropion, alar fold resection and in some cases of sinus surgery. It is useful in minimizing the dose of sedative and general anesthetics (Tremaine, 2007).This study was designed to provide information on some clinically important parameters in the head of donkey to detect the easier ways of needle application for nerve block and to detect the effect of anesthetic agents on the supplied area.

Material and Methods

Preparation of the skull

Ten adult donkeys of both sexes were collected from Beni-Suef governorates for dissection purposes in Anatomy and Embryology Department, Faculty of Veterinary Medicine, Beni Suef University, Egypt. The heads were without any skeletal abnormalities were cut at the occipitoatlantal joint. Manual skinning and defleshing of the heads recently dead animals by using dissecting equipments such as scalpel, knives, forceps and scissors (Hildebrand, 1968; Merai, 2012).

The cheek muscles, eyes, tongue and nasal cartilages were removed. Also, the brain was removed by filling the cranial cavity with water and stirred using a long forceps or with vigorous shaking and pouring off through the foramen magnum with repetition till complete evacuation occurred. The skulls was boiled in a suitable sized metal container and heated using for two hours then removed the soft tissue by teeth brush then rinsed it under tape water. The skull was macerated by bacterial maceration method via keeping the skull in a cloth mesh immersed in a hot water and kept in plastic container and stored in a warm place for six weeks. The skull was taken out and scraped using teeth brush and knife for cleaning. The skull was left to dry for two weeks then bleached by soaking in hydrogen peroxide 3% for four days in a sealed container until the bones appeared clean and whitish in color. Finally, the skull was thoroughly rinsed with water and left to dry for two weeks.

Anatomical landmarks

The following measurements and appropriate indices were calculated according to Monfared (2013) in donkey, horse, camel and buffalo, Allouch (2014) in bovine and Samuel *et al.* (2013) in goat.

1- Skull length: from the rostral end of the alveolar process of the incisive bone to the occipital crest and divided into cranial and nasal skull. 2- Nasal skull length: from the cranial edge of the maxillary bone cranially at the level incisor tooth to cranial border of the frontal bone caudally. 3- Cranial skull length: from the cranial border of the frontal bone cranially to occipital crest.

4- Distance from the medial canthus to the supraorbital foramen: produced by caudal diagonal line from the medial canthus along the orbit to the supraorbital foramen.

5- Supra-orbital foramina distance: greatest width between the two supra-orbital foramina.

6- Infraorbital foramina distance: facial width between the infraorbital foramina.

7- Rostral end of facial crest to infra orbital foramen: measurement was taken oblique craniodorsally from the level of the facial crest to the midlevel level of the infra-orbital foramen.

8- Distance from the medial canthus to the infraorbital foramen.

9- From the infra-orbital foramen to the nasoincisive notch: measurement was taken vertically from the infra-orbital foramen to the nasoincisive notch between rostral part of the nasal bone and nasal process of incisive bone.

10- From the infraorbital foramen to the midpoint of the first upper premolar at alveolar border of the first upper premolar.

11- The infra-orbital foramen to the nasal process of the incisive bone
12- Mandibular length: from the level of alveolar border of the incisive bone to the caudal border of the mandible.
13- Mandibular foramen to the caudal border of mandible: the vertical line from the mandibular foramen to the caudal border of the mandible.
14- Mandibular foramen to base of mandible: straight vertical line from the mandibular foramen to the base of the mandible.
15- Mandibular foramen to mandibular angle: from the mandibular foramen to the angle of the mandible.
16- Lateral alveolar border to mental foramen: short distance from the mental foramen to the lateral extent of the alveolar root of lower incisor.
17- Mental foramen to the caudal mandibular border: from the level of the mental foramen to the caudal border of the mandible.
18- Mental foramen to the Lateral alveolar border of the first premolar tooth: from the mental foramen to the lateral extent of the alveolar root of lower first premolar.
19- Mental foramen to the ventral border of the mandible: vertical line from the mental foramen to the ventral border.
20- Maximum mandibular height: from the highest point of the coronoid process to the basal level of the mandible.
21-Condyloid fossa to the base of the mandible: measure the length from the condyloid fossa to the base of the mandible.

Statistical Analysis

Data was analyzed using Paleontological Statistics Software Excel for Education and Data Analysis. All the measurements were expressed as mean measurements with the standard deviation (Mean ± SD).

Nerve block applications

In this part, three donkeys were prepared to nerve block application in surgery, anesthesiology and radiology department, Faculty of Beni-Suef University as the following:

A-Supra-orbital nerve block: the animals were tranquilized by 10 mg/kg b.wt. Xylazine HCL 2% (Xylaject HCL2 %, Adwia Co. S.A.E.). The animals were restrained and according to the anatomical landmarks and by putting one finger to palpate the supra-orbital foramen which passed through it supra-orbital nerve. The needle of 22 gauges was inserted subcutaneously to reach the foramen and 8 ml of lidocaine HCL 2% (Debocaine HCL 2%, Al-Debeiky Pharmaceutical Industry Co.-A.R.E) was injected then waited for 10 minutes to detect the effect

B-Infra-orbital nerve block: the animals were tranquilized by 10 mg/kg b.wt. Xylazine HCL 2% (Xylaject HCL 2%, Adwia Co. S.A.E.). The animals were restrained and according to the anatomical landmarks and by putting one finger to palpate the infra-orbital foramen in which the infra-orbital nerve was passed. The needle of 22 gauges was inserted subcutaneously to reach the foramen and then 10 ml of lidocaine HCL 2% (Debocaine HCL 2%, Al-Debeiky Pharmaceutical Industry Co.-A.R.E) was injected then left the animal for 10 minutes to notice the effect.

C-Mandibular nerve block: the animals were tranquilized by 10 mg/kg b.wt. Xylazine HCL 2% (Xylaject HCL 2 %, Adwia Co. S.A.E.). The animals were restrained and according to the anatomical landmarks, the needle of 22 gauge was inserted into the inner aspect of the mandible to reach the foramen and

15 ml of lidocaine HCL 2% (Debocaine HCL 2%, Al-Debeiky Pharmaceutical Industry Co.-A.R.E) was injected then the animals were left for 10 minutes to observe the drug effect.

D-Mental nerve block: The animals were tranquilized by 10 mg/kg b.wt. Xylazine HCL 2% (Xylaject HCL 2 %, Adwia Co. S.A.E.). The animals were restrained and according to the anatomical landmarks and by putting one finger to palpate the mental foremen in which the mental nerve emerged. The needle of 22 gauges was inserted subcutaneously to reach the foramen and 15 ml of lidocaine HCL 2 % (Debocaine HCL 2%, Al-Debeiky Pharmaceutical Industry Co.-A.R.E) was injected and waited for 10 minutes for detection the anesthetic drug effect.

The supra-orbital foramen

The supraorbital foramen was located dorsal to the orbital cavity. It was the pathway of the supraorbital nerve which was a branch of the ophthalmic branch of the trigeminal nerve and it supplied the forehead and the middle two-thirds of the upper eyelid. The supraorbital foramen was been detected easily by measuring the distance between the supraorbital foramina (Fig.1) or measuring the distance dorsal to the medial canthus (Fig.2).

Regarding, supra-orbital nerve block, the injection of the anesthetic drug into the foramen blocked the function of the nerve, caused lacrimation from the eye, and desensitized the areas supplied by the nerve which were forehead and upper eyelid. Finally, upper eyelid dropping was appeared (Figs. 5, 6& 7).

The infra-orbital foramen

The maxillary nerve was a branch of the trigeminal nerve which entered the maxilla through the maxillary foramen which was distal to the eye. After entrance into the infra-orbital canal, the nerve proceeded cranially branching off to each individual cheek tooth and maxillary sinuses then exited from the infra-orbital foramen as infra-orbital nerve supplying sensory and motor innervations to the skin on the side of the face, the nostrils and the upper lip. The infra-orbital foramen was easily palpated under the levator labii maxillaries and levator nasolabialis muscles, so these muscles should move dorsally (Fig. 8). The infra-orbital foramen was detected by measuring the distance between it and the rostral part of the facial crest which was a vital and prominent, the medial canthus of the eye, the nasoincisive notch, the midpoint of the first upper premolar or the nasal process of incisive bone (Fig. 2). A needle was inserted into the infra-orbital canal via the infraorbital foramen which nerve can be blocked within the canal before it emerged. Desensitizing the nose, muzzle, incisors and rostral maxilla on the side injected was occurred. Also, the maxillary nerve was blocked (Figs 9 &10). It is not necessary to insert the needle this entire distance for a complete block, because the local anesthetic progressed caudally in the canal with pressure as it is injected

The mandibular foramen

The mandibular foramen was located on the medial surface of the mandible. The inferior alveolar nerve was a branch of the mandibular branch of the trigeminal nerve. It passed through the mandibular foramen supplying the mandibular teeth, alveoli, gingiva and the skin and mucosa of the lips and chin. Branches from this nerve supplied the teeth before its exiting via the mental foramen. The mandibular nerve was detected via measuring the distance between the mandibular foramen and the caudal border of the mandible, the base of the mandible, or the mandibular angle (Fig. 3). This nerve was been blocked difficulty by entering a needle medially and vertically into the mandibular foramen, so the lower teeth, the mandible and lower lip on that side were been desensitized (Figs.11&12). A risk in mandibular nerve block may be occurred when the needle was inserted to mandibular foramen due to presence of arteries and veins which may be injured during injection.

The mental foramen

The mental nerve was the rostral continuation of the inferior alveolar branch after its emerging from mental foramen supplying the chin and lips. The site of the mental foramen was detected by measuring the distance between it and lateral alveolar border of the mandible, the caudal mandibular border, the lateral alveolar border of the first premolar tooth or the ventral border of the mandible (Fig. 4). To feel the foramen the depressor labii inferioris muscle was displaced dorsally (Fig. 14). The mental nerve can be injected close to its exiting from the mental foramen on the lateral side of the mandible rostral to the first cheek tooth. The needle was directed in a rostro-caudal direction towards the foramen. Ipsilateral dropping and desensitization of the lower lip, the canine and incisor teeth as well as part of the interdental space were occurred (Figs. 13, 15& 16).

The current investigation clarified that the skull length, nasal and cranial skull length in donkey were 44.9cm, 19.8cm and 21.95cm, respectively. While these measurements were 39.7cm, 39.7cm, 13.4cm and 26.3cm in Iranian donkey (Monfared, 2013a), 50.7cm, 20.8 cm and 29.9cm in Iranian horse (Monfared, 2013b), 51.23cm, 27.97cm and 22.72cm in bovine (Allouch, 2014) as well as 46.2cm, 13.3cm and 32.5 cm in one-humped camel (Monfared, 2013c) respectively.

The current work revealed that the distance between the medial canthus of the orbit and the supraorbital foramen was 4.05cm. Literature on this distance was insufficient except Samuel *et al.* (2013) which stated that the overall mean of this distance is 3.05cm.

Our findings stated that the mean distance between the supra- orbital foramina was10.95cm. While Monfared (2013a, b& c) in Iranian donkey, Iranian horse and one-humped camel reported that this distance was 17.7cm, 21.4cm and 18.3cm respectively. However, Allouch (2014) in bovine mentioned this distance is 13.91cm.

The infra-orbital foramen was detected by measuring the distances between the foramen and the opposite one, the facial crest, the medial canthus, the nasoincisive notch, the midpoint of the first upper premolar and nasal process of incisive bone, they were13.28cm, 4.55cm, 8.95cm, 5.47cm, 6.01cm and12.85cm respectively. While, Allouch (2014) in bovine reported that the distance between the infra-orbital foramen and nasal process of the incisive bone, nasoincisive notch and first upper premolars were 4.7cm, 5.86cm and 2.32cm respectively. On the other hand, Monfared (2013a, b &d) reported that the distances from the facial crest to the infra-orbital canal and from the latter to the alveolar tooth were 3.4 cm and 6.1 cm in Iranian donkey and were 4.9 cm and 7.53 cm in Iranian horse, 2.9 cm and 2.7 cm in buffalo respectively. Moreover, Monfared (2013c) in one-humped camel mentioned that the distances from the third upper premolar tooth to the infraorbital canal and from the latter to the root of first upper premolar tooth were 6.2 cm and 3.47 cm respectively.

In the present study, the mandibular length and mandibular height were 31.2 cm and 22.75 cm respectively. These measurements were higher than the values obtained by Monfared (2013a) in Iranian donkey who stated these measurements were 19.5 cm and 10.8 cm respectively and also than those obtained by Monfared (2013b) in Iranian horse and they were 28.5 cm and 17.1 cm respectively. On the other hand, our measurements indicated that the length of the mandible in donkey was higher than that of one-humped camel (Monfared, 2013c) which was 39.9 cm, while the height of mandible of camel, 9.92 was lower that of donkey in the present study. However, our value indicated that the mandibular height was nearly equal that that of bovine, 22.6 cm (Allouch, 2014), while the mandibular length in bovine was longer than that of donkey, 38.3 cm. On the other hand the maximum mandibular height in buffalo (Monfared, 2013d) was 15.97 cm which is lower than our value.

The distance of the condyloid process to the base of the mandible in donkey was 17.56 cm and this value was higher than that obtained in other animals mentioned by Monfared (2013a, b, c&d) which is 8.5 cm in Iranian donkey, 13.4 cm in Iranian horse, 6.27 cm in one humped camel and 11.9 cm in buffalo. However, this distance is higher in bovine, 19 cm (Allouch, 2014).

The obtained results declared that distances from the mandibular foramen to caudal border of mandible, to the mandibular angle and to the base of the mandible were 6.5 cm, 6.95cm and 9.25 cm respectively. These distances were higher than obtained by (Monfared, 2013a, b &c) who stated that the distance from the caudal border of mandible to the level of mandibular foramen and from the latter to the border of mandibular angle was 3.5 cm and 4.1 cm in Iranian donkey, 4.8 cm and 6.4 cm in Iranian horse, 1.8 cm as 3.7 cm and 4.3 cm in one-humped camel and as well 5.04 cm in buffalo respectively. Moreover, our values were higher than that obtained by (Allouch, 2014) in bovine except the distance from the mandibular foramen to mandibular angle was lower where they were 3.81 cm, 8.05 cm and 8.9 cm respectively.

Our results achieved that the distance from lateral alveolar border to mental foramen was 4.32 cm a result which simulated that to Monfared (2013c) in one-humped camel, 4.74 cm. While, this value is lower than that obtained by Monfared (2013a &b) in Iranian donkey, Iranian horse and buffalo which are 11.5 cm and 7.4 cm, 6.0 cm respectively. However, (Allouch, 2014) reported that this value was 3.71 cm in bovine.

The current study revealed that there were another dimensions for mental foramen such its distance from the mental foramen to caudal mandibular border, to Lateral alveolar border of the first premolar tooth and to ventral border of the mandible as 26.36 cm, 2.89 cm and 1.78 cm respectively. These values are lower than that recorded by Allouch (2014) in bovine who mentioned that the distance from the mental foramen to the first premolar, the caudal mandibular border and to base of the mandible was 6.7 cm, 32.14 cm and 1.23 cm respectively. However, Monfared (2013d) mentioned that the distance from the mental foramen to the caudal border of the mandible is 5.5 cm in buffalo.

Observations of the present study confirmed those of Hall *et al.*, (2001) where blocking of supra-orbital nerve block lowing the risk and doses of general anesthesia during operations were done.

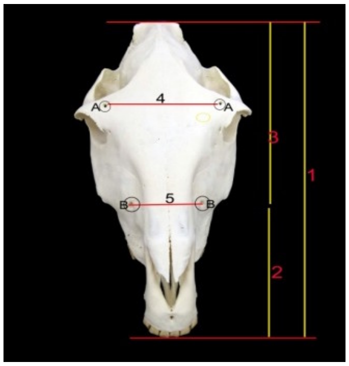
Table.I-Morphometric of the cranium of Donkey (Figs. 1 &2)

Item	**Parameters** (cm)	Mean ± SD
1	Skull length	44.9±1.37
2	Nasal skull length	19.8±0.91
3	Cranial skull length	21.95±0.83
5	Supra-orbital foramina distance	10.95±0.15
6	Infraorbital foramina distance	13.28±0.76
4	Medial canthus to the supraorbital foramen	4.05±0.28
7	Facial crest to infra orbital foramen	4.55±0.36
8	Medial canthus to the infraorbital foramen	8.95±0.59
9	Infra-orbital foramen to the nasoincisive notch	5.47±0.55
10	Infraorbital foramen to the midpoint of the first upper premolar	6.01±0.48
11	Nasal process of incisive bone to infra orbital foramen	12.85±0.78

Table.II- Morphometric of the mandible of Donkey (Figs 3&4)

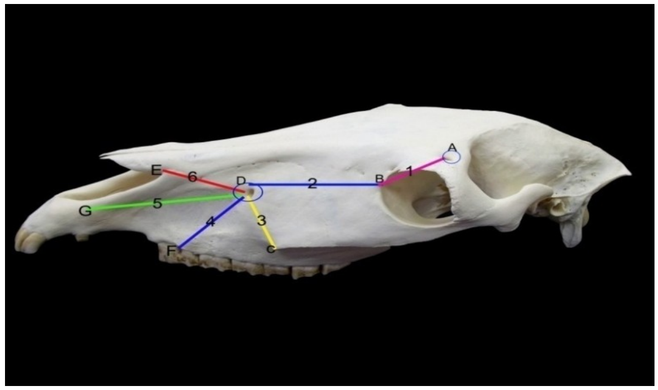
Item	**Parameters** (cm)	Mean ± SD
1	Mandibular foramen to the caudal border of mandible	6.5±0.36
2	Mandibular foramen to mandibular angle	6.95±0.15
3	Mandibular foramen to base of mandible	9.25±0.67
4	Mandibular length	31.2±1.30
5	Mental foramen to the Lateral alveolar border of the first premolar tooth	2.89±0.28
6	Lateral alveolar border to mental foramen	4.32±0.41
7	Mental foramen to the caudal mandibular border	26.36±1.18
8	Mental foramen to the ventral border of the mandible	1.76±0.53
9	Maximum mandibular height	22.75±1.13
10	Condylar process to the base of the mandible	17.56±1.089

Fig.1 Skull of donkey; dorsal view



1: Skull length; 2: Nasal length; 3: Cranial length; 4: Supra- orbital foramina distance; 5: Infra-orbital foramina distance; A: Supra-orbital foramina; B: Infra-orbital foramina

Fig.2 Skull of Donkey; Lateral view

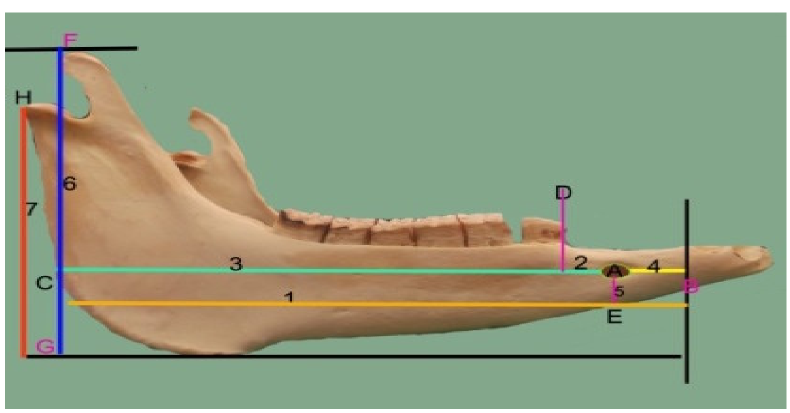


1: Medial canthus to the supra-orbital foramen; 2: Medial canthus to the infra-orbital foramen; 3: Facial crest to infra orbital foramen; 4: Infra-orbital foramen to the midpoint of the first upper premolar; 5: Nasal process of incisive bone to infra- orbital foramen; 6: Infra-orbital foramen to the nasoincisive notch; A: Supra-orbital foramen; B: Medial canthus of the eye; C: Rostral part of facial crest; D: Infraorbital foramen; E: Nasoincisive notch; F: First upper premolar; G: Nasal process of incisive bone.

Fig.3 Mandible of the Donkey; Medial view

1: Mandibular foramen to the caudal border of mandible; 2: Mandibular foramen to mandibular angle; 3: Mandibular foramen to base of mandible; A: Mandibular foramen; B: Caudal border of the mandible; C: Mandibular angle; D: Base of the mandible

Fig.4 Mandible of the Donkey Lateral View



1: Mandibular length; 2: Mental foramen to the Lateral alveolar border of the first premolar tooth; 3: Mental foramen to the caudal mandibular border; 4: Lateral alveolar border to mental foramen; 5: Mental foramen to the ventral border of the mandible; 6: Maximum mandibular height; 7: Condylar process to base of the mandible; A: Mental foramen; B- Lateral alveolar border; C: Caudal mandibular border. D: Lateral alveolar border of the first premolar tooth, E: the ventral border of the mandible; F- highest point of the coronoid process; G- base of the mandible

Fig.5 Donkey skull, the site of needle in supra-orbital foramen (red head arrow)

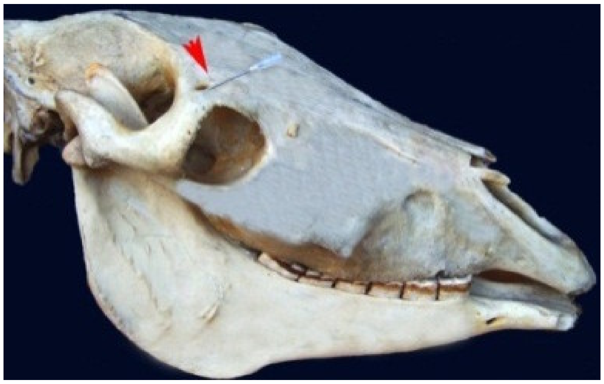


Fig.6 Donkey head, the site of needle in the supra-orbital foramen (black head arrow)

Fig.7 donkey head, Supra-orbital nerve block Note: Lacrimation and upper eye dropping (read head arrow)

Fig.8 A photomicrograph of the head region of the donkey showing the infraorbital nerve and foramen. Note: the levator labii maxillaries and levator nasolabialis muscles were moved dorsally.1: Infra-orbital nerve; A: Infra-orbital foramen- Levator labii maxillaries; C- Levator nasolabialis muscle

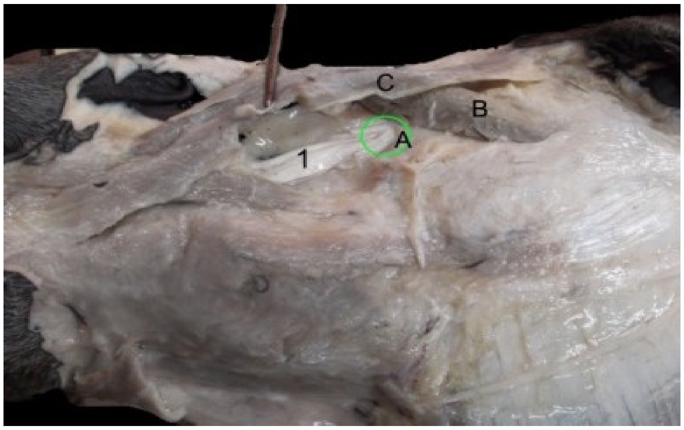


Fig.9 Donkey skull, the site of needle inserted into the infra-orbital foramen for maxillary and infra-orbital nerve blocks(red head arrow)

Fig.10 Donkey head, the site of needle inserted s/c into the infra-orbital foramen for maxillary and infra-orbital nerve blocks (black head arrow)

Fig.11 Donkey skull, the needle was inserted into the mandibular foramen for inferior alveolar and mental nerve blocks(black head arrow)

Fig.12 Donkey head, the needle was inserted at the site of the medial aspect of mandible into mandibular foramen for inferior alveolar and mental nerve blocks

Fig.13 Donkey skull, the site of needle inserted into the mental foramen for inferior alveolar and mental nerve blocks (red head arrow)

Fig.14 A photomicrograph of the head region of the donkey showing the mental nerve and foramen. Note: the depressor labii inferioris muscle was moved dorsally1: Mental nerve; A: mandible; B: Mental Foramen; C: Depressor labii inferioris muscle

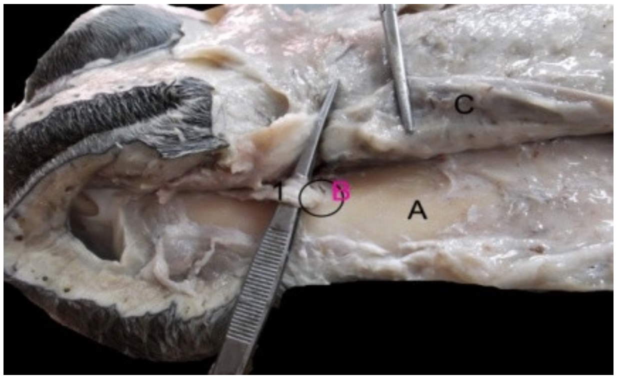


Fig.15 Donkey head, the site of needle inserted below the depressor labii inferioris muscle into the mental foramen for inferior alveolar and mental nerve blocks (yellow head arrow)

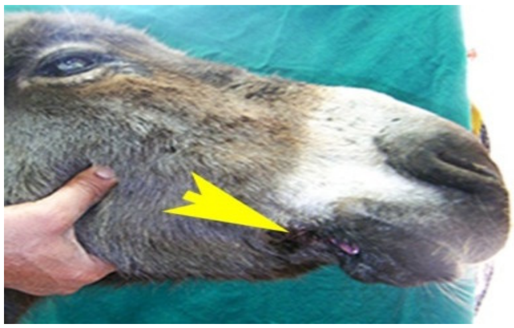


Fig. 16 Donkey head showing mental nerve block note lower lip dropping (yellow head arrow)

Our findings as well as those obtained by Hall *et al.*, (2001), Monfared (2013a & b) in Iranian donkey and Iranian horse and Kataba *et al.* (2014) in goat ascertained that the facial crest is prominent feature as a guide for infra-orbital nerve block to desensitize the skin of the upper lip, nostril and face on that side of the level of the infra-orbital foramen. So that the injection of local anesthetic drug within the infra-orbital canal leads to the analgesia and easily extraction of the incisor, canine and first two premolar teeth.

Observations of the present study confirmed those of Hall *et al.* (2001), Monfared

(2013a, b &c) in Iranian donkey, Iranian horse and one-humped camel, Allouch (2014) in bovine and Kataba *et al.* (2014) in goat, where the parameters of the mandibular foramen were of clinical importance for attaining the regional anesthesia of the mandibular foramen for desensitization of all teeth on the lower jaw side of the block.

In agreement with the results of Hall *et al.*, (2001), Tremaine (2007),Monfared (2013a, b &c) in Iranian donkey, Iranian horse and one-humped camel, Allouch (2014) in bovine and Kataba *et al.* (2014) in goat, the parameters of the mental foramen are vital landmarks for injection of local anesthetic drugs in mandibular canal via the mental foramen for blocking the infra-alveolar nerve, so desensitization of lower jaw with its teeth and the lower lip will be occurred and this method is easier and avoid all risks of blood vessel injures in case of infra-alveolar nerve block.

Conclusion

The results were of clinical importance and will aid in regional nerve blocks by easier methods like blocking the maxillary nerve via inject the anesthetic agent through infra-orbital foramen. As well as blocking of mandibular nerve via inject the anesthetic agent through mental foramen, in addition to the supra-orbital and mental nerves which are useful during surgical operations in head region and dental extraction or rasping. Also the results will help the veterinarian to avoid risks and toxicity of the general anesthesia and perform surgical procedures in standing position which need short time, less surgical and anesthetic equipment and low cost.

Acknowledgment

Our prayerful thanks to ALLAH, The Most Beneficent, The Most Merciful, Who enabled us to complete our research work successfully.

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