Indian Journal of Anatomy

Indexing information: Indexed in Index Copernicus, Poland, Google Scholar, ProQuest, USA, Genamics JournalSeek.

Printed at Saujanya Printing Press, D-47, Okhla Industrial Area Phase-1, New Delhi - 20

Corresponding address

Red Flower Publication Pvt. Ltd.
48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I
Delhi - 110 091(India)
Phone: 91-11-22754205, 65270068, Fax: 91-11-22754205
E-mail: redflowerppl@vsnl.net
Web:www.rfppl.com

The Indian Journal of Anatomy (ISSN 2320-0022) is a half-yearly print and online journal of the Red Flower Publication Pvt. Ltd. publishes original and peer-reviewed articles, for the dissemination of anatomical knowledge with clinical, surgical and imaging guidance. Includes articles of history, reviews and biographies, locomotors, splachnology, neuroanatomy, imaging anatomy, anatomical variations, anatomical techniques, education and pedagogy in anatomy, Human Anatomy, Veterinary Anatomy, Embryology, Gross Anatomy (Macroscopic), Microscopic Anatomy (Histology, Cytology), Plant Anatomy (Phytotomy), Comparative Anatomy, editorials, letters to the editor, and case reports. Articles of veterinary anatomy, comparative and other morphological sciences are accepted.

Subscription Information

India

Individual	
1 year	Rs.500
Life Subscription (Valid for 10 Years)	Rs.3000
Institutional (1 year)	Rs.3200

Rest of the World

Individual (1 year)	USD100
Insitutional (1 year)	USD 260

PAYMENT METHOD

By cheque/Demand Draft:

Cheque should be in the name of **Red Flower Publication Pvt. Ltd**. payable at Delhi.

By Bank Transfer/TT:

Bank name: Bank of India

Swift Code: BKIDINBBDOS

Account Name: Red Flower Publication Pvt. Ltd.

Account Number: 604320110000467

Branch: Mayur Vihar Phase-I

Delhi – 110 091 (India)

Send all Orders to: **Red Flower Publication Pvt. Ltd.,** 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi – 110 091, India, Phone: 91-11-22754205, Fax: 91-11-22754205, E-mail: redflowerppl@vsnl.net, Website: www.rfppl.com.

Indian Journal of Anatomy

July - December, 2013

Volume 2 Number 2

Contents

Original Article

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Morphometric Assessment of the Greater Palatine Foramen with the Adjacent Anatomical Landmarks

Abu Ubaida Siddiqui*, Kusum Rajendra Gandhi, Syed Rehan Hafiz Daimi**, Sudhir Saxena***, Soumitra Trivedi*, Manisha B. Sinha*, Mrithunjay Rathore***

Abstract

Introduction: Blocking of the maxillary branch of the trigeminal nerve and its branches is a widely practiced procedure in numerous surgeries of the region such as dental implants in the posterior maxilla, maxillary sinus elevation and surgery in the maxillary quadrant, periodontal procedures, tooth extraction and abscess drainage. The route most commonly utilized in the oral cavity is through the Greater Palatine Foramen (GPF). GPF leads to the palatine canal which gives passage to the greater palatine nerve and vessels. The various published descriptions of the positional geometry of the GPF in the skull are in a much generalized manner without scarce information on the minor details. **Methods:** The present study was undertaken to define the exact position of GPF in relation to the well defined anatomical landmarks in the maxilla of Indian skulls We studied 98 adult dried, unsexed human skulls. The measurements were taken with the help of stainless steel pointed caliper, scale in millimeters and a needle to show the direction of opening of the GPF. **Results:** The GPF was located opposite the maxillary third molar tooth in 72.44% of skulls. The direction of opening was forward and medially in 69.4%. The distance of the centre of the GPF to the posterior border of the hard palate was 14 mm on right and left side. **Conclusion:** These measurements shall assist the clinicians and interventionists to localize the GPF with far greater accuracy. These findings accrue interest as they can reduce the attempts needed to introduce local anaesthetic agents in surgeries involving the maxillofacial region as well as other dental procedures.

Keywords: reater palatine foramen; Incisive foramen; Hard palate; Maxillary molar teeth.

Introduction

The hard palate is an essential region of the skull formed by two palatal processes of the maxilla and two horizontal plates of the palatine bones. These bones are interlinked by a cruciform suture. Greater palatine foramen (GPF) is the foramen in the postero-lateral border of the hard palate through which the greater palatine nerves and vessels pass to supply most of the palatal region. Greater palatine nerve is the branch of maxillary nerve which contains sensory and secretomotor fibers to nasal, palatine and pharyngeal glands. Greater palatine nerve descends through the greater palatine canal, emerges on the hard palate from the GPF, then it traverses forward in a groove on the inferior surface of the bony palate almost to the incisor teeth and supplies the gums and the mucosa and glands of the hard palate.

The greater palatine nerve block is widely used and is an effective method of attaining anesthesia of the hemi maxilla in various surgical modalities. The published analyses of the geometrical position of this foramen in the human skulls have not been very consistent and even the standard anatomy textbooks describe the foramen only in a much generalized way e.g. near the lateral palatal border[1], medial to the last molar tooth.[2] The present study was undertaken to define the

Author's Affiliation: *Assistant Professor, Department of Anatomy, All India Institute of Medical Sciences (AIIMS), Raipur, Chhattisgarh, India, **Assistant Professor, Department of Anatomy, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Ahmednagar, Maharashtra, India. ***Associate Professor, Department of Anatomy , GR Medical College, Gwalior, MP, India.

Reprint's request: Dr. A.U. Siddiqui, Assistant Professor, Department of Anatomy, All India Institute of Medical Sciences (AIIMS), Tatibandh, GE Road, Raipur, Chhattisgarh, India-492099

Email: its_meesha@yahoo.com

(Received on 20.07.2013, accepted on 12.08.2013)

accurate position of the GPF relative to anatomical landmarks in the maxilla of Indian skulls.

Material and Methods

The present study was conducted on 98 normal human adult, dried, unsexed skulls available in the departmental collection of the participating institutes. All the skulls studied were free of any pathological changes. Well defined and unequivocal points were identified for the measurements. The measurements were taken with the help of pointed stainless steel sliding caliper, scale in mm and a needle to show the direction of opening of the GPF. All measurements were done bilaterally and directly on the dry skull. Each skull was examined for the following:

a) The location of the GPF in relation to the maxillary molar tooth,
b) Distance from the medial wall of the GPF to the midline maxillary suture (MMS),
c) Distance of the posterior wall of GPF to the posterior border of hard palate,
d) Direction of opening of the GPF on to the hard palate,
e) Distance from the anterior border of GPF to the incisive foramen (IF),
f) The angle between the MMS and the line passing from the incisive foramen to the GPF (GIM Angle).

Results and Discussion

The present study indicated that the location of the GPF in relation to the maxillary molars is variable, as reported by former authors**.** The location of GPF to the maxillary molars is shown in Table I.

In 72.44% the GPF was located opposite the third molar tooth, in 23.9% it was between the second and third molar teeth and in 3.06% the GPF was behind the third molar tooth. The distance of GPF to the mid maxillary suture was variable from 12 mm to 18 mm (mean 14 mm) on both right and left side. The mean distance of GPF from the posterior border of hard palate was consistent bilaterally, at a mean distance of 3.4 mm. The mean distance from the anterior wall of GPF to the posterior border of incisive foramen was 28 mm and 32 mm on right and left side respectively.

The knowledge of direction of opening of the greater palatine canal on to the hard palate is essential to deliver the injections efficiently. We found the direction of opening was forward and medially in 69.4% followed by forward in 23.4% and forward and laterally in 7.2% of cases (Table II). The mean angle between the MMS and the line from the incisive foramen and the GPF (GIM angle) was 21.2°on the right side and 21. 5° on the left side in 76% of the cases. In rest of the specimen, it was 22.9° on both the sides. A comparative analysis of the directions encountered by other workers is shown in Table III. These findings are of interest as it can reduce the attempts needed to introduce local anesthetic agent in the maxillofacial surgeries. A bony projection along the posterior margin of the GPF was observed in 28.3% of cases. It is formed by the raised posterior margin of the greater palatine foramen.

According to Saralaya and Nayak[3] the GPF was located medial to the maxillary third molar in 74.6% of cases, and Ajmani[4] found the GPF medial to third molar in 48% in Nigerian and 64% in Indian skulls. Slavkin et al reported that the GPF was located 1-3 mm distal to the maxillary third molar in adult skull.[5] Westmoreland and Blanton studied on three hundred skulls and reported that in 57% the GPF was located opposite or distal to the third molar tooth, the same in only in 6%, in 9.7% the GPF was medial to the second molar tooth.[6] The GPF was located opposite the third molar tooth in 76% of Kenyan skulls whereas in Chinese skulls it was commonly located between the second and third maxillary molar teeth. Chrcanovic R B *et al* studied on 80 Brazillian skulls and found that in 54.87% the GPFs were opposite to the maxillary third molar, 38.94 of foramina were

Table I: Variation in the location of GPF in relation to maxillary molars in Indian skull

Relation to maxillary molars	Right side	Left side	Total	Percentage
Between second and third molars	12	11	23	23.9
Opposite the third molars	35	36	71	72.44
Posterior to third molars	2	1	3	3.06

Table II: The direction of opening of GPF in the oral cavity

Direction of the foramen	Right side	Left side	Total	Percentage
Forward	12	11	23	23.4
Forward and medial	34	34	68	69.4
Forward and lateral	3	4	7	7.2
Total	49	49	98	100

Table III: Comparison between studies in various geographical regions on the direction of opening of the foramen onto the palate

Study	Nationality	Direction of opening of GPF			
		Antero medial	Anterior	Antero lateral	Vertical
Hasanali and Mwaniki (1984)	Kenyan	76.0	NA	NA	24.0
Wang et al (1988)	Chinese	NA	90.5	NA	9.5
Ajmani (1994)	Nigerian	58.7	NA	38.7	3
	Indian	91.4	NA	NA	NA
Saralaya and Nayak (2007)	Indian	46.2	41.3	12.5	NA
Chrcanovic BR and Custodio AL (2010)	Brazilian	18.75	69.38	0	11.87
Our study (2012)	Indian	69.4	23.4	7.2	0

NA: Not Available

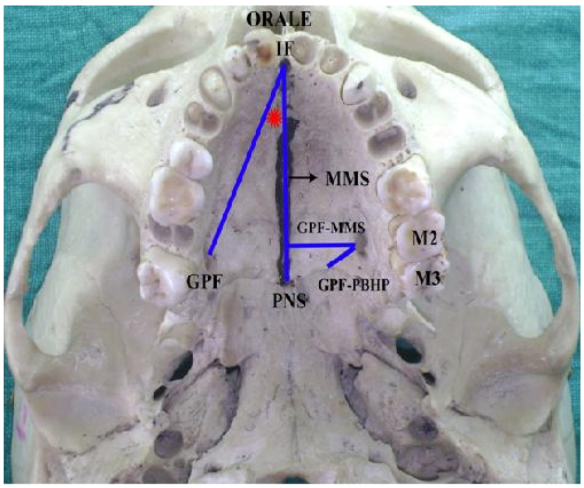
Table IV: Distance of GPF from Post border of hard palate

Study	Nationality	Distance of GPF from Post border of hard palate(mm)
Methatharip (2005)	Thai	2.1
Wang *et al* (1988)	Chinese	4.1
Ajmani (1994)	Nigerian	3.5
	Indian	3.7
Saralaya and Nayak (2007)	Indian	4.2
Westmoreland and Blanton (1982)	American (East Indian)	1.9
Our study (2012)	Indian	3.4

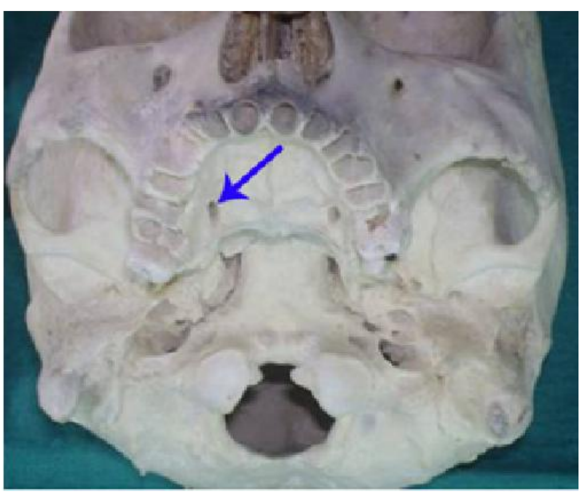
distal to third molar, and 6.19% between the second and third molars.[7] In the present study we found 72.44% of the GPF were located opposite the third molar tooth, in 23.9% between the second and third molar teeth and in 3.06% the GPF was behind the third molar tooth. These studies suggest that the position of GPF differs between ethnic groups. Furthermore it is very interesting to note that different studies from same country, India, reported data that differed among themselves in percentage of location of GPF in relation to the molar tooth, mean distance of GPF-PBHP and variation in the opening of the GPF onto hard palate. This suggests that large variation may also exist in the same population. The variability in the position of GPF may be because of change in the position with relation to the development of the molars.

The distance of GPF from the posterior border of hard palate was consistent bilaterally, at a mean distance of 3.4mm. Ajmani reported this distance as 3.5 and 3.7 mm in Nigerian and Indian skulls respectively.[4] Westmoreland and Blanton[6] found a mean distance of 1.9 mm from PBHP, Wang *et al*[8] 4.11 mm and Methatharip *et al*[9] found the GPF 2.1± 1.3 mm anterior to the posterior border of hard palate. Saralaya and Nayak[3] observed a mean distance of 4.2 mm in 132 skulls.(Table IV). Variability in the

Photograph 1: Showing Hard palate, GPF (Greater Palatine Foramen), IF (Incisive Foramen), M2 (Maxillary Second molar tooth), M3 (Maxillary third molar tooth), MMS (Midline Maxillary Suture), GPF-PBHP (Distance between posterior wall of GPF to the posterior border of hard palate), GPF-MMS (Perpendicular distance from medical wall of GPF to the MMS), GIM Angle (The mean angle between the MMS and the line from the IF and the GPF (GIM angle-red asterix)



Photograph 2: Showing the direction of opening onto the hard palate (antero-medially)-blue arrow



location of the foramen may be related to the sutural growth occurring between the maxilla and the palatine bones. The anteroposterior dimension of the palate increases with the eruption of the posterior teeth.

In order to administer injections, the direction of the opening of the greater palatine canal should be kept in mind. Ajmani found that the opening of the foramen was directed in an anteromedial direction in 58.7% Nigerian and 91.4% Indian skulls.[4] In 38.7% of Nigerian skulls the direction of opening was anterolaterally pointing towards maxillary molars. Saralaya and Nayak reported it was forward and medially in 46.2% and forward in 41.3%.[3] In Brazilian skulls the direction of opening was anterior in 69.38% followed by anteromedial in 18.75% and vertical in 11.87%. In present study the direction was forward and medially in 67.3% followed by forward in 23% and forward and laterally in 9.78% of cases. These variations explain that the occasional difficulty encountered during insertion of the needle into GPF. If observed geographically, in Indian skulls the opening is directed anterior or anteromedially whereas in Chinese skull it is anterior or vertical and in Kenyan skulls the opening is anteromedial or vertical.

The distance from the MMS and PBHP to the GPF also showed variation in the literature. According to Westmoreland and Blanton, the distance GPF-MMS on the right had a mean of 14.8 mm and 15 mm on the left.[6] Ajmani mentioned a distance of 15.4 mm from the sagittal plane in Nigerian skulls and 14.7mm on the right and 14.6mm on the left in Indian skulls [4]. Saralaya and Nayak reported 14.7 mm on both sides [3]. Wang et al found it 16 mm.[8] Chrcanovic *et al* reported it as 14.68 mm on right and 14.44 on the left side.[7] We found this distance as 14.61 mm on the right and 14.7 mm on the left side.

A bony projection, formed by the raised posterior margin of the foramen was observed in 21% of cases. Ajmani[4] mentioned this bony projection in 24.6% whereas Westmoreland and Blanton[6] in 16% of skulls. This projection may be helpful in preventing the clinical hazards associated with the injection by obstructing the needle. The distance from the GPF to the incisive fossa was 37.3 mm on left side and 37.2 mm on the right side in the study of Saralaya and Nayak [3] which was similar to the findings of the

Chrcanovic *et al.*[7] We found this distance to be 28mm and 32 mm on right and left side respectively. The mean angle between the MMS and the line joining the incisive foramen to the GPF was almost equal on both the sides (right=22.12°; left= 23.3°). Saralaya and Nayak reported small difference between two sides (right= 21.1°; left=21.2°).[3] These data will be helpful in comparing the skulls with those of the skulls of different other regions as well as comparing the skulls of different races. It also provides the anatomical references to block the maxillary division of the trigeminal nerve through the GPF accurately to avoid the risk of haematoma resulting from the vein puncture of the pterygoid plexus.

Summary and Conclusion

The GPF was related opposite to the third molar tooth in 72.44% of cases which was consistent with Hasanali[10], Saralaya and Nayak.[3] The direction of opening of GPF to the palate is forward & medial in 69.4% of cases which is in accordance of Ajmani,[4] Chrcanovic[7] & Hasanali.[10] The GIM angle was 21.2 in 76% of cases. The present findings accrue an additional interest as these can assist the interventionists in reducing the attempts required to inject local anesthetics in the numerous maneouvres involving the maxillofacial region as a whole and the dental procedures in particular.

References

1. Williams PL, Warwick R, Dyson M, Bannster H. Gray's Anatomy. 37th ed, London: 1989; 354.
2. Moore KL. Clinically Oriented Anatomy. Ist ed. Baltimore: Williams and Wilkins; 1980, 1004.
3. Saralaya V, Nayak SR. The relative position of the greater palatine foramen in dry Indian skulls. *Singapore Med J.* 2007; 48: 1143-1146.
4. Ajmani ML. Anatomical Variation in Position of Greater Palatine Foramen in adult human skull. *J Anat.* 1994; 184: 635-637.
5. Slavkin HC, Canter MR, Canter SR. An anatomical study of the pterygomaxillary region in the craniums of infants and children. *Oral Surg.* 1966; 21: 225-235.
6. Westmoreland EE, Blanton PL .An analysis of the variations in position of the greater palatine foramen in the adult human skull. *Anat Rec.* 1982; 204(4): 383-388.
7. Chrcanovic BR, Custodio ALN. Anatomical variation in the position of the Greater Palatine Foramen. *J of Oral Sci.* 2010; 52(1): 109-113.
8. Wang TM, Kuo KJ, Shih C, Ho LL, Liu JC. Assessment of the relative locations of the GPF in adult Chinese skulls. *Acta Anat Basel.* 1988; 132: 182-186.
9. Methathrathip D, Apinhasmit W, Chompoopong S, *et al*. Anatomy of greater palatine foramen and canal and pterygopalatine fossa in Thais: considerations for maxillary nerve block. *Surg Radiol Anat.* 2005; 27: 511-516.
10. Hassanali J, Mwaniki D. Palatal analysis and Osteology of the hard palate of the Kenyan African skulls. *Anat Rec.* 1984; 209: 273-280.

Indian Journal of Anatomy

Library Recommendation Form

If you would like to recommend this journal to your library, simply complete the form below and return it to us. Please type or print the information clearly. We will forward a sample copy to your library, along with this recommendation card.

Please send a sample copy to:

Name of Librarian

Library

Address of Library

Recommended by:

Your Name/ Title

Department

Address

Dear Librarian,

I would like to recommend that your library subscribe to the **Indian Journal of Anatomy**. I believe the major future uses of the journal for your library would be:

1. As useful information for members of my specialty.
2. As an excellent research aid.
3. As an invaluable student resource.
4. **I have a personal subscription and understand and appreciate the value an institutional subscription would mean to our staff.**
5. Other

Should the journal you're reading right now be a part of your University or institution's library? To have a free sample sent to your librarian, simply fill out and mail this today!

Stock Manager

Red Flower Publication Pvt. Ltd.

48/41-42, DSIDC, Pocket-II, Mayur Vihar, Phase-I

Delhi - 110 091 (India)

Tel: 91-11-65270068, 22754205, Fax: 91-11-22754205

E-mail: redflowerppl@gmail.com, redflowerppl@vsnl.net

Website: www.rfppl.com

Original Article

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Vertical Orientation of Cervical Part of Vertebral Canal in the Human Foetuses

Nidhi Sharma*, Nazim Nasir, Tarun Prakash Maheshwari*****

Abstract

In a morphometric study of normal human foetuses the size and shape of foetal spinal canal was evaluated to determine the reference values for the cervical part of vertebral canal. 30 human foetuses were dissected which were divided in five different groups I to V with gestational ages of less than 17, 17-20, 21-25, 26-30 and more than 30 weeks respectively. The foetuses were dissected and vertebral canal was exposed in coronal plane. Length of cervical part of vertebral canal and transverse diameters at different vertebral levels were recorded by the help of vernier caliper. The widest part of cervical vertebral canal was observed in the upper segment in first three groups, middle in group IV and in the lower part in foetuses of group V. Aforementioned parameters showed a steady but variable rate of growth with increasing gestational age.

Keywords: Cervical; Foetus; Morphometry; Vertebral canal.

Introduction

Although developmental process during first two months of intrauterine life i.e. embryogenesis, has been thoroughly investigated, features during postembryonic period i.e. foetal anatomy, has received very little attention. Detailed study on foetal anatomy by some of the investigators recently has proved that there are enormous facts of the subject yet to be explored.[1-3]

Foetal anatomy is the emerging specialty in itself, for the diagnosis and treatment of various neural tube defects. The prerequisite for the early diagnosis of disorders is the accurate knowledge of normal spine appearance at different gestational age. In humans, most foetal operations are performed between 18 and 30 weeks of gestation.[4]

Some workers gave a detailed account of foetal development of cervical spine and spinal cord by using different imaging techniques. Remes standardized the morphometry of cervical vertebral bodies in humans during postnatal period and found it to be reliable indicator to study the growth pattern.[5]

Different studies found direct correlation between cervical vertebral morphology of foetuses and newborns with gestational age.[6,7] Castellana and Kosa provided information about morphology of the cervical vertebrae in the foetal-neonatal human skeleton but their main focus was to highlight the ossification centres.[8] Bradley studied normal and abnormal cervical canal by using myelography.[9]

But none of the aforementioned workers provided accurate measurements of various parameters of cervical part of vertebral canal in different foetal age groups. In our study we have not only collected quantitative informations i.e. length and diameters, by

Author's Affiliation: *Assistant Professor, Department of Anatomy, TMMC, TMU, Moradabad, UP, India, **Assistant Professor, Department of Anatomy, King Khalid University, Abha, KSA, ***Demonstrator, Department of Anatomy, SHKM GMC, Nalhar, Mewat, Haryana, India.

Reprint's request: Dr. Nidhi Sharma, Assistant Professor, Department of Anatomy, TMMC, TMU, Moradabad, UP, India.

E-mail: drnidhivarshney@gmail.com & rohitmaxy@gmail.com

(Received on 23.07.2013, accepted on 02.08.2013)

Figure 1: Measuring length of cervical part of vertebral canal by vernier caliper

direct measurements of cervical canal but also highlighted changes in vertical shape of the same in coronal plane in different gestational age groups.

Materials and Methods

Thirty foetal cadavers comprising of equal males and females were collected from museum of Department of Anatomy, TMMC, TMU, Moradabad. Ethical clearance was obtained from Institutional Ethics Committee.

Gestational age was determined with the help of foetal foot length.[10] For the purpose of study 30 foetuses were divided into five groups I, II, III, IV and V with gestational age < 17, 17-20, 21-25, 26-30, >30 respectively, with six foetuses in each group.

A vertical cutaneous incision extending from external occipital protuberance to natal cleft was made on the back of the foetus. Vertebral canal was opened with the help of scissor which was introduced in sacral hiatus on either side of midline then continued upwards, till it reached the posterior arch of atlas. Spinal cord was removed before measuring the cervical part of canal with the help of Venire calipers. Length of the cervical part of vertebral canal was taken from upper border of posterior arch of atlas to lower border of seventh cervical vertebral body (Fig. 1). Transverse diameter of cervical vertebral body was measured at different vertebral levels. Readings were analyzed by using Students't test.

Results

Length of cervical part of vertebral canal showed steady growth with increasing gestational age (Table 1). The growth was statistically insignificant between group I and group II foetuses. Thereafter the growth was highly significant (p value <0.001) with percent change ranging from 14 to 24. O'Rahilly observed vertebral column of nine embryos of 8 postovulatory weeks and compared the lengths of different regions i.e. cervical, thoracic, lumbar, sacral and coccygeal without mentioning the length of cervical canal, though the total length of vertebral column (20-23 mm) was well documented.[11]

In our experiment we compared the transverse diameters of cervical spinal canal at different cervical vertebral levels in the same group of foetuses to determine the vertical shape of canal in coronal plane (Table2-6).

Transverse diameter of vertebral canal in first foetal group at the level of 1st cervical vertebra was 3.15 mm which is increased to 4.5 mm (p value < 0.001) at C_2 level (Table 2). Then upto C_4 there was no significant change but then there was reduction in diameter at the level of C_5 making it 3.43mm. It again increased significantly to reach the value of 4.15mm at the level of C-6 which continued upto C-7 without any change (Table 2).

In second foetal group the transverse

Table 1: Length of cervical part of vertebral canal (mm)

Groups	No. of cases (n)	Mean ± S.D.	Per cent change	T value	P value
I	6	18.19 ± 2.87	_	_	_
II	6	19.98 ± 0.66	+10	0.17	Insignificant
III	6	24.85 ± 0.13	+24	6.9	<0.001
IV	6	28.28 ± 0.13	+14	6.78	<0.001
V	6	33.57 ± 0.06	+19	8.87	<0.001

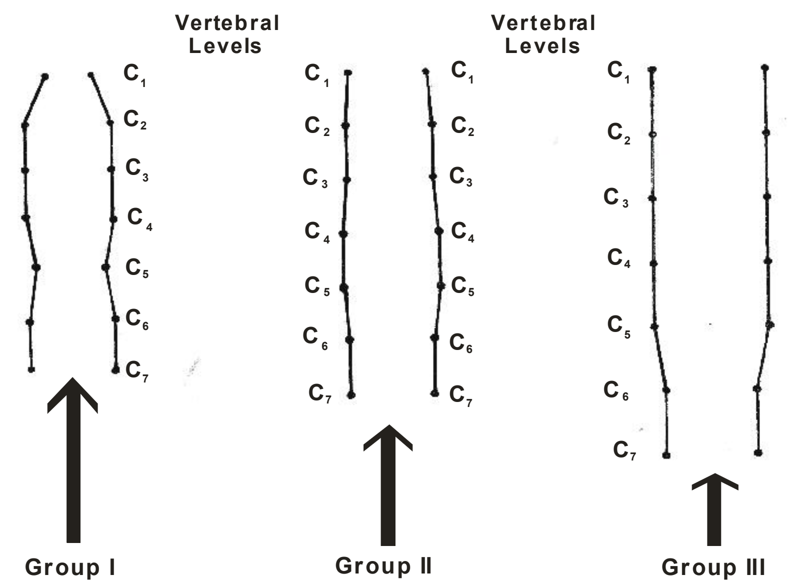
Table 2: Transverse diameter of cervical vertebral canal at different levels of cervical vertebrae in group I foetuses

Cervical vertebral level	Measurements (mm)	Per cent change	T value	P value
1st	3.15 ± 0.04	_	_	_
2nd	4.5 ± 0.06	+43	6.75	<0.001
3rd	4.23 ± 0.52	-6	0.23	Insignificant
4th	4.3 ± 0.13	+2	0.79	Insignificant
5th	3.43 ± 0.12	-20	2.66	<0.001
6th	4.15 ± 0.18	+21	8.46	<0.001
7th	4.13 ± 0.19	-0.5	0.82	Insignificant

Table 3: Transverse diameter of cervical vertebral canal at different levels of cervical vertebrae in group II foetuses

Cervical vertebral level	Measurements (mm)	Percent change	T value	P value
1st	4.1 ± 0.08	_	_	_
2nd	4.5 ± 0.06	+10	5.82	<0.001
3rd	4.5 ± 0.05	0	0.63	Insignificant
4th	4.7 ± 0.03	+4	4.14	<0.001
5th	4.3 ± 0.16	-9	0.004	Insignificant
6th	4.5 ± 0.04	+5	0.05	Insignificant
7th	4.5 ± 0.13	-0	0.67	Insignificant

Fig 2: Vertical orientation of cervical part of vertebral canal in coronal plane in groups I, II, III human foetuses



diameter of vertebral canal increased significantly between 1st and 2nd cervical levels and 3rd and 4th cervical vertebral levels only (Table 3). This made the cervical canal wider in lower part as compared to upper one (Fig 2), possibly to accommodate the cervical enlargement of spinal cord. This also highlighted the importance of upper limbs compared to head and neck in terms of innervations.

In third group transverse diameter of cervical vertebral canal showed a significant decrease only between 5th and 6th cervical vertebral levels making most of the upper cervical canal wider compared to lower one (Fig 2), possibly again to accommodate the cervical enlargement as well as nuclei of cervical plexus (Table 4).This highlighted the importance of both head and neck, upper limb in group III foetuses in terms of development.

The transverse diameter of 6.6 mm in group IV foetuses at 1st cervical vertebral level

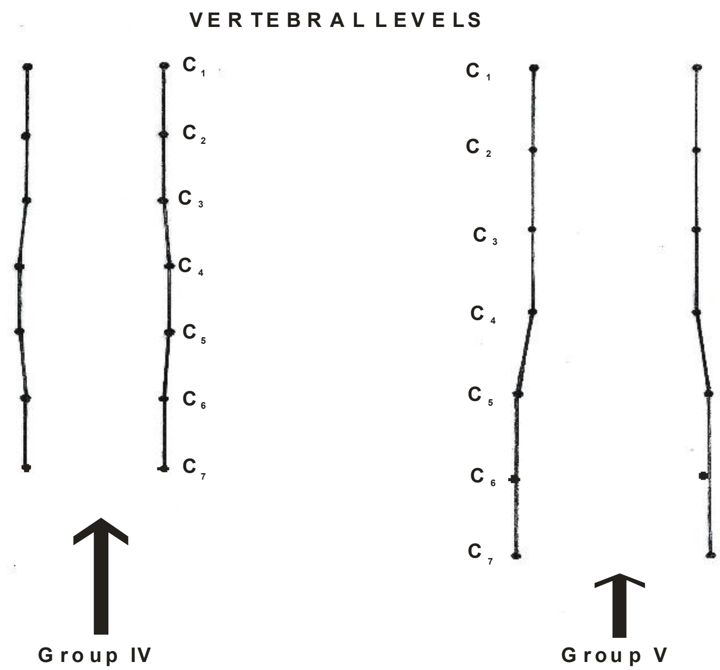
Table 4: Transverse diameter of cervical vertebral canal at different levels of cervical vertebrae in group III foetuses

Cervical vertebral level	Measurements (mm)	Percent change	T value	P value
1st	5.85 ± 0.05	_	_	_
2nd	5.53 ± 0.03	-5	1.37	Insignificant
3rd	5.59 ± 0.05	+1	0.02	Insignificant
4th	5.56 ± 0.04	-0.5	0.22	Insignificant
5th	6.3 ± 0.04	+13	1.23	Insignificant
6th	5.38 ± 0.25	-14	4.44	<0.001
7th	5.88 ± 0.14	+9	0.02	Insignificant

Table 5: Transverse diameter of cervical vertebral canal at different levels of cervical vertebrae in group IV foetuses

Cervical vertebral level	Measurements (mm)	Percent change	T value	P value
1st	6.6 ± 0.06	_	_	_
2nd	6.5 ± 0.02	-2	0.008	Insignificant
3rd	6.5 ± 0.09	0	0.68	Insignificant
4th	6.9 ± 0.03	+6	5.08	<0.001
5th	7.1 ± 0.1	+3	0.004	Insignificant
6th	6.6 ± 0.1	-7	8.12	<0.001
7th	6.5 ± 0.02	-2	0.24	Insignificant

Fig.3: Vertical orientation of cervical part of vertebral canal in coronal plane in groups IV and V human foetuses



showed no change upto 3rd cervical vertebra but the measurement significantly increased to 6.9 mm at C_4 level. It continued to C_5 without any change but then there was significant reduction to make the reading 6.6 mm only at C_6 level which continued upto C7 without any change (Table 5). The cervical canal therefore was widest between C-4 and C-5 vertebral levels located between upper and lower narrow segments (Fig 3). This might be due to fact that in foetal spinal cord, 5th segment was widest part of cervical enlargement as reported by Fountas *et al*[12] and Ko *et al.*[13]

The transverse diameter of spinal canal in V foetal group from level of C_1 to C_4 showed no significant change but at C_5 level it

Table 6: Transverse diameter of cervical vertebral canal at different levels of cervical vertebrae in group V foetuses

Cervical vertebral level	Measurements (mm)	Percent change	T value	P value
1st	7.6 ± 0.06	_	_	_
2nd	7.5 ± 0.03	-1	0.02	Insignificant
3rd	7.5 ± 0.05	0	0.34	Insignificant
4th	7.4 ± 0.03	-1	0.003	Insignificant
5th	7.8 ± 0.04	+5	2.93	<0.001
6th	7.5 ± 0.3	-4	0.02	Insignificant
7th	7.4 ± 0.09	-1	0.52	Insignificant

increased to 7.8 mm which remained the same at the lowest level of cervical spinal canal (Table 6). The wide lower segment again accommodated the cervical enlargement which increased in size due to well developed upper limbs in late foetuses.

Discussion

The most interesting finding in our study was the change in shape of vertical orientation of canal in coronal plane with gestational age. In early groups of foetuses the canal is wider in upper than the lower part. In group IV foetuses the canal was wider in the middle than its extremes i.e., at the upper and lower parts. The largest foetuses of V group showed lower half being wider than upper half. The latter was more like adult in which maximum transverse dimension was reported at the level of C6 and C7 vertebrae (Flyn).[14] Moreover the wider upper cervical spinal canal observed in small foetuses of earlier groups could be explained by the facts that in smaller foetuses head was relatively larger receiving innervations from upper cervical spinal segments. With the relatively faster growth of forelimbs in older foetuses, the cervical enlargement came into existence making the lower part of canal wider. The latter provided origin to roots of brachial plexus.

The knowledge of the parameters and shape of the vertebral canal at different gestational age will prove to be helpful in early diagnosis of the defect in embryological development. Some workers believe that congenital malformations follow two hit hypothesis.[15,16] According to this hypothesis the initial error is the defect in embryological development and secondary injury occurs throughout the gestation with continuous damage to exposed neural tissue. Intra-uterine repair may improve the neurologic outcome by decreasing the secondary damage.

Conclusion

With increasing interest in intrauterine foetal surgeries for corrective developmental defects, these parameters at different gestational age will prove to be helpful in early diagnosis of disease as well as in deciding the prognosis of disease. Besides this, parameters showing steady growth also seemed to be important in determination of gestational age and therefore of great medicolegal importance too.

References

1. Ghaus F, Faruqi NA. Morphometric analysis of developing maxillary sinuses in human foetuses. *Int J Morphol.* 2006; 24(3): 303-308.
2. Ghaus F, Faruqi NA. Morphometric analysis of infraorbital foramen in human foetuses. *Int J Morphol.* 2007; 25(2): 301-304.
3. Ghaus F, Faruqi NA. Bilateral variations and sexual dimorphism in morphometric analysis of infraorbital groove, canal and foramen in human foetuses. *Int J Morphol.* 2009; 27(2): 475-480.
4. Demirkan I, Cevik A. In utero foetal surgery. *Veteriner Cerrahi Dergisi.* 2004; 10(1-2): 66-74.
5. Remes VM. Reference values for radiological evaluations of cervical vertebral body shape and spinal canal. *World Wide Science Org.* 2000.

6. Marginean OM. Study of the correlation between newborn and foetus ages and some morphometric cervical vertebral arches indices. *Rom J Morphol Embryol.* 2008; 49(3): 387-390.
7. Fily RA. Foetal spine morphology and Maturation during the second trimester, Sonographic evaluation. *Journal of Ultrasound in Medicine.* 2002; 6(11): 631-636.
8. Castellana C, Kosa F. Morphology of the cervical vertebrae in the foetal neonatal human skeleton. *Journal of Anatomy.* 1999; 194: 147-152.
9. Bradley WG, Banna M. A study of the tight Dural canal and of syringomyelia by prone and supine myelography. *Br J Radiol.* 1968; 41: 608-614.
10. Streeter GL. Weight, sitting height, head size, foot length and menstrual age for human embryo. *Contrib Embryol.* 1920; 11: 14.
11. O' Rahilly R, Muller F, Meyer DB. The human vertebral column at the end of the embryonic period proper 1: the column as a whole. *Journal of Anatomy.* 1980; 131: 565-575.
12. Fountas KN. Cervical spinal cord- smaller than considered? *Spine Phila Pa.* 1998; 23: 1513-1516.
13. Ko HY, Park JH. Gross quantitative measurements of spinal cord segments in human. *Spinal Cord.* 2004; 42: 35-40.
14. Flynn. Measurement of the vertebral canal dimensions of the neck of the rat with a comparison to the human. *World Wide Science Org.* 2007.
15. Sutton LN, Adzick NS, Bilaniuk LT. Improvement in hindbrain herniation demonstrated by serial fetal magnetic resonance imaging following fetal surgery for myelomeningocele. *JAMA.* 1999; 282: 1826–1831.
16. Bruner JP, Tulipan N, Paschall RL. Fetal surgery for myelomeningocele and the incidence of shunt-dependent hydrocephalus. *JAMA.* 1999; 282: 1819–1825.

Original Article

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

The Anatomy of Extraoral Mandibular Nerve Block

Alipta Bhattacharya*, Arpan Dey, Debjyoti Basu**, Apala Bhattacharya*****

Abstract

Effective pain control is one of the most important aspects of dental care and maxillofacial surgery.. Having broad knowledge of anatomy is essential for practicing dentistry. The main difficulty with the traditional approach to the mandibular nerve block is the absence of consistent anatomical landmarks. The Significant advantages of the Mandibular nerve block over Inferior Alveolar nerve block include its higher success rate and the absence of problems with accessory sensory innervation to the mandibular teeth. Extraoral mandibular nerve blocks can be attempted in cases of Trismus . However this approach of MNB is not conventional due to unavailability of surface landmarks . The aim of this study is to specify landmarks in dissected cadaveric specimens that will act as a guide for an easy approach to Extraoral Mandibular nerve block(EOMNB). Our study revealed that, in a case of EOMNB , the average distance from centre of base of tragus to the point of needle entry is 1.44 ± 0.15 cm.The average depth the needle has to pass from the skin surface perpendicularly to reach the trunk of the mandibular nerve for a proper dissipation of dye to occur is 4.26 ± 0.33 cm.

Keywords: Mandibular nerve; Extraoral mandibular nerve block.

Introduction

Effective pain control is one of the most important aspects of dental care and maxillofacial surgery. Having broad knowledge of anatomy is essential for practicing dentistry. The nerves in relation to the parasympathetic ganglia located in the cranial part of the autonomic nervous system, are located very deep e.g. the mandibular nerve is related to the otic ganglion right beneath the oval foramen. The deep location of the nerve in the infratemporal fossa makes it quite inaccessible for mandibular nerve block.

The main difficulty with the traditional approach to the mandibular nerve block is the absence of consistent anatomical landmarks. Multiple authors have described numerous approaches to this often elusive nerve.[1,2] Indeed, reported failure rates for the MNB(Mandibular Nerve Block) are commonly high, ranging from 31% and 41% in mandibular second and first molars to 42%, 38%, and 46% in second and first premolars and canines, respectively,[3] and 81% in lateral incisors.[4] Not only is the Mandibular nerve elusive, studies using ultrasound[5] and radiography[6,7] to accurately locate the nerve bundle revealed that accurate needle location did not guarantee successful pain control specially if the inferior alveolar nerve is approached which seems an easier approach.[8] This difficulty in achieving mandibular anesthesia has over the years led to the development of alternative techniques to the traditional (Halsted approach) inferior alveolar nerve block. These have included the

Author's Affiliation: *Demonstrator (Anatomy), **Assistant Professor (Anatomy), Malda Medical College, Malda-732101, Assistant Professor (Ophthalmology),Regional Institute Of Ophthalmology, Medical College, Kolkata-700073.

Reprint's request: Dr. Alipta Bhattacharya, Address-Flat no. 1E , Arindam Apartment, Garia Station Road, Kolkata-700084, West Bengal, India.

E-mail: alipta.bhattacharya@gmail.com

(Received on 29.07.2013, accepted on 03.08.2013)

Gow-Gates mandibular nerve block,[9] the Akinosi-Vazirani closed-mouth mandibular nerve block,[10] the periodontal ligament (PDL, intraligamentary) injection,[11] intraosseous anesthesia,[12] and, most recently, buffered local anesthetics.[13] Although all maintain some advantages over the traditional Halsted approach, none is without its own faults and contraindications. The introduction of the Gow-Gates mandibular nerve block in 1973 spurred interest in alternative methods of achieving anesthesia in the lower jaw. In 1977, Dr. Joseph Akinosi reported on a closed-mouth approach to mandibular anesthesia.[14] Although this technique can be used whenever mandibular anesthesia is desired, its primary indication remains those situations where limited mandibular opening precludes the use of other mandibular injection techniques. Such situations include the presence of spasm of the muscles of mastication (trismus) on one side of the mandible after numerous attempts at IANB(Inferior Alveolar Nerve Block), as might anesthesia adequate to extirpate the pulpal tissues of the involved mandibular molar. When the anesthetic effect resolves hours later, the muscles into which the anesthetic solution was deposited become tender, producing some discomfort on opening the jaw. During a period of sleep, when the muscles are not in use, the muscles go into spasm (the same way one's leg muscles might go into spasm after strenuous exercise, making it difficult to stand or walk the next morning), leaving the patient with significantly reduced occlusal opening in the morning. If it is necessary to continue dental care in the patient with significant trismus, the options for providing mandibular anesthesia are extremely limited. Inferior alveolar, Gow-Gates or Akinosi techniques of mandibular nerve block cannot be attempted when significant trismus is present. In such cases Extraoral mandibular nerve blocks can be attempted and, indeed, possess a significantly high success rate in experienced hands. Extraoral mandibular blocks can be administered through the sigmoid notch or inferiorly from the chin.[15,16] Because the mandibular division of the trigeminal nerve provides motor innervation to the muscles of mastication, a third division (V3) block will relieve trismus that is produced secondary to muscle spasm (trismus may also result from other causes). However this approach of MNB is not conventional due to unavailability of surface landmarks . The aim of this study is to specify landmarks in dissected cadaveric specimens that will act as a guide for an easy approach to Extraoral Mandibular nerve block.

Aims and Objectives

To identify specific anatomic landmarks for Extraoral Mandibular Nerve Block making use of cadaveric dissection.

Materials and Methods

Ten adult cadavers of both sexes were selected for the study in the department of Anatomy at Malda Medical College. Study period was approximately eight months. It was carefully noted that they were free from any form of maxillofacial deformity. Any cadaver with scar mark over the maxillary region indicative of previous trauma or surgery was also excluded from study.

With the aid of guidance provided by existing literature on Extraoral MNB, 3 ml of yellow *Acryllic* dye was injected into the infratemporal fossa with a 6 inch long needle fitted to a 5 ml syringe. The base of the Tragus was taken as the landmark and the needle was negotiated close to the base of the tragus below the zygomatic arch at an angle of 90 degrees until a bony obstruction was felt. This was repeated on both sides in all 10 cadavers. Then the infratemporal fossa was dissected upto the trunk of the Mandibular nerve close to the foramen ovale. Generous amount of dye around the trunk of the mandibular nerve was noted and taken to be a satisfactory outcome. Presence of dye below the bifurcation of the main trunk of the nerve or too much dissipation of the dye in the overlying skin or

Fig 1: The Anatomical landmarks

muscular layers was considered dissatisfactory and the results were excluded from study. From the satisfactory cases thus obtained (14 cases were satisfactory and 6 cases were excluded) we measured the distance between point of needle entry from the centre of the base of tragus. Depth of the needle to reach the mandibular nerve was also measured. The data thus obtained was evaluated statistically to come to a conclusion.

Tools required

1. Skin marking pen
2. Scalpel

Fig 2: Injection of dye into the trunk of Mandibular nerve in the cadaver

Fig 3: Dissipation of dye over trunk of Mandibular nerve

3. Tooth forceps
4. 5 ml syringe fitted with 6 inch long needle
5. Yellow acrylic dye
6. Plain forceps
7. Chisel hammer
8. Periosteum elevator
9. Osteotome
10. Bone nibbler
11. Scissors
12. Allis' tissue forceps
13. Vernier slide calipers.

Results

After the dissection, we could see that in 12 dissections (60%), the otic ganglion was situated medial to the mandibular nerve, right under the foramen ovale. The otic ganglion also had a flattened, small, and oval form. In 5 (25%) of the specimens dissected we failed to observe any oval structure reminiscent of an otic ganglion, instead there was a fusiform swelling in the trunk of the Mandibular nerve itself close to the point of its exit from the Foramen Ovale. In 3 (15 %) of the specimens no anatomic structure like that of an Otic Ganglion could be located on the medial aspect of the Mandibular nerve. During the course of our dissections in the Infratemporal fossa, our findings mostly corroborated with those of classical literature[17] with regard to the structures found in this region. In all the specimens, the Inferior Alveolar Nerve was found to emerge between the medial and lateral pterygoid muscles; distally the neurovascular bundle of the Inferior Alveolar nerve was found to enter the Mandibular foramen. In all the 20 specimens dissected the Lingual nerve was seen to course anterior to the Inferior Alveolar nerve, before entering the oral cavity between the medial pterygoid muscle and the Ramus of the Mandible. In all specimens barring one , the Chorda Tympani nerve was found to join the Lingual nerve posteriorly ,where the chorda tympani failed to join the Lingual nerve and ran downwards parallel to it, a small nerve fibre however connected the two nerves. No anatomical variation was noted with regard to the trunk of the Mandibular nerve. After piecemeal dissection of the Lateral Pterygoid muscle the trunk of the mandibular nerve was seen lying

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Avg (cm)	S.D.
Tragus to needle entry point (cm)	1.28	1.36	1.55	1.47	1.23	1.59	1.22	1.38	1.24	1.47	1.66	1.52	1.43	1.70	1.44	0.16
Length of needle (cm)	3.96	4.26	4.48	4.29	3.88	4.58	4.13	3.95	3.82	4.28	4.35	5.11	4.25	4.23	4.26	0.33

medial to the muscle, immediately below the foramen ovale. After A brief course of about 4-5 mm the trunk divided into a small anterior and a large posterior division. Both the Inferior Alveolar and the Lingual nerves could be traced from the posterior division.The average distance from centre of base of tragus to the point of needle entry is 1.44 ± 0.15 cm. The average depth the needle has to pass from the skin surface perpendicularly to reach the trunk of the mandibular nerve for a proper dissipation of dye to occur is 4.26 ± 0.33 cm.

Discussion

The classic description of the Otic Ganglion and the Mandibular nerve of humans has remained unaltered for quite sometimes now .In the course of our study we found that Otic ganglia resembling the classic description were found in about 60% of the cases. In 25%, some thickening could be seen adjacent, almost adherent to the mandibular nerve and in 15%, no definite structure could be observed. Our results offer some contradiction to the observations made by *Roitman R. et al*,[18] where the above percentages were 40%, 13%, and 27% respectively. For ages, dentists have endeavored to control pain in their procedures by utilizing a method that blocked the pathway of pain impulses to the brain. When the trunk of the mandibular is blocked areas usually anesthetized are:[19]

1. Mandibular teeth to the midline.
2. Buccal mucoperiosteum.
3. Anterior two thirds of the tongue and floor of the oral cavity.
4. Lingual soft tissues and periosteum.
5. Body of the mandible, inferior portion of the ramus.
6 Skin over the zygoma, posterior portion of the cheek, and temporal regions.

The Significant advantages of the MNB over IANB include its higher success rate,and the absence of problems with accessory sensory innervation to the mandibular teeth.[20]

Indications of MNB

1. Multiple procedures on mandibular teeth.
2. When buccal soft tissue anesthesia, from the third molar to the midline, is necessary.
3. When lingual soft tissue anesthesia is necessary.
4. When a conventional inferior alveolar nerve block is unsuccessful.

Gow-Gates and Akinosi Techniques are standard yet complicated procedures and present to the clinician greater elements and degrees of risk. Gow-Gates advocates the use of an intra-oral technique while utilizing extra-oral landmarks. The dentist must inject in the mouth and at the same time visualize the outside of the patient's head and face regions, in order to carry out this maneuver. The target for the needle point is the neck of the condyle which lies in the upper portion of the pterygomandibular space. In addition, injecting the needle and local anaesthetic into the anterior portion of the temperomandibular joint capsule could also produce damage and prolonged side effects in the form of severe joint dysfunctions. The Akinosi technique also advocates placing the needle and local anaesthetic in the upper portion of the pterygomandibular space. Coupled with this is the disadvantage of not having any hard tissue landmarks that can be utilized as the proceedure is carried out with the patient's mouth closed. If it is necessary to continue dental care in the patient with significant trismus, the options for providing mandibular anesthesia are extremely limited. Inferior alveolar and Gow-Gates mandibular nerve blocks cannot be attempted when significant trismus is present. Extraoral mandibular nerve blocks can be attempted and, indeed, possess a significantly high success rate in experienced hands. Extraoral mandibular blocks can be administered through the sigmoid notch. Mandibular division of the trigeminal nerve provides motor innervation to the muscles of mastication, a third division (V3) block will relieve trismus that is produced secondary to muscle spasm (trismus may also result from other causes. EOMNB is however not very conventional because of limited surface landmarks and related studies. Our study attempts to throw some light on this aspect of MNB. We noted, that the average distance from centre of base of tragus to the point of needle entry is 1.44 ± 0.15 cm. The average depth ,the needle has to pass from the skin surface perpendicularly to reach the trunk of the mandibular nerve for a proper dissipation of dye to occur is 4.26 ± 0.33 cm. Hence these anatomical landmarks can be used as a guidance for efficient MNB from extraoral aspect for providing adequate pain relief.

Conclusion

With this study, we can conclude that there is some variation from standard literature regarding the location and morphology of the Otic ganglion and the Mandicular nerve with its branches. The main focus of this study was to provide adequate surface landmarks for EOMNB and we have been able to do so to a large extent. The major limitation of this study has been the relatively small number of specimens dissected, which can hopefully be compensated by further studies on similar subjects .

References

1. Bennett CR. Techniques of regional anesthesia and analgesia. In Bennett, CR (Ed.). *Monheim's local anesthesia and pain control in dental practice*. ed 7. St. Louis: CV Mosby; 1984.
2. Evers, H, Haegerstam, G. Anaesthesia of the lower jaw. In Evers, H, Haegerstam, G (Eds.). *Introduction to dental local anaesthesia*. Fribourg, Switzerland: Mediglobe SA; 1990.
3. OnPharma Inc. *Results of 38 studies on LA success rates, unpublished.* Available at www.onpharma.com.
4. Kanaa MD, Whitworth JM, Corbett IP, *et al*. Articaine buccal infiltration enhances the effectiveness of lidocaine inferior alveolar nerve block. *Int Endod J*. 2009; 42: 238–246.
5. Hannan L, Reader A, Nist R, *et al*. The use of ultrasound for guiding needle placement for inferior alveolar nerve blocks. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1999; 87: 658–665.
6. Berns JM, Sadove MS. Mandibular block injection: a method of study using an injected radiopaque material. *J Am Dent Assoc*. 1962; 65: 736–745.
7. Galbreath JC. Tracing the course of the mandibular block injection. *Oral Surg Oral Med Oral Pathol*. 1970; 30: 571–582.
8. Reader A. American Association of Endodontists. Taking the pain out of restorative dentistry and endodontics: current thoughts and treatment options to help patients achieve profound anesthesia. Endodontics: Colleagues for Excellence. Winter 2009.
9. Gow-Gates GA. Mandibular conduction anesthesia: a new technique using extraoral landmarks.*Oral Surg Oral Med Oral Pathol*. 1973; 36: 321–328.
10. Akinosi JO. A new approach to the mandibular nerve block. *Br J Oral Surg*. 1977; 15: 83–87.
11. Malamed SF. The periodontal ligament (PDL) injection: an alternative to inferior alveolar Nerve block. *Oral Surg*. 1982; 53: 117–121.
12. Coggins R, Reader A, Nist R, *et al*. Anesthetic efficacy of the intraosseous injection in maxillary and mandibular teeth. *Oral Surg Oral Med Oral Pathol*. 1996; 81: 634–641.
13. Whitcomb M, Drum M, Reader A, *et al*. A prospective, randomized, double-blind study of The anesthetic efficacy of sodium bicarbonate buffered 2% lidocaine with 1:100,000 epinephrine in inferior alveolar nerve blocks. *Anesth Prog*. 2010; 57: 59–66.
14. Akinosi JO. A new approach to the mandibular nerve block. *Br J Oral Surg*. 1977; 15: 83– 87.
15. Murphy TM. Somatic blockade. In Cousins, MJ, Bridenbaugh, PO (Eds.): *Neural blockade In clinical anesthesia and management of pain*. Philadelphia: JB Lippincott; 1980.

16. Bennett CR. Monheim's local anesthesia and pain control in dental practice. ed 6. St Louis: Mosby; 1978.
17. Standring Susan *et al.* Gray's Anatomy: The Anatomical Basis Of Clinical Practice. Fortieth Edition. Churchill Livingstone: Elsevier Publication; 527-541.
18. Roitman R, Talmi YP, Finkelstein Y, Sadov R, Zohar Y. Anatomic study of the otic ganglion in humans: *Head Neck*. 1990; 12(6): 503-6.
19. Gaum LI, Moon AC. The "ART" mandibular nerve block: a new approach to accomplishing regional anesthesia. *J Can Dent Assoc*. 1997; 63(6): 454-9.
20. Malamed SF. The Gow-Gates mandibular block: evaluation after 4275 cases. *Oral Surg*. 1981; 51: 463.

Instructions to Authors

Submission to the journal must comply with the Guidelines for Authors.

Non-compliant submission will be returned to the author for correction.

To access the online submission system and for the most up-to-date version of the Guide for Authors please visit:

http://www.rfppl.com

Technical problems or general questions on publishing with **IJA** are supported by Red Flower Publication Pvt. Ltd's Author Support team (http://ww.rfppl.com)

Alternatively, please contact the Journal's Editorial Office for further assistance.

A Lal

Publication -in-Charge

Indian Journal of Anatomy

Red Flower Publication Pvt. Ltd.

48/41-42, DSIDC, Pocket-II

Mayur Vihar Phase-I

Delhi – 110 091

India

Phone: 91-11-22754205, Fax: 91-11-22754205

E-mail: redflowerppl@gmail.com

Website: www.rfppl.com

Case Report

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Horseshoe Kidney: A Case Presentation

Jain S.R.*, Baig M.M., Pradeep Nahar*****

Abstract

Introduction: Horseshoe kidneys are most common type congenital anomaly of excretory system. The incidence of this anomaly is approximately 1 in 400-500 adults. It is a condition in which there is fusion of both kidneys either at upper or at lower poles mostly fusion of lower poles. This knowledge will be very useful for radiological and surgical procedures. **Methods:** The present variation was observed during routine dissection 58 year old male cadaver in department of Anatomy of the institute. **Results:** Both the kidneys were placed at lower level as compared to their normal positions. The lower poles were fused to form the isthmus opposite to the L4 vertebra. As a result of this fusion the inferior pole of each kidney pointed medially. There was no extra renal anomaly such as polycystic kidney or renal cysts were observed. Weight of each kidney was approximately 200 g. While dimensions were length 100mm, width 20mm, and thickness 45mm for right kidney and 108mm, 18mm, 46mm respectively for left. Relation of structures in hilum was on right side from above downward renal vein, renal artery, renal vein and ureter. That on left side was from above downward renal vein, renal artery and pelvis; from before backward renal vein, renal artery. **Conclusion:** The horseshoe kidneys are usually asymptomatic. They themselves don't require any treatment and subject can have normal life expectancy unless any complications occur. But since horseshoe kidney can not only alter imaging appearance but also render the kidneys susceptible to trauma, stone formation and transitional cell carcinoma of the renal pelvis. It becomes essential to recognise their presence.

Keywords: Horse shoe kidney; Renal anomalies; Renal artery; Renal vein.

Introduction

Horseshoe kidneys are most common type congenital anomaly of excretory system. The incidence of this anomaly is approximately 1 in 400-500 adults. The condition is more commonly found in males. Higher incidence rate has been reported from patients having Down's syndrome and Turner syndrome.[1]

It is a condition in which there is fusion of both kidneys either at upper or at lower poles.

Author's Affiliation: *JR 3, V M Medical College, Solapur, ** Professor and HOD, V M Medical College, Solapur, ***Assistant Professor, Department of Physiology, B J Medical College, Pune – 411001.

Reprint's request: Dr. Pradeep Nahar, Department of Physiology, B J Medical College, Pune – 411001.

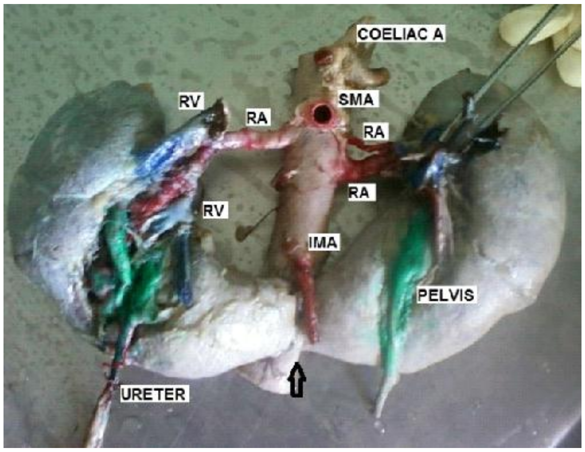
E-mail: pradeepnahar85@yahoo.com

(Received on 24.05.2013, accepted on 22.06.2013)

Horseshoe kidney is formed by fusion across the midline of two distinct functioning kidneys, one on each side of the midline. They are connected by an isthmus of functioning renal parenchyma or fibrous tissue. In the vast majority of cases the fusion is between the lower poles (90%). When superior or both the superior or inferior poles are fused, it is referred to as a sigmoid kidney. Horseshoe kidney is malrotated kidney. During embryonic life at the stage of migration of kidney the two metanephric blastomere come in contact mainly at the lower pole and in some cases at upper pole.[2]

It has also been postulated that during normal development, the kidneys rotate in such a way that the ureters leave the kidney from its medial aspect and the axis of the kidneys diverge. But in horseshoe kidney the normal rotation of the kidney is incomplete, so that the ureters leave the kidney from its ventral aspect and the longitudinal axis of the

Figure 1: Horse shoe kidney after removal from cadaver (Anterior view)



RV - Renal Vein, RA - Renal artery, SMA- Superior Mesenteric Artery, IMA - inferior Mesentric artery,

kidneys converge.

In the present case, we have described the horseshoe kidney in detail. This knowledge will be very useful for radiological and surgical procedures.

Material and Method

The present variation was observed during routine dissection of a cadaver in department of Anatomy, Dr. Vaishampayan Memorial Government Medical College, Solapur.

The cadever was 58 years old male. After removal of perirenal fat, the kidneys were carefully examined. It relation with various structures were carefully studied. All the morphological parameters were measures and recorded.

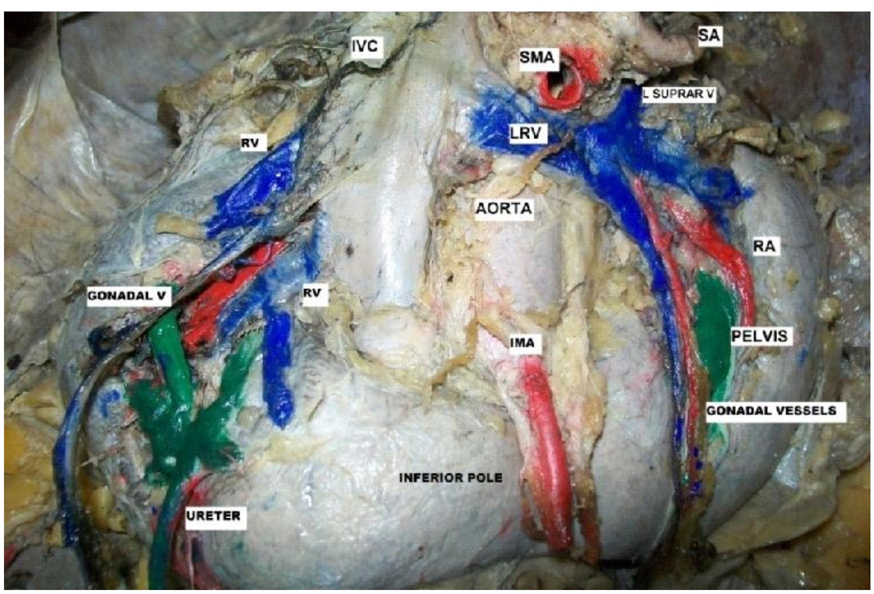
Result

Both the kidneys were placed at lower level as compared to their normal positions. The lower poles were fused to form the isthmus opposite to the L4 vertebra. As a result of this fusion the inferior pole of each kidney pointed medially. There was no extra renal anomaly such as polycystic kidney or renal cysts were observed.

Weight of each kindey was approximately 200 g. While dimensions were length 100mm, width 20mm, and thickness 45 mm for right kidney and 108 mm, 18 mm, 46 mm respectively for left.

The right and left renal arteries arose as lateral branches of the aorta just below the

Figure 2: Horse shoe kidney in situ (Anterior view)



RV - Renal Vein, RA - Renal artery, SMA- Superior Mesenteric Artery, IMA - inferior Mesentric artery, IVC - Inferior Vena Cava, SA- Splenic artery, L SUPRA RV - left suprarenal vein level of superior mesenteric artery. Their accompanying renal veins entered the inferior vena cava. One accessory left renal artery originated from lateral wall of the aorta above the main left renal artery. Then it ran downward behind left renal vein. Right kidney was drained by two renal veins separately into the inferior vena cava; one renal vein had two tributaries outside the hilum. Left gonadal and suprarenal veins drained into left renal vein.

Relation of structures in hilum was on right side from above downward renal vein, renal artery, renal vein and ureter (Figure 1). That on left side was from above downward renal vein, renal artery and pelvis; from before backward renal vein, renal artery.

The relations of other structure were as follows - Inferior mesenteric artery was hooked over the isthmus (Figure 1). The posterior surface of the isthmus was grooved by the aorta. From anterior surfaces of kidneys, the calyces emerged to form the ureters. There was no distinct kidney pelvis on right side. The ureters passed downward over lower poles, then across the terminal parts of the common iliac vessels, to enter the bladder in the usual manner.

Discussion

Embryologically, horseshoe kidney represents the most common failure of migration and rotation of the metanephric buds from their pelvic position during forth – sixth week of gestation.[2] Horseshoe kidney, which cannot ascend out of the pelvic cavity because the inferior mesenteric artery prevents further migration. The vessels thus develop an abnormal relation to the renal pelvis and ureters.

Horseshoe kidneys can also be associated with other congenital renal anomay such as pelviureteric junction obstruction. The obstruction is further precipitated by anomalous vessels crossing the ureter and the abnormal course of the ureter as it passes over renal substance. Horseshoe kidneys also have an increased incidence of stone disease, probably as a consequence of areas of insufficient drainage.[3,4]

Horseshoe kidneys are also susceptible for injury since it lies lower than normal it is not protected by the ribs and costal margin. The large hydronephrotic kidney resulting from congenital obstruction associated with horseshoe kidney is susceptible to rupture by minimal trauma. They are also liable to parenchymatous diseases like nephritis, solitary cyst. Horseshoe kidneys are further associated with the Leriche syndrome. In this condition there is a thrombosis of the terminal aorta with claudication of the buttocks and lower extremities, impotence and diminished or absent a pulses beyond the aortic bifurcation.[4]

The horseshoe syndrome (Rovsing's syndrome) is characterized by nausea, vomiting and abdominal pain accentuated by hyperextension. Carcinoid tumours originate 60-85 times more often in horseshoe kidneys than normal one.

Conclusion

The horseshoe kidneys are usually asymptomatic. They themselves don't require any treatment and subject can have normal life expectancy unless any complications occur. But since horseshoe kidney can not only alter imaging appearance but also render the kidneys susceptible to trauma, stone formation and transitional cell carcinoma of the renal pelvis.[5] It becomes essential to recognise their presence.

References

1. Basar H, Basar R, Basar M, Erbil M. The comparison of the incidence of horseshoe kidney in autopsy cases versus urologic patient population. *Okajimas Folia Anat Jpn.* 1999; 76: 137-9.
2. Kilpatric F. Horseshoe kidney. *Proc R Soc Med.* 1967; 60: 433-8.

3. Bennani S, Touijer A, Aboutaieb R, Mrini M, Benjelloun S. Pathological horseshoe kidney - Therapeutic aspects. *Ann Urol.* 1994; 28: 2-5.
4. Evans WP, Resnick MI. Horseshoe kidney and urolithiasis. *J Urol.* 1981; 125: 620-21.
5. Holger G, Christoph E, Dietmar B, Thomas S. Successful transureteropyelostomy after heminephrectomy of a bilateral hydronephrotic horseshoe kidney: A case report . *Journal of Medical Case Reports.* 2008; 2: 231-3.

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Ossified Anterior Longitudinal Ligament in the Lumbar Region of the Vertebral Column

Sayee Rajangam*, Flossie Jayakaran**

Abstract

Background: Radiological investigation has classified the ossified anterior longitudinal ligament into 3 types: segmental, continuous, mixed. The associated common symptoms are the compression of the oesophagus and trachea. **Aim:** It is aimed to report the noticed ossified anterior longitudinal ligament in a bony specimen. **Material and Method:** During osteology class a bone specimen with ossified anterior longitudinal ligament was noticed. **Results:** Ossified anterior longitudinal ligament was observed in the lumbar region of the vertebral column may be between the 3rd and 4th lumbar vertebrae. In the present study, based on the projected upper and lower cut ends, it was opined, that the specimen belonged to the continuous type of the ossified anterior longitudinal ligament. **Conclusion:** The article even though reported the ossified anterior longitudinal ligament; in view of the specimen being bony, the associated clinical findings could not be surmised.

Keywords: Anterior longitudinal ligament; Ossified; Lumbar vertebrae.

Introduction

Anterior longitudinal ligament (ALL) is a wide strong fibrous band of tissue and it covers centrally the anterior aspect of the vertebral column. Its attachments are from the basilar part of the occipital bone to the front of the upper sacrum. From the anterior tubercle of the atlas, it ascends to blend with and form a central thickening in the anterior atlanto-axial and the anterior atlanto-occipital membranes. It is broader caudally, thicker & narrower in the thoracic than in the lumbar regions and is relatively thicker and narrower opposite the vertebral bodies than at the levels of the intervertebral symphyses. The longitudinal fibres are strongly adherent to the intervertebral discs, hyaline cartilage end plates and margins of the adjacent vertebral bodies; but loosely attached at intermediate levels of the bodies, where the ligament fills their anterior concavities, thereby flattens the profile of the vertebral column. At these various levels, the ligamentous fibres blend with the subjacent periosteum, perichondrium & peripheral fibres of the annulus fibrosus of the intervertebral discs. It has several layers; the most superficial fibres are the longest and extend over 3 or 4 vertebrae; intermediate fibres between 2 or 3 and the deepest from one body to the next. It maintains the stability of the intervertebral joints and is the only intervertebral ligament that limits the extension of the vertebral column. ALL along with the posterior longitudinal ligament (PLL) hold the vertebrae firmly together but also permits a small amount of movement to take place between them.[1,2,3,4] Ossification in the ALL and PLL have been reported. Based on the radiological investigation, the ossified ALL is classified into 3 types:

i) segmental

ii) continuous

Author's Affiliation: * Professor, **Professor and In-Charge , Department of Anatomy, International Medical School, New BEL Road, Bangalore - 560054

Reprint's request: Dr. Mrs. Sayee Rajangam, Professor, Anatomy, International Medical School, New BEL Road, Bangalore - 560054.

E-mail: drsayee@gmail.com

(Received on 19.06.2013, accepted on 05.07.2013)

iii) mixed.

Reports have also described the common symptoms such as compression of trachea and oesophagus because of the ossified ALL; radiological evaluation; surgical and medical management.[5]

Aim

It is aimed to report the noticed ossified anterior longitudinal ligament in a bony specimen.

Material and Method

During the regular demonstration classes in osteology on the vertebral column to the 1st MBBS students in the Department of Anatomy, International Medical School at Bangalore, the ossified ALL was noticed between 2 lumbar vertebrae (LV).

Results

The observed structure was a single piece with the ossified ALL between 2 LV. Subjectively, because of the rough and thick markings of the attachments of the muscles and the heaviness, it was determined that the piece could be that of an adult male and the LV could be in the mid lumbar region of L3 and L4. The ossified ALL was continuous over the space for the intervertebral disc as well as between the LV and had broken edges at the upper and the lower ends of the piece. It was noted that the ossified ALL may be of the continuous type.

Figure 1: Ossifield ALL

Discussion

The literature survey on the ossified ALL are mostly on the clinical and the radiological studies. The present study is an observation on the presence of the ossified ALL from the available bone piece as a study material from the lumbar region of the vertebral column. The features of the 3 types of the ossified ALL from its radiological appearance are:

i) the segmental type may have partial or total ossification over a vertebral body without involving the space for the intervertebral disc.

ii) the continuous type may have ossification covering over a number of intervertebral disc spaces

iii) the mixed type may have the combinations of both the segmental and the continuous type; i.e. the ossified ALL may be segmentally present only on the anterior aspect of the vertebra and also may be continuously present over the anterior aspects of the bodies of the vertebrae including the spaces for the intervertebral disc.[5]

In the present study, the ossified ALL extended over the anterior aspects of the 2 lumbar vertebrae including the space for the intervertebral disc and the cut ends both at the upper and the lower ends also indicated that the sample belonged to the continuous type. Normal anatomical description states that:

i) ALL is perforated by the foramina for arteries and veins passing to and from the vertebral bodies[6]

ii) ALL forms a fascial plane with the prevertebral & endothoracic fasciae and with the subperitoneal areolar tissue of the posterior abdominal wall. Prevertebral fascia blends inferiorly with ALL of the upper thoracic vertebrae in the posterior mediastinum and the infection and other pathological processes may spread along the fascial plane.[2]

Ossified PLL associated with radiculomyopathy is reported; but ossified ALL has not been frequently described; since it is rarely symptomatic.[5] The reported associated features with ossified ALL are:

i) Forestier's disease (FD)[7]

ii) Dysphagia[8]

iii) Dysphagia with diffuse idiopathic skeletal hyperostosis (Kobayashi *et al* 1999, cited[5]

iv) Radiculomyelopathy due to the associated stenosis of the cervical spine.[5]

Of course, in the present study, any information pertaining to the associated aspects was not available. Resnick *et al*, 1975 cited[5] coined the term diffuse idiopathic skeletal hyperostosis for FD and the ossified spinal ligaments was considered as part of the FD.[9] The diffuse idiopathic skeletal hyperostosis was defined as showing ossification or calcification along the anterior to anterolateral aspect of 4 contiguous vertebral bodies with relative preservation of the height of the intervertebral disc in the affected area; which distinguishes it from the degenerative discogenic disease. In the present study, the upper and the lower cut ends of the ossified ALL suggest that the sample may be included under the category of the diffuse idiopathic skeletal hyperosteosis. Articles in literature also describe the surgical and the medical management for the ossified ALL.

Conclusion

With the above background, a short note on the observed ossified ALL in the lumbar region of the vertebral column is reported.

References

1. Sinnatamby CS. *Last's Anatomy.Regional and Applied.* 11th edition. Philadelphia, USA: Churchill Livingstone Elsevier; 2006, 282.
2. Standring S. Gray's Anatomy. *The Anatomical Basis of Clinical Practice.* 40th edition. UK: Churchill Livingstone Elsevier; 2008, 713, 728-729.
3. Snell RS. *Clinical Anatomy by Regions.* 9th edition. New Delhi, India: Wolters Kluwer/ Lippincott Williams & Wilkins; 2012, 690.
4. Moore KL, Agur AMR, Dalley AF. *Essential Clinical Anatomy.* 4th edition. Philadelphia, India: Wolters Kluwer/ Lippincott Williams & Wilkins; 2011, 288.
5. Mizuno J, Nagakawa H, Song J. Symtomatic ossification of the anterior longitudinal ligament with stenosis of the cervical spine. A report of seven cases. *J of Bone Joint Surg Br.* 2005; 87-B(10): 1375-9.
6. Agur AMR, Dalley AF. *Grant's Atlas of Anatomy.* 12th edition. New Delhi, India: Wolters Kluwer/ Lippincott Williams & Wilkins; 2009, 298 & 306.
7. McCarthy RR, Harrison MJ, Tamas LB, Larkins MV. Ossification of the anterior longitudinal ligament and Forestier's disease: an analysis of seven cases. *J Neurosurg.* 2005; 83: 13-7.
8. Epstein N, Hollingworth R. Ossification of the cervical anterior longitudinal ligament contributing to dysphagia: case report. *J Neurosurg.* 1999; 90(Suppl 2): 261-3.
9. Mizuno J, Nagakawa H. Anterior decompression for cervical spondylosis associated with an early form of cervical ossification of the posterior longitudinal ligament. *Neurosurg Focus.* 2002; 12.

Subscription Form

I want to renew/subscribe to international class journal **"Indian Journal of Anatomy"** of Red Flower Publication Pvt. Ltd.

Subscription Rates:
• India: Institutional: Rs.3000, Individual: Rs.500, Life membership (10 years only for individulas) Rs.3000.
• All other countries: $260

Name and complete address (in capitals):

Payment detail:
Demand Draft No.
Date of DD
Amount paid Rs./USD

1. Advance payment required by Demand Draft payable to Red Flower Publicaion Pvt. Ltd. payable at Delhi.
2. Cancellation not allowed except for duplicate payment.
3. Agents allowed 10% discount.
4. Claim must be made within six months from issue date.

Mail all orders to
Red Flower Publication Pvt. Ltd.
48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi - 110 091 (India)
Tel: 91-11-22754205, Fax: 91-11-22754205
E-mail: redflowerppl@vsnl.net, redflowerppl@gmail.com
Website: www.rfppl.com

Case Report

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Thoraco-Omphalopagus: A Case Study

Tiwari Amrish*, Mishra Meghana, Naik D.C.*****

Abstract

Conjoined twins have interested people throughout history. In the earliest times they were known as gods, or feared as bad omens and exiled, abandoned or killed. In later days they were viewed as curiosities, and became circus or sideshow attractions. Now days, because of sophisticated separation techniques conjoined twins are no longer looked as freaks but individuals. Approximately 75% of conjoined twins are female, and 70% are fused at the thorax (Thoracopagus) or abdomen (Omphalopagus). The union can be in the frontal, transverse, or sagittal plane. In broad terms, conjoined twins may be regarded as a doubling anomaly. The later the incomplete embryologic separation occurs, the higher the likelihood of a complicated fusion.

Keywords: Conjoined; Twins; Thoraco-Omphalopagus.

Introduction

Conjoined twins (also known as Siamese twins) are identical twins whose bodies are joined in utero.[1] A rare phenomenon, the occurrence is estimated to range from 1 in 50,000 births to 1 in 100,000 births, with a somewhat higher incidence in Southwest Asia and Africa. Approximately half are stillborn, and a smaller fraction of pairs born alive have abnormalities incompatible with life.[2,3] The overall survival rate for conjoined twins is approximately 25 percent. The condition is more frequently found among females, with a ratio of 3:1.

Author's Affiliation: *Post graduate student, **Associate Professor, ***Professor & Head, Department Of Anatomy, S.S. Medical College, Rewa, (M.P.) India.

Reprint's request: Dr. Amrish Tiwari, Post Graduate Student, Department of Anatomy, Shyam ShahMedical College, REWA, Madhya Pradesh – 486001 (INDIA).

E-mail: dramrishtiwari@gmail.com

(Received on 20.07.2013, accepted on 12.08.2013)

Case report

A case of Thorao-omphalopagus is brought from the department of Gynaecology to department of Anatomy, S.S.M.C, Rewa. These are identical twins of female sex with symmetrical conjoined twinning of Thoraco-Omphalopagus, united in coronal plane.Crown Rump length of both fetuses are 32 cm and 35 cm respectively (Figure 1 and Figure 2).

Figure 1: Thoraco-Omphalopagus – Lateral view, showing fused chest and abdomen

Figure 2: Thoraco-Omphalopagus – Superior view, slowing two separate heads

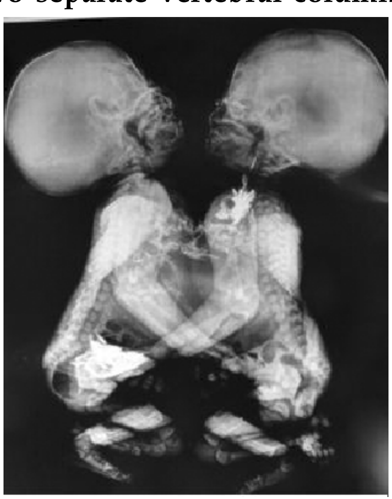
Radiological findings: (Figure 3)

- 2 Skulls
- 2 Vertebral columns
- 2 Separate sacra
- 4 Upper limbs (2 on each side)
- 4 Scapulae
- 4 Clavicles
- 2 Broad ribcages
- 4 Lower limbs
- 1 Umbilical cord

Discussion

How does it happen? If the split occurs more than 12 days post conception, the embryos do not fully divide and the twins may share body parts.[4] Researchers still do not know the exact mechanism regarding why some twins become conjoined. There may be specific genetic reason responsible for delaying the fertilized egg from splitting into two embryos. There may also be environmental reasons that prevent the egg from splitting completely. More research is required to determine the cause of conjoined twins.

Figure 3: X-Ray, Lateral view – showing two separate vertebral columns



On embryological ground, some generalizations are of assistance in the evaluation of conjoined twins:

1. From the clinician's point of view, the question of the degree of completeness of each of the conjoined twins is of fundamental importance. The more extensive the conjoining,the more incomplete the twins and the more extensive the sharing of viscera and other vital structures. It would follow that external conjoining of extensive degree suggests the probability of a high degree of internal asymmetry, but the extent of the internal joining is only partially suggested by external examination.
2. One concept of the mechanism of conjoining suggests a defect in the development of the primitive streak. It is postulated that cellular injury and molecular interference result in the development of two inductor centers. A second factor which conditions the development of conjoined twins relates to the degree of propinquity that exists between two developing embryonic axis on a single embryonal disc. The area of maximal chance for conjoining have greatest possibilities for fusion,active metabolism and spatial crowding. A review of the clinical literature of conjoining supports this embryologic concept.
3. By embryologic corollary, one might expect structures rostral to the umbilicus to be the most often conjoined. For example, fusions and sharing of

pericardium, heart, diaphragm, liver and gastrointestinal tract would be expected to occur in conjoined thoracopagus twins.

Separation of conjoined twin is a challenge to the surgeon, all of them cannot be separated due to sharing of vital organs but others can be separated and live normal life. Success of the surgery depends on skill of the surgical team and point of joining.[5] Craniopagus and thoracopagus are very difficult to separate as they may share vital structures, while ischiopagus and pyopagus can be separated surgically and have good outcome.[6,7]

References

1. Gould GM, Pyle WL. Anomalies and curiosities of medicine. Philadelphia: WB Saunders; 1896, 174-190.
2. Kalchbrenner M, Weiner S, Templeton J, Losure TA. Prenatal ultrasound diagnosis of thoraco-omphalopagus conjoined twins. *J Clin Ultrasound*. 1987; 15: 59-63.
3. Wilson RL, Shaub MS, Cetrulo CJ. The antepartum finding of conjoined twins. *J Clin Ultrasound*. 1977; 5: 35-37.
4. Kaufman MH. The embryology of conjoined twins. *Childs Nerv Syst*. 2004; 20(8-9): 508-25. Epub Jul 27, 2004.
5. Hoyle RM. Surgical separation of conjoined twins. *Surg Obstet Gynecol*. 1990; 170: 549.
6. Eades J, Thomas C. Successful separation of ischiopagustetrapus-conjoined twins. *Ann Surg*. 1966; 164: 1059-72.
7. Fieggen AG, Dunn RN, Pitcher RD. Ischiopagus and pygopagus conjoined twins: neurosurgical considerations. *Childs Nerv Syst*. 2004; 20(8-9): 640-51.

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Variations Associated with Median Nerve and Musculocutaneous Nerve: A Case Report

Pratima Baisakh*, Chinmayee Mohapatra, Minati Patra***, Bijay Kumar Dutta******

Abstract

Anatomic variations involving different nerves and muscles of upper limb are known to occur. Knowledge of any deviation from the normal pattern of distribution of anatomical structures helps the surgeons and other clinicians during any intervention of the upper limb. In the present case, during routine dissection of a female cadaver in the left upper limb, we found communication between left median nerve and musculocutaneous nerve in the proximal region of arm and left musculocutaneous not piercing the coracobrachialis muscle in the arm. The musculocutaneous nerve instead of piercing coracobrachialis passes in between biceps and brachialis. Coracobrachialis is supplied by a branch directly from the lateral cord and another from musculocutaneous nerve. However, the rest of the distribution of the median and musculocutaneous nerve were normal.

Key words: Musculocutaneous nerve; Coracobrachialis muscle; Biceps; Brachialis.

Introduction

Anatomic variations involving different nerves and muscles of upper limb are previously reported. Knowledge of variations in anatomy is important to anatomists, radiologists, anesthesiologists and surgeons. Presence of anatomic variations of the peripheral nervous system is often used to explain unexpected clinical signs and symptoms of nerve palsy syndrome and vascular problems. Median-nerve (MN) formed by medial and lateral roots from the medial and lateral cords of brachial plexus. Musculocutaneousnerve (MCN)-branch from lateral cord, supplies and pierces the coracobrachialis muscle, then passes through anterior compartment of arm. MCN also supplies biceps and brachialis muscle in the arm and then continues as lateral cutaneous nerve of forearm. We found concomitant variations of MN and MCN in the upper part of the arm along with an additional supply of coracobrachialis directly from the lateral cord.

Author's Affiliation: *Assistant Professor, Department of Anatomy, IMS and SUM Hospital, Bhubaneswar, **Professor, Department of Anatomy, V.S.S. Medical College, Burla, ***Professor, Department of Anatomy, KIMS Hospital, Bhubaneswar, ****Professor, Department of Anatomy, S.C.B. Medical College, Cuttack.

Reprint's request: Pratima Baisakh, MD, Assistant Professor, Department of Anatomy, IMS and SUM Hospital, Bhubaneswar.

E-mail: drpbaisakh@gmail.com

(Received on 21.07.2013, accepted on 12.08.2013)

Case summary

During routine dissection for undergraduate students, in the left arm of a female cadaver of approximately 60 yrs of age, we found 3 concurrent variations in the upper part of the arm. MN received a communicating branch from musculocutaneous nerve in the proximal region of arm just after its formation of main

Figure 1: Musculocutaneous nerve not piercing the coracobrachialis muscle. Coracobrachialis supplied by branches directly from lateral cord and musculocutaneous nerve

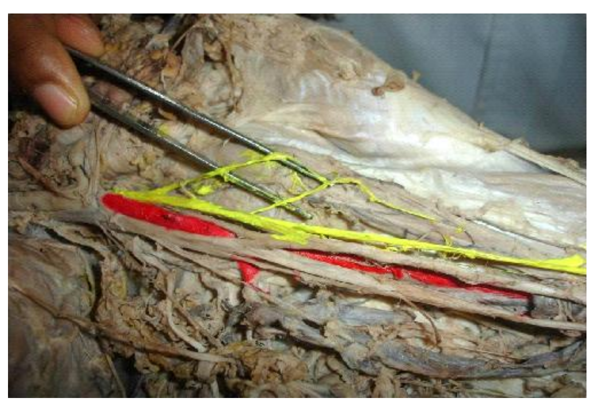
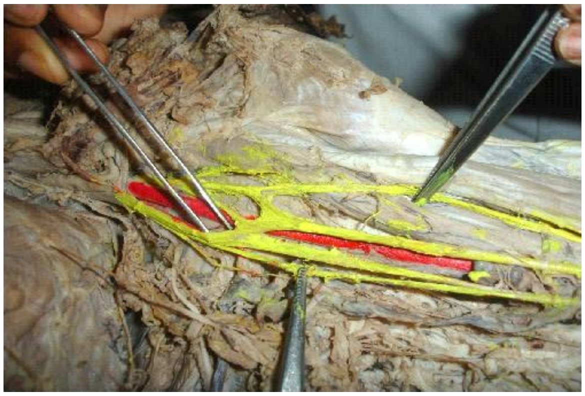


Figure 2: Median nerve formed by 3 roots (Lateral cord, medial cord and twigs from musculocutaneous nerve



trunk. That communicating branch can be taken as the third or 2nd lateral root of median root. Musculocutaneous nerve originating from the lateral cord doesn't pierce coracobrachialis and traverse in between biceps and brachiais. Coracobrachialis muscle is supplied by a branch directly from the lateral cord along with a separate twig from MCN. Rest of the course and distribution of MN and MCN was normal.

Discussion

Knowledge of anomalous branching pattern of brachial plexus and coexisting muscular anomalies help the surgeons during surgical interventions of upper limb to avoid inadvertent consequences. The forelimb muscles develop from the mesenchyme of the para-axial mesoderm during 5th week of embryonic life. The axons of spinal nerves grow distally to reach the limb bud mesenchyme. As suggested by Sannes *et al*[1], the migration of the developing axons is regulated in a highly coordinated specific fashion. Any alterations in signalling between mesenchymal cells and neuronal growth cones can lead to significant variations.

Le Minor (1990) reported Types I – V regarding variant communications between the musculocutaneous and median nerve.[2] However, *Venieratos and Anangnostopoulou (1998)* have described only three types of communications between the MCN and MN in relation to the coracobrachialis muscle.[3]

Type 1: communicationbetween MCN and MN is proximal to the entrance of the MCN into the coracobrachialis.

Type 2: the communication is distal to the muscle.

Type 3: neither the nerve nor its communicating branch pierced the muscle

In present case, the communication of MN and MCN can be categorized as type III of *Venieratos and Anangnostopoulou (1998)*.[3] The communicating branch from MCN which is of same calibre as that of the lateral root joins the MN in the upper third of the arm, hence can be considered as 3rd root of medial nerve. As described in present case, MCN does not pass through the coracobrachialis muscle, can be explained in terms of such developmental abnormalities for axonal guidance in the coracobrachialis muscle or circulatory factors during fusion of cords of brachial plexus.

Knowledge of variation is of immense importance during surgical exploration of axilla and arm region, during nerve block, during internal fixation of humeral fracture from common anterior approach to avoid injury to these nerves

References

1. Sannes HD, Reh TA, Harris WA. Development of the nervous system In: Axon growth and guidance. New York: Academic Press; 2000, 189-97.
2. Le Minor JM. A rare variant of the median and musculocutaneous nerves in man. *Archieves Anatomy Histology Embryology.* 1992; 73: 33-42.
3. Venieratos D, Anangnostopoulou S. Classification of communications between the musculocutaneous and median nerves. *Clinical Anatomy.* 1998; 11: 327-31.

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Case Report

Malrotation of Left Kidney with Accessory Lower Renal Artery: A Case Report

Ashfaq Ul Hassan*, Ghulam Hassan**

Abstract

Malrotation is not a common condition in relation to kidney and can present with certain problems during different surgical procedures. A proper knowledge of Anatomy of Kidneys is important . The condition has been associated with many other clinical conditions like accessory or aberrant vessels and in relation to certain distinctive syndromes.we present a rare case of Malrotation of Left Kidney with Accessory Lower Renal artery

Keywords: Metanephros; Kidney; Malrotation.

Introduction

Malrotation of kidney is an important embryological defect. They usually remain asymptomatic and silent and are incidential findings which are discovered during autopsies or dissection or radiological procedures performed on urinary system. The anomaly is frequently seen to be associated with Turner's Syndrome. An association with lobulated kidney, ectopic position of kidney and accessory renal arteries is also seen usually. The chances of hydronephrosis and stone formation are increased in malrotated kidneys.

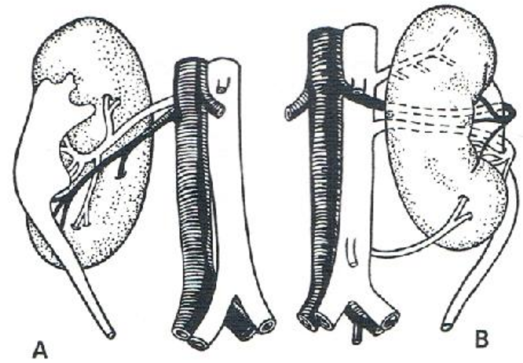
Observations

During Educational cadaveric dissection of an adult male, a case of non rotation of left kidney was encountered. In this case the kidney was of normal appearance, non lobulated and in its normal position however an accessory renal vessel supplying the lower pole was present.

Discussion

The kidneys in humans develop from metanephros. Initially the embryonic kidneys

Fig 1: Kidneys are the organs which ascend early in their development. They begin to develop in the sacral region until they reach their final and normal position in abdomen. This ascent is accompanied by slight rotation of kidneys. Failure to do so can result in problems during radiological procedures, surgeries as well as association with certain other diseases.



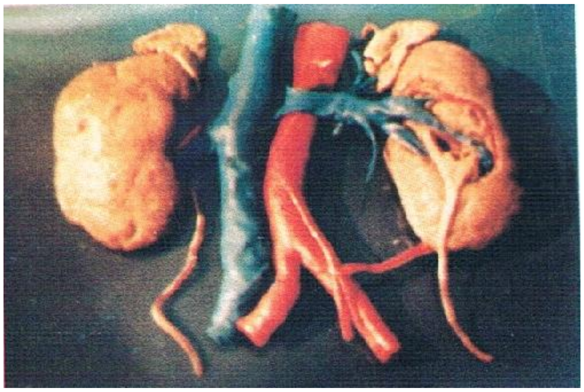
Author's Affiliation: *Lecturer, **Ex Prof and Head, SKIMS Medical College Srinagar Kashmir, India.

Reprint's request: Dr. Ashfaq Ul Hassan, MBBS, MS, Lecturer, SKIMS Medical College Srinagar Kashmir, India.

E-mail: ashhassan@rediffmail.com

(Received on 06.08.2013, accepted on 19.08.2013)

Fig 2: Malrotation of Left Kidney with accessory lower renal artery



are present in the Sacral region. The unique feature of the kidneys is that they ascend as well as undergo medial rotation. Failure to do so results in ectopic kidneys as well as malrotated kidneys.

The embryological development of the kidney results from the interaction between the mesonephric duct-derived ureteric bud, and the metanephros, the most caudal part of the nephrogenic cord. Development begins early in the 4^{th} week of gestation and during the 6^{th} and 8^{th} weeks the lobulated embryonic kidneys ascend from the pelvic region upwards along the posterior abdominal wall to their normal position and undergo a 90% axial rotation from horizontal to medial. At the same time the ureteric bud divides sequentially to form the pelvicalyceal system. During the process of ascent from the pelvis, the kidneys derive their blood supply sequentially from vessels that are closest to them- initially median sacral, then common iliac and inferior mesenteric, and finally, the aorta. An ectopic kidney results from either incomplete, excess or abnormal ascent. If during the process of ascent the kidneys come into contact, a horseshoe kidney or crossed renal ectopia will result.

Normally the kidney rotates through 90^0 in the ventromedial direction. Felix (1912) postulated that the rotation is a result of unequal and differential branching of uretral tree as more parenchyma develops ventrally than dorsally thus the kidney rotates medially. Errors in this normal physiological rotation give rise to various types of developmental anomalies described by Braasch[1] and Weyrauch[2] as non rotation, incomplete rotation , reverse rotation or excess rotation. In non rotation the renal pelvis presents itself ventrally in relation to kidney mass. In case of incomplete rotation the pelvis presents itself ventromedially whereas in excessive rotation which is rare the renal pelvis is ventro laterally placed and may assume any position depending upon degree of rotation.

According to Grays and Skandalakis the anomaly is frequently seen to be associated with Turner's Syndrome.[3]

Bilateral additional renal arteries and an additional right renal vein associated with unrotated kidneys have also been found.[4]

Bilateral malrotation and lobulation of kidney with altered hilar anatomy was also reported.[5] Here the renal pelvis was present anterior to the renal vessels instead of posterior position. The right kidney in addition showed lower lumbar position with three supplementary arteries and two veins. The right ovarian vein arched over the laterally rotated hilum of kidney and drained into superior renal vein instead of inferior vena cava.

As such in surgeries on kidneys which present with malrotation it is important to examine the position of kidneys with great care not only to establish the diagnosis but also to make sure that vessels vital to blood supply of kidneys are not damaged. Weyrauch suggested that anomalies of rotation are entirely compatible and may not present clinically, hence no attempt should be made to correct this rotation as it may lead to torsion of ureter causing functional disorders of kidney. According to Badenoch, the malrotations are of little significance but when not appreciated may give rise to difficulty in interpretation of pyelograms in what otherwise appears to be a normally functioning kidney.[6]

Conclusion

Though Malrotation can be clinically insignificant but as the non rotation may be associated with Accessory renal vasculature The importance of the Malrotation lies in realizing this anomaly in case of Renal Transplant Procedures, Surgeries on Aortic aneurysms, performing surgeries on Kidneys and interpretation of arterograms where it can pose a therapeutic and diagnostic challenge.

Refrences

1. Braasch WF. Anomoluos renal rotation and associated anomalies. *J Urol*. 25: 9.
2. Weyrauch HM. Anomolies of Renal Rotation. *Surg Gynaec and Obst.* 68: 183.
3. Gray SW and Skandalkalis. The Kidney and Ureter. Embryology for Surgeons. Phildalephia: WB Saunders 2003: p 124-167
4. Bayramoglu A, Demiryurek D, Erbil KM. Bilateral additional renal arteries and an additional right renal vein associated with unrotated kidneys. *Saudi Medical Journal*. 2003; 24(5): 535-537.
5. Patil ST, Meshram MM, Kasote AP. Bilateral malrotation and lobulation of kidney with altered hilar anatomy. *Surgical and Radiologic Anatomy: SRA*. 2011; 33(10): 941-944.
6. Badenoch AW. Manual of Urology 2nd Edn. William Heinemann Medical Books Pvt Ltd.; 1974.

Call for Reviewers

The Indian Journal of Anatomy (ISSN 2320-0022) is a half-yearly print and online journal of the Red Flower Publication Pvt. Ltd. publishes original and peer-reviewed articles, for the dissemination of anatomical knowledge with clinical, surgical and imaging guidance. Includes articles of history, reviews and biographies, locomotors, splachnology, neuroanatomy, imaging anatomy, anatomical variations, anatomical techniques, education and pedagogy in anatomy, Human Anatomy, Veterinary Anatomy, Embryology, Gross Anatomy (Macroscopic), Microscopic Anatomy (Histology, Cytology), Plant Anatomy (Phytotomy), Comparative Anatomy, editorials, letters to the editor, and case reports. Articles of veterinary anatomy, comparative and other morphological sciences are accepted.

One must have at least five years of experience in the field after completion of the education in that field and at least five original research papers in journal(s).

Please note that the acceptance of your application will be at the sole discretion of the editors.

Please provide your complete information and affiliation in brief through e-mail or you can register your self on our website www.rfppl.com.

For more information, please contact:

Publication–in-charge

Red Flower Publication Pvt. Ltd.

48/41-42, DSIDC, Pocket-II

Mayur Vihar Phase-I

Delhi – 110 091

India

Phone: 91-11-22754205, Fax: 91-11-22754205

E-mail: redflowerppl@vsnl.net, redflowerppl@gmail.com

Website: www.rfppl.com

Indian Journal of Anatomy
Volume 2 Number 2, July - December 2013

Unilateral Duplication of Retromandibular Vein an Unusual Variation

Roy Tapati*, Nene Ajay R.**, Gude Sujatha B.***

Abstract

Background: Variation in blood vessels is not uncommon and is more frequently seen in veins including retromandibular vein. The Knowledge of variation of superficial veins of head -neck is important to surgeon as these may be used for reconstruction surgery. **Aims & objectives**: To know variation in origin, course and termination of retromandibular vein. **Methods and observations:** During routine dissection for undergraduate class in the department of anatomy, a duplication of retromandibular vein was observed on left side in a 47 year old male cadaver. **Conclusions:** This case is being reported to highlight this rare variation of retromandibular vein, which may have significance in surgical and modern imaging field to localize the parotid tumor in relation to facial nerve and its subsequent removal. Although variations of retromandibular vein are reported earlier, but duplication is unique because of its rarity.

Keywords: Retromandibular vein; Facial nerve; Parotidectomy.

Introduction

Variations in blood vessels of body are not uncommon and are more frequently seen in veins including retromandibular vein (RMV). The Knowledge of variation of superficial veins of head -neck is important to surgeon as these may be used for reconstruction surgery or cannulation for intravenous medication. Moreover RMV is used as a guide to expose facial nerve branches in superficial parotidectomy.[1] RMV is also important clinically because venous aneurysm can develop in it.[2] The present case is being reported for its surgical importance as the variations of RMV may be helpful to take pre-surgical decision to avoid excessive bleeding during parotidectomy.

Author's Affiliation: *PG Student (MD Anatomy), Professor & HOD (Anatomy), ***Lecturer (Anatomy), GSL Medical College, Rajahmundry, Andhra Pradesh.

Reprint's request: Dr. Tapati Roy, Department of Anatomy, GSL Medical College, Laxmipuram, Rajahmundry, pin-533296, Andhra Pradesh.

E-mail: tapatiroy74@gmail.com.

(Received on 16.08.2013, accepted on 10.09.2013)

Aims & Objectives

To know variation in origin, course and termination of RMV vein.

Materials and Method

A 47 year old embalmed male cadaver was used for undergraduate students in Department of Anatomy, GSL Medical College, and Rajahmundry. Dissection was

Fig 1: Formation of SRMV & DRMV

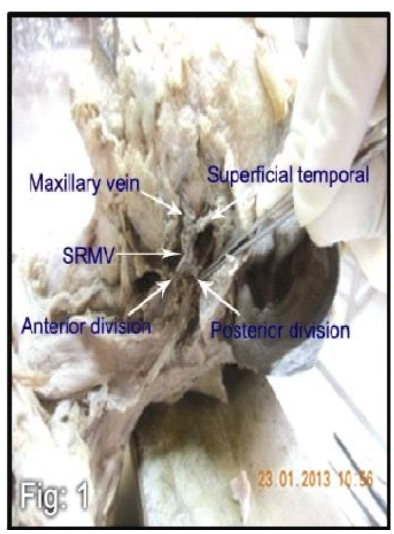
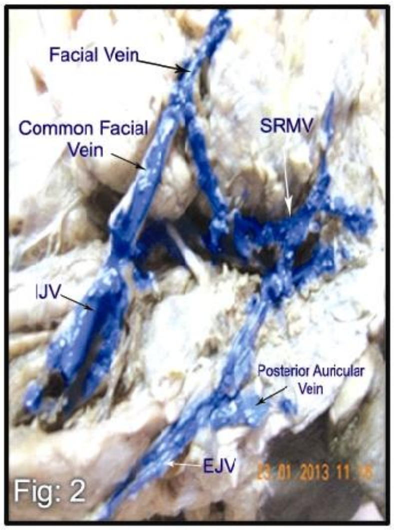


Fig 2: relations of SRMV & DRMV



done according to the Cunningham's Manual of Practical Anatomy (vol-3, page 115-118). After careful dissection variation of RMV was observed and photographed.

Results

In present case we observed unusual variation of RMV which consisted of two components (superficial SRMV-Fig 1, 2 & deep DRMV- Fig 3, 4).

Formative tributaries of both RMV arose from superficial temporal and maxillary vein and both the veins divided to form retromandibular veins (SRMV & DRMV)

Fig 3: Tributaries of SRMV & DRMV

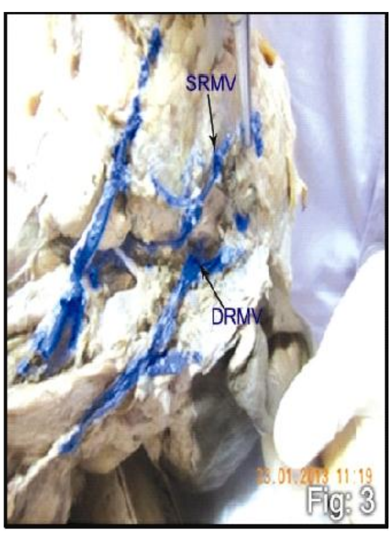
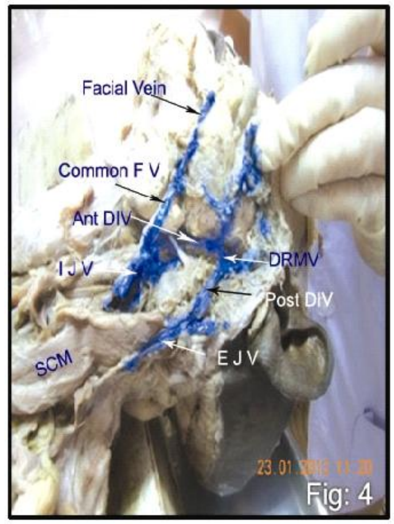


Fig 4: Termination of SRMV & DRMV



within the parotid gland.

After formation both veins divided into anterior and posterior division. Posterior division of SRMV united with posterior division of DRMV to form common trunk which in turn joined with posterior auricular vein to form external jugular vein.

Anterior division of SRMV united with facial vein to form common facial vein which drained into internal jugular vein.

The anterior division of DRMV directly joined with internal jugular vein although a communication was found between anterior divisions of both veins (SRMV & DRMV).

No variation was found in right RMV. No variations were noted on either side in any other vessel of head neck.

Discussion

During embryonic development, the venous drainage of head neck region gets established after the formation of skull.[3] The variation of size and pattern of veins in head and neck is quite common including the RMV. The anomalous venous patterns are due to regression and/or retention of venous anastomotic channels as described by Veena Vidya shankar *et al* in their article.[4]

Hamilton and Boyd *et al* described that variation of superficial veins of head neck is a common phenomena because superficial veins of head neck develop from superficial plexus of capillaries.[5] This plexus ultimately gives rise to primary head vein. Larger veins are formed by joining of confluence of capillaries or enlargement of individual veins. Regression of few venous channels alters the venous flow.

In present case we have observed bifurcation of superficial temporal vein. Similar findings were also noted by Veena Vidya shankar *et al*[4].

Tour *et al* reported in their study that the relationship between facial nerve and RMV was not fixed.[6] They dissected 132 cadavers and found following results. The vein was medial to the nerve in 65.2% cases and lateral to the nerve in 13% cases. In 6.8% cases they found the nerve was placed between superficial and deep venous plane.

In present case we also found superficial and deep RMV but both were situated deep to facial nerve.

According to Yao Wancai *et al*, the most common variation of RMV was that the vein crossed the facial nerve medially (33.31%) at a point between the bifurcation and ramification points of the lower trunk of facial nerve.[7] They investigated 31 cadavers. In 15.4% cases they observed the course of RMV was different on right and left side of face in same cadaver.

Copuz *et al* reported in their series of 30 cadaveric dissections that in 90% of cases RMV was located on the medial side of the upper and lower trunks of facial nerve.[8] In 10% cases RMV was located lateral to the lower trunk and 15% cases the course of RMV was different on right and left side of same cadaver.

The present case showed variation in RMV on left side alone.

Mehera *et al* reported that an undivided RMV joined with common venous trunk (formed by union of submental vein with facial vein) to form common facial vein which in turn drained into internal jugular vein (IJV).[9]

In present case although anterior division of SRMV joined with facial vein to form common facial vein which drained into IJV but DRMV directly drained into IJV.

Sahanaz *et al* found undivided RMV on both side of same cadaver which in turn joined with posterior auricular vein to form external jugular vein.[10]

No such variation was observed in present case.

Conclusion

We discussed a rare variation of RMV. Although variation of formation, termination and division of RMV were found but duplication is unique because of its rarity. Knowledge of this variation may be useful in planning and executing surgical or radiological intervention

References

1. Alzahrani F, AL- Qahtani KH. The facial nerve versus the retromandibular vein: a new anatomical relationship. *Head Neck Oncol*. 2012; 4(4): 82.
2. Tomori Hidetoshi, Ishikawa Takenori, Ishibashi Ryuhei, Miyauchimiwa, Igakoichi, Inoue Shingo. A case of venous aneurysm of the retromandibular vein presenting with sudden example growth in the parotid region. *Japanese Journal of Oral and Maxillofacial Surgery*. 2003; 49(10): 586-589.
3. Standring S. Gray's Anatomy–The Anatomical Basis of the Medicine and Surgery.38th edition. Edinberg: Churchill Livingstone; 1995, 327.
4. Veena Vidya Shankar, Divya Chandrashekar, Sheshgiri Chowdapurkar. Anatomical Variations in the Formation, Communication and the Termination of the Retromandibular Vein. *Journal of Clinical and Diagnostic Research*. 2012; 6(7): 1286–1288.
5. Hamilton, Boyd and Mossman. Human embryology. (1972): 4th Edition; page 261.
6. Tour, Gaoussou, Vacher, Christian. Relations of the facial nerve with the retromandibular

vein: anatomic study of 132 parotid glands. *Surgical and Radiologic Anatomy*. 2010; 32(10): 957.

7. Yao Wancai, Qi Jinipin, Yao Bo. Intraparotid anatomy of the facial nerve and retromandibular vein. *Chinese Journal of Oral and Maxillofacial Surgery*.1991; www.en.cnki.com.cn/Article - en/CJFDTotal-KQHM902.006.htm (accessed June 18, 2013)
8. Kopuz C, Ilqi S, Yavuz S, Onderoqlu S. Morphology of the Retromandibular Vein in Relation to the Facial Nerve in the Parotid Gland. *Cells Acta Anat (Basal)*. 1995; 152(1): 66-8.
9. Mehra S, Kaul JM, and Das S. Unusual Venous Drainage Pattern of Face. A Case Report. *Journal of the Anatomical Society of India*. 2003; 52(1): 64-65.
10. Shahnaz Choudhary, Ashwani K Sharma, Harbans Singh. Undivided Retromandibular Vein Continuing As External Jugular Vein with Facial Vein Draining Into It an Anatomical Variation. *Journal of Medical Education and Research*. 2010; 12(4): 203-204.

Manuscripts must be prepared in accordance with "Uniform requirements for Manuscripts submitted to Biomedical Journal" developed by international committee of medical Journal Editors.

Types of Manuscripts and Limits

Original articles: Up to 3000 words excluding references and abstract and up to 10 references.

Original articles: Up to 2500 words excluding references and abstract and up to 10 references.

Case reports: Up to 1000 words excluding references and abstract and up to 10 references.

Online Submission of the Manuscripts

Articles can also be submitted online from http://www.rfppl.com (currently send your articles through e-mail attachments)

I) First Page File: Prepare the title page, covering letter, acknowledgement, etc. using a word processor program. All information which can reveal your identity should be here. use text/rtf/doc/PDF files. Do not zip the files.

2) Article file: The main text of the article, beginning from Abstract till References (including tables) should be in this file. Do not include any information (such as acknowledgement, your name in page headers, etc.) in this file. Use text/rtf/doc/PDF files. Do not zip the files. Limit the file size to 400 kb. Do not incorporate images in the file. If file size is large, graphs can be submitted as images separately without incorporating them in the article file to reduce the size of the file.

3) Images: Submit good quality color images. Each image should be less than 100 kb in size. Size of the image can be reduced by decreasing the actual height and width of the images (keep up to 400 pixels or 3 inches). All image formats (jpeg, tiff, gif, bmp, png, eps etc.) are acceptable; jpeg is most suitable.

Legends: Legends for the figures/images should be included at the end of the article file.

If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks from submission. Hard copies of the images (3 sets), for articles submitted online, should be sent to the journal office at the time of submission of a revised manuscript. Editorial office: **Red Flower Publication Pvt. Ltd., 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi – 110 091, India, Phone: 91-11-22754205, Fax: 91-11-22754205, E-mail: redflowerppl@vsnl.net.**

Preparation of the Manuscript

The text of observational and experimental articles should be divided into sections with the headings: Introduction, Methods, Results, Discussion, References, Tables, Figures, Figure legends, and Acknowledgment. Do not make subheadings in these sections.

Title Page

The title page should carry

1) Type of manuscript (e.g. Original article, Review article, Case Report)
2) The title of the article, which should be concise, but informative;
3) Running title or short title not more than 50 characters;
4) The name by which each contributor is known (Last name, First name and initials of middle name), with his or her highest academic degree(s) and institutional affiliation;
5) The name of the department(s) and institution(s) to which the work should be attributed;
6) The name, address, phone numbers, facsimile numbers and e-mail address of the contributor responsible for correspondence about the manuscript;
7) The total number of pages, total number of photographs and word counts separately for abstract and for the text (excluding the references and abstract);
8) Source(s) of support in the form of grants, equipment, drugs, or all of these;
9) Acknowledgement, if any; and
10) If the manuscript was presented as part at a meeting, the organization, place, and exact date on which it was read.

Abstract Page

The second page should carry the full title of the manuscript and an abstract (of no more than 150 words for case reports, brief reports and 250 words for original articles). The abstract should be structured and state the Context (Background), Aims, Settings and Design, Methods and Material, Statistical analysis used, Results and Conclusions. Below the abstract should provide 3 to 10 keywords.

Introduction

State the background of the study and purpose of thestudy and summarize the rationale for the study or observation.

Methods

The methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods; all information obtained during the conduct of the study belongs in the Results section.

Reports of randomized clinical trials should be based on the CONSORT Statement (http://www. consort-statement. org). When reporting experiments on human subjects, indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000 (available at http://www.wma.net/e/policy/l 7-c_e.html).

Results

Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations. Extra or supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be published only in the electronic version of the journal.

Discussion

Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, what this study adds to the available evidence, effects on patient care and health policy, possible mechanisms); Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

List references in alphabetical order. Each listed reference should be cited in text (not in alphabetic order), and each text citation should be listed in the References section. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/bsd/uniform_requirements.html) for more examples.

Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006;35:540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003;61:347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997;195 Suppl 2:3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000;71:1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O, Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

More information about other reference types is available at www.nlm.nih.gov/bsd/uniform_requirements.html, but observes some minor deviations (no full stop after journal title, no issue or date after volume, etc).

Tables

Tables should be self-explanatory and should not duplicate textual material.

Tables with more than 10 columns and 25 rows are not acceptable.

Number tables, in Arabic numerals, consecutively in the order of their first citation in the text and supply a brief title for each.

Explain in footnotes all non-standard abbreviations that are used in each table.

For footnotes use the following symbols, in this sequence: *, ¶, †, ‡‡,

Illustrations (Figures)

Graphics files are welcome if supplied as Tiff, EPS, or PowerPoint files of minimum 1200x1600 pixel size. The minimum line weight for line art is 0.5 point for optimal printing.

When possible, please place symbol legends below the figure instead of to the side.

Original color figures can be printed in color at the editor's and publisher's discretion provided the author agrees to pay

Type or print out legends (maximum 40 words, excluding the credit line) for illustrations using double spacing, with Arabic numerals corresponding to the illustrations.

Sending a revised manuscript

While submitting a revised manuscript, contributors are requested to include, along with single copy of the final revised manuscript, a photocopy of the revised manuscript with the changes underlined in red and copy of the comments with the point to point clarification to each comment. The manuscript number should be written on each of these documents. If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks of submission. Hard copies of images should be sent to the office of the journal. There is no need to send printed manuscript for articles submitted online.

Reprints

Journal provides no free printed reprints, however a author copy is sent to the main author and additional copies are available on payment (ask to the journal office).

Copyrights

The whole of the literary matter in the journal is copyright and cannot be reproduced without the written permission.

Declaration

A declaration should be submitted stating that the manuscript represents valid work and that neither this manuscript nor one with substantially similar content under the present authorship has been published or is being considered for publication elsewhere and the authorship of this article will not be contested by any one whose name (s) is/are not listed here, and that the order of authorship as placed in the manuscript is final and accepted by the co-authors. Declarations should be signed by all the authors in the order in which they are mentioned in the original manuscript. Matters appearing in the Journal are covered by copyright but no objection will be made to their reproduction provided permission is obtained from the Editor prior to publication and due acknowledgment of the source is made.

Abbreviations

Standard abbreviations should be used and be spelt out when first used in the text. Abbreviations should not be used in the title or abstract.

Checklist

- Manuscript Title
- Covering letter: Signed by all contributors
- Previous publication/ presentations mentioned Source of funding mentioned
- Conflicts of interest disclosed

Authors

- Middle name initials provided.
- Author for correspondence, with e-mail address provided.
- Number of contributors restricted as per the instructions
- Identity not revealed in paper except title page (e.g. name of the institute in Methods, citing previous study as 'our study')

Presentation and Format

- Double spacing
- Margins 2.5 cm from all four sides
- Title page contains all the desired information. Running title provided (not more than 50 characters)
- Abstract page contains the full title of the manuscript
- Abstract provided: Structured abstract provided for an original article.
- Key words provided (three or more)
- Introduction of 75-100 words

- Headings in title case (not ALL CAPITALS). References cited in square brackets
- References according to the journal's instructions

Language and grammar

- Uniformly American English
- Abbreviations spelt out in full for the first time. Numerals from 1 to l0 spelt out
- Numerals at the beginning of the sentence spelt out

Tables and figures

- No repetition of data in tables and graphs and in text.
- Actual numbers from which graphs drawn, provided.
- Figures necessary and of good quality (color)
- Table and figure numbers in Arabic letters (not Roman).
- Labels pasted on back of the photographs (no names written)
- Figure legends provided (not more than 40 words)
- Patients' privacy maintained, (if not permission taken)
- Credit note for borrowed figures/tables provided
- Manuscript provided on a CDROM (with double spacing)

Submitting the Manuscript

- Is the journal editor's contact information current?
- Is a cover letter included with the manuscript? Does the letter

1. Include the author's postal address, e-mail address, telephone number, and fax number for future correspondence?
2. State that the manuscript is original, not previously published, and not under concurrent consideration elsewhere?
3. Inform the journal editor of the existence of any similar published manuscripts written by the author?
4. Mention any supplemental material you are submitting for the online version of your article?

Contributors' Form (to be modified as applicable and one signed copy attached with the manuscript)

Subject Index

Author Index