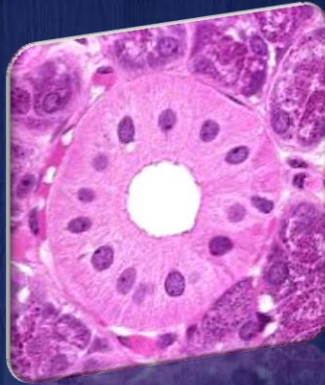
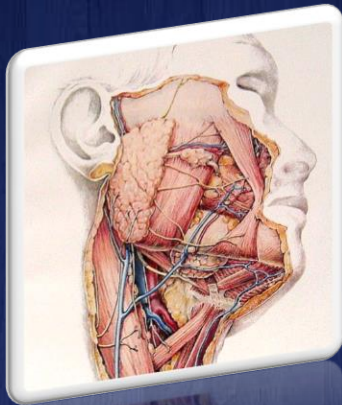


JAS *Journal of Anatomical Sciences*

(U.P. Chapter of Anatomical Society of India)



Editor-in-Chief
Dr. Satyam Khare



Joint Editor
Dr. Shilpi Jain



SUBSCRIPTION

Subscription Rate:

Individual Subscription: **Rs. 1000 (one thousand)** per annum

Institutional or Library Subscription: **Rs. 2000 (two thousand)** per annum

Information for subscribers:

The order should be placed with the Editor: Dr. Satyam Khare, Professor & Head,
Department of Anatomy, Subharti Medical College, Meerut - 250005 (India).

The order should accompany an advance remittance via electronic funds transfer
(RTGS/NEFT/IMPS) towards -

Name of the Bank - **ORIENTAL BANK OF COMMERCE**
Branch - **SKKB CHARITABLE TRUST M**
Name of the Beneficiary - **The Anatomical Society of UP Chapter**
Account No. - **52282122034300**
IFSC Code - **ORBC0105228**
MICR Code - **250022512**

(Please submit the receipt of the transaction along with the subscription order.)

About JAS

Journal Title	Journal of Anatomical Sciences
ISSN	0970-1842
E - ISSN	(Application under process)
Website	www.asiupjas.com
Email	asiupjas@gmail.com
Journal Categories	Gross & Comparative Anatomy, Histology & Histochemistry, Embryology, Neuroanatomy, Cytogenetics, Radiological Anatomy, Clinical Anatomy, Medical Education
Language	English
Inaugural Issue	December 1979
Frequency	Biannual (June - December)
Organisation	U. P. Chapter of the Anatomical Society of India
Editor-in-Chief	Dr. Satyam Khare (MS)
Joint Editor	Dr. Shilpi Jain (MD)
Associate Editors	Dr. Alok Tripathi Dr. Shobhit Raizaday
Current status	Active
Review process	Double-blinded peer review
Type of access	Open access
Full text format	PDF
License type	CC - BY (Creative Commons Attribution 3.0 licence)
Publication principles	International Committee of Medical Journal Editors (ICMJE)
Document Identifier type	DOI: 10.46351/jas
Editorial Office	Department of Anatomy Subharti Medical College Swami Vivekanand Subharti University Subharti Puram NH - 58, Delhi - Haridwar Bypass Road Meerut - 250005 Uttar Pradesh INDIA
Publisher	Dr. Satyam Khare (<i>for the U. P. Chapter of the Anatomical Society of India</i>)
Publisher Address	Department of Anatomy Subharti Medical College Swami Vivekanand Subharti University Subharti Puram NH - 58, Delhi - Haridwar Bypass Road Meerut - 250005 Uttar Pradesh INDIA
Webmaster	Phone: 0121 – 3055000 (Extn: 2170) Dr. Shobhit Raizaday (<i>Email: asiupjas@gmail.com</i>)

U.P. CHAPTER OF THE ANATOMICAL SOCIETY OF INDIA

OFFICE BEARERS

President

Dr. Vasundhara Kulshreshtha (Agra)

Vice Presidents

Dr. Naresh Chandra (Lucknow)

Dr. Brijendra Singh (Rishikesh)

Secretary cum Treasurer

Dr. Kuldeep Singh (Budaun)

Joint Secretary cum Joint Treasurer

Dr. V. D. Pandey (Meerut)

Editor

Dr. Satyam Khare (Subharti Medical College, Meerut)

Joint Editor

Dr. Shilpi Jain (Subharti Medical College, Meerut)

Executive Members

Dr. Dushyant

Dr. Adil

Dr. Vinay Sharma

Dr. Anshu Gupta

Dr. R. K. Verma

Dr. Kuldeep Kumar

Dr. Mukhtiyaz Hussein

Dr. Perna

Dr. M. K. Pant

Dr. Ankit Shrivastava

EDITORIAL BOARD

Editor-in-Chief



Dr. Satyam Khare
Professor & Head
Department of Anatomy
Subharti Medical College, Meerut (INDIA)

Joint Editor



Dr. Shilpi Jain
Professor
Department of Anatomy
Subharti Medical College, Meerut (INDIA)

Associate Editors



Dr. Alok Tripathi
Associate Professor
Department of Anatomy
Subharti Medical College, Meerut (INDIA)



Dr. Shobhit Raizaday
Assistant Professor
Department of Anatomy
Subharti Medical College, Meerut (INDIA)

Sectional Editors

Gross Anatomy & Comparative Anatomy
Dr. Archana Sharma
LLRM Medical College,
Meerut (INDIA)

Embryology
Dr. Rekha Lalwani
All India Institute of Medical Sciences,
Bhopal (INDIA)

Cytogenetics
Dr. Prabhat Goel
Vardhman Mahavir Medical College,
New Delhi (INDIA)

Clinical Anatomy
Dr. Royana Singh
Institute of Medical Sciences, BHU,
Varanasi (INDIA)

Histology & Histochemistry
Dr. Anita Rani
King George's Medical University,
Lucknow (INDIA)

Neuroanatomy
Dr. Priti Sinha
Saharanpur Medical College,
Saharanpur (INDIA)

Radiological Anatomy
Dr. Jyoti Chopra
King George's Medical University,
Lucknow (INDIA)

Medical Education
Dr. Brijendra Singh
All India Institute of Medical Sciences,
Rishikesh (INDIA)

Advisory Board (National)

Dr. Krishna Garg (New Delhi)

Dr. A. K. Asthana (Meerut)

Dr. Anita Tuli (New Delhi)

Dr. D. N. Sinha (Gorakhpur)

Dr. A. K. Srivastava (Lucknow)

C. S. Ramesh Babu (Meerut)

Dr. Vandana Mehta (New Delhi)

Dr. Dhiraj Saxena (Jaipur)

Dr. Mandavi Singh (Varanasi)

Dr. R. K. Suri (New Delhi)

Dr. Vinod Kumar (Kanpur)

Dr. R. J. Thomas (Jhansi)

Dr. S. K. Pandey (Varanasi)

Dr. Ramji (Gorakhpur)

Dr. N. A. Faruqi (Aligarh)

Dr. Dinesh Kumar (New Delhi)

Advisory Board (International)

Dr. Sanjay P. Singh
M.D., FAAN
Director - Neurological Institute. - CHI
Health-Creighton University,
Omaha, (USA)

Mr. Sumit Goyal
M.S., FRCS, L.L.M.
Consultant Oncoplastic Surgeon
Cardiff and Vale University Health Board
Cardiff, (U.K.)

Instructions to Authors

CATEGORIES OF ARTICLES

The journal publishes –

- Original communications
- Brief communications including Case Reports
- Review articles
- Book reviews
- Scientific proceedings of U.P Chapter of the Anatomical Society of India

For original and brief communications, the journal accepts original research in the fields of –

- Gross anatomy and Comparative anatomy
- Embryology
- Histology and Histochemistry
- Cytogenetics
- Radiological anatomy
- Neuroanatomy
- Clinical anatomy
- Medical education

MANUSCRIPT PREPARATION

General Information –

- The manuscript should be written in British English and typed double-spaced throughout on **A4** paper size with 2.5 cm margin all around.
- All pages should be consecutively numbered in Arabic numerals.
- Sentences should not start with an abbreviation.
- The word *Figure* should be spelled out in the text except when in parenthesis: *example – Figure 1 or (Figs. 2-3).*
- All anatomical terms should be in conformation with those specified in Terminologia Anatomica (1998) Stuttgart.
- Nontechnical terms must be spelled according to the current Oxford English Dictionary.

- Numerical figures must be mentioned in Arabic numerals followed by abbreviated units in metric system.
- The manuscript should have a uniform style in a simple format. Complex formatting should be avoided.

Arrangement of the Main Document –

The main text of the manuscript should have the following subdivisions in sequence:

SEPARATE TITLE PAGE

TITLE & ABSTRACT

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS (if any)

Text Body

INTRODUCTION

MATERIALS AND METHODS

RESULTS

DISCUSSION

CONCLUSIONS

REFERENCES

Illustrations

Tables

(Start each subdivision on a new page)

SEPARATE TITLE PAGE

- The complete title of the paper.
- Full name of each author.
- List the affiliation of each author separately, linked to the author's name with a superscript number.

Example:

Rajveer Singh Chourasia¹, Ranjeet Kumar²
¹Department of Anatomy, SLN Medical College, Koraput, Odisha, India

²Department of Anatomy, Hind Institute of Medical Sciences, Safedabad, Barabanki, UP, India

- Institution from which the paper emanated (with city, state and

- zip/postal code)
- A short running title
- Address for correspondence

TITLE AND ABSTRACT

- Should be on the second page of each manuscript, not exceeding 300 words. The abstract should include a brief introduction, materials & methods, main results and important conclusions.
- A list of 3-9 key words should be given below the abstract.

TEXT BODY

- The manuscript text should be uniform in style and typed in Microsoft Word .doc or .docx format.
- The authors' name, affiliations or any other identifying information should NOT be included in the text body.
- The text of the manuscript should include, 1. Introduction, 2. Material and Methods, 3. Results, 4. Discussion, 5. Conclusion, if any, in that order.

REFERENCES

- References should be arranged chronologically as they appear in the body of the text according to the VANCOUVER SYSTEM.
- The reference number should be indicated in Arabic numerals in square brackets. *Example:* [1], [3-7], etc.

Papers published in periodicals:

1. Each author's surname followed by initials.
2. Full title of the paper
3. Abbreviation of the journal according to the style of index medicus
4. Year of Publication
5. Volume number, followed by a colon
6. First and the last page of paper.

Example: Longia, G.S., Kumar, V., and Gupta, C.D. Intra renal arterial pattern of

human kidney -corrosion cast study. *Ant. Anz.*, 1982., 166 :183-194.

Work referred from books:

1. Each Editor's surname followed by initials
2. Full title of the book
3. Name of the Chapter
4. Edition
5. Name of publisher
6. Domicile of publisher
7. Year of publication
8. Page numbers (a small 'p' with a full stop should be prefixed to the page number, pp with a full stop if the number of the pages are more).

Example: Sinnatamby C.S. In Last's Anatomy Regional and Applied, Upper limb, 11th ed., Churchill Livingstone London., 2005: p. 96.

Illustrations:

- All the illustrations including charts and diagrams and graphs should be referred to in the text and should be numbered.
- Every illustration should have legend typed on a separate page.
- For good reproduction, while printing, only good drawings and original photographs will be accepted.
- All the illustrations must be submitted in complete and finished form with adequate labelling.
- The abbreviations used in each illustration should be arranged alphabetically and should be included with the respective legends.

Tables:

- All the tables should be referred to in the text and should be numbered in Roman numerals.
- Every table should be prepared on a separate sheet and should have a heading (complete and brief) and may have footnotes.

- The tables should be simple with as few as possible vertical and horizontal lines.
- Too long and exhaustive tables are not acceptable because they can not be reproduced as such.

For further instructions, please visit –

<https://www.asiupjas.com/author-guidelines>

ARTICLE PROCESSING CHARGES

Once accepted for publication, the authors are required to submit article processing charges for each submitted manuscript for the planning, scanning, plate making and printing on art paper as -

- @ Rs. 800/- (USD 25/-) per black & white photograph
- @ Rs. 1400/- (USD 40/-) per colored photograph
- @ Rs. 800/- (USD 25/-) per table, graph or drawn figures

If the total amount is less than Rs. 5000/-, it will be rounded off to a minimum of Rs. 5000/- (USD 150/-).

METHOD OF PAYMENT

Payment of the article processing charges are to be made via electronic funds transfer (RTGS/NEFT/IMPS) as per the following details.

Name of the Bank - [ORIENTAL BANK OF COMMERCE](#)

Branch - [SKKB CHARITABLE TRUST M](#)

Name of the Beneficiary - The Anatomical Society of UP Chapter

Account No. - 52282122034300

IFSC Code - ORBC0105228

MICR Code - 250022512

(Please submit the receipt of the transaction along with the manuscript with the first author's name as the file name of the receipt.)

Original Article

STUDY OF VARIATIONS OF CERVICAL SEGMENT OF INTERNAL CAROTID ARTERY

Mahendra Kumar Pant ¹, Jayanti Pant ²

1. Department of Anatomy, Government Doon Medical College Dehradun, Uttarakhand, India
2. Department of Physiology, AIIMS, Rishikesh, Uttarakhand, India

ABSTRACT

Introduction: Presence of variations in the course of the cervical (extracranial) part of the internal carotid artery (I.C.A.) in the form of tortuosity, kinking, coiling or looping is a rare condition. These may be attributed to embryological or acquired factors. Patients with such variations may be asymptomatic in some cases, whereas, they may develop cerebrovascular symptoms due to carotid stenosis affecting cerebral circulation.

Materials and methods: The present study was performed during routine undergraduate dissection classes in total 21 human cadavers (6 females and 15 males) on bilateral sides.

Results: Bilateral kinking and looping of the cervical part of the I.C.A. was found in two cadavers.

Conclusions: The risk of transient ischemic attacks (TIA) in patients with carotid stenosis is high and surgical correction is indicated as a part of treatment. Further, patients having these variations are more prone to injury during radical neck dissection and other surgical operations of the neck region. Knowledge about anatomy of such variations provides a framework to review the embryogenesis of the structure and also provides insight into surgical, medical and radiological implications.

Keywords: Looping, Internal carotid artery, Variations

INTRODUCTION

Neck is the vital area which contains major blood vessels supplying the brain. The Internal Carotid Artery (ICA), which constitutes a major medium of blood circulation to brain, is one of the terminal branches of the common carotid artery. ICA passes straight upward through the

neck within the carotid sheath [1-3]. ICA generally comprises of four parts namely, cervical, petrous, cavernous and cerebral part. In Cervical region, ICA generally has a straight course and rarely gives any branch. ICA lies superficially in the carotid triangle and then takes a deep course medial to the posterior

Address for Correspondence:

Dr Mahendra Kumar Pant, Professor and Head, Department of Anatomy, Government Doon Medical College Dehradun, Uttarakhand (India) Email - pant.mahendra@gmail.com

Date of Receiving: 19 May 2020

Date of Acceptance: 24 June 2020

0970-1842/Copyright © JAS 2020

belly of digastric muscle. Carotid sinus is a bulbous enlargement located at the beginning of ICA and functions as a baroreceptor which regulates heart rate and blood pressure [3].

Variations in the cervical segment of ICA are said to be between 10 and 40% of the population. These variations are usually bilateral [4-9]. ICA variations have been observed in 4-66% in adults and 16-43% in children [10-13].

Sometimes, the cervical part of ICA may be tortuous especially when it is located closer to tonsil [4]. This makes the ICA prone to injury during surgical procedures like tonsillectomy, drainage of peritonsillar abscess, soft palate injuries, as well as adenoidectomy and velopharyngoplasty [14-20].

The explanation for origin of such variations of ICA has been described by various researchers. Some studies report that the variations represent congenital vascular anomalies, whereas other studies correlate these variations to arteriosclerotic pathology or fibromuscular dysplasia [21,22].

Though there may be different explanations supporting the variations of ICA, their knowledge is important for the clinicians who deal with patients suffering from cerebrovascular diseases and surgeons who operate in head-neck region. In the present study, we discuss the variations of ICA, which were observed in cadavers while performing dissection to teach first year undergraduate students.

MATERIALS AND METHODS

The present study was conducted during routine educational dissection for undergraduate students. In this study, we explored 21 (twenty-one) cadavers which were formalin fixed. Dissection of cervical part of ICA was performed bilaterally (42 ICA) following standard procedure of dissection. To begin with, common carotid artery was identified by retracting the sternocleidomastoid. Then it was traced towards upper end of thyroid cartilage of larynx. At the upper end of thyroid cartilage, the common carotid artery (CCA) bifurcated into external and internal carotid artery. In the cervical segment, the origin of branches from ICA and distribution in the neck area were observed.

RESULTS

All formalin preserved 21 human cadavers were dissected on both right and left side (total 42 ICA were studied). Of these, variations were observed in cervical part of ICA in 2 male cadavers on bilateral sides (Table 1).

In one 60 year old male cadaver, we could observe the kinking and looping of cervical part in bilateral internal carotid artery. On right side, the internal carotid artery was found to arise from the common carotid artery at the level of upper border of thyroid cartilage. The artery coursed postero-superiorly up to the angle of mandible to make a loop (proximal) and then descended up to the greater cornu of hyoid bone to form another loop (distal). Finally it ascended supero-medially to reach the carotid canal (Fig. 1).

On the left side, the ICA originated from CCA at the level of upper border of thyroid cartilage then coursed postero-superiorly up to the angle of mandible to make a loop (proximal) and then descended up to the greater cornu of hyoid bone to form another loop (distal). Finally, it ascended supero-medially to reach the carotid canal. Carotid sinus as dilatations were also observed on both sides. The loops of ICA on bilateral sides appeared as S-shaped loop (Fig. 2).

In another cadaver of about 69 year old male, we observed a different pattern of ICA on both left and right side. On right side, after origin from CCA, ICA travelled in a straight course in cervical region. External carotid artery (ECA) was located lateral to ICA. ICA did not give any branch from the cervical part (Fig. 3)

On left side, ICA had a tortuous course. Immediately after origin, it was dilated to form carotid sinus. Thereafter, the ICA travelled straight on the lateral side and became deeper (Fig. 4).

DISCUSSION

Exploration of anatomy of the neck region is essential for identification of the blood vessels. The CCA and its branches ECA & ICA, act as an important landmark for neck dissection. ICA develops from third aortic arch and cranial part of dorsal aorta. During the process of development at around fifth and sixth embryonic weeks, a loop is formed where these two vessels meet.



Fig. 1. Right Side Loops of Internal Carotid Artery in cadaver (60 year male) 1. Common Carotid Artery 2. Internal Carotid Artery 3. Proximal loop 4. Distal loop 5. Internal Jugular vein 6. Vagus nerve 7. External Carotid Artery

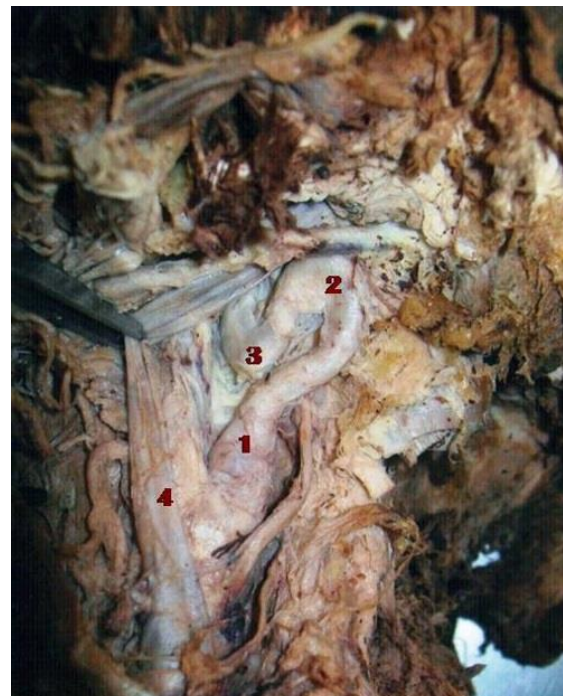


Fig. 2. Left Side S-shape Loop of Internal Carotid Artery in cadaver (60 year male). 1. Internal Carotid Artery 2. Proximal loop of Internal Carotid Artery 3. Distal loop of Internal Carotid Artery 4. Internal Jugular Vein

At the same time, the heart and the large vessels descend into the mediastinal space, which causes straightening of the ICA. In case this development is affected at any phase, it leads to formation of a loop in the ICA. Most of the times, ICA follows a straight course in the cervical region but malformations of ICA are also common which alter the regular anatomy. Some vessels are longitudinally elongated and become tortuous. In our observation, in two cadavers we found tortuous and looped ICA.

S or C shaped loops and tortuosities are reported to arise due to embryological development of branchial arch arteries [5]. During development, large vessels descend into mediastinal space and this leads to elongation and straightening of arteries. Any obstruction in this process or excessive growth of artery may lead to the looping of artery. Elongation of vessels is attributed to traction of vessels by surrounding tissue which stretches the vessel and increase pressure inside the lumen of the vessel. Further, such variations have been often linked to increasing age, where arteriosclerosis, stenosis and loss of elasticity of arterial walls have been associated with the changes. The cadavers in our study were of elderly humans and the variations may be result of embryological malformation or age-related degenerative changes.

These variations are prone to cause cerebral ischemia or stroke. The change in diameter of lumen of the ICA leads to decrease in blood pressure to finally reduces cerebral circulation to cause TIA [23]. However, reduction in blood pressure leads to activation of baroreceptors



Fig. 3. Right Side of Internal Carotid Artery in cadaver (69 year male) 1. Common Carotid Artery 2. Internal Carotid Artery 3. External Carotid Artery

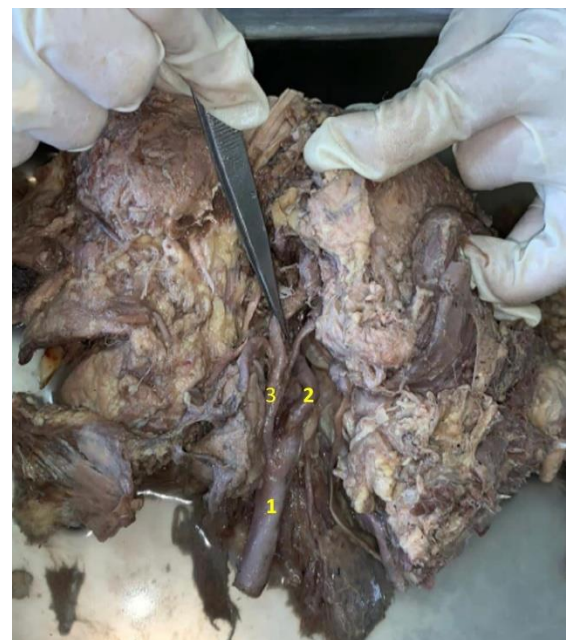


Fig. 4. Left Side of Internal Carotid Artery in cadaver (69 year male) 1. Common Carotid Artery 2. Internal Carotid Artery 3. External Carotid Artery

which try to compensate for change in pressure. Failure of the compensatory mechanisms may lead to decreased blood flow to brain. Further, studies have reported for association of tortuosity of ICA with increased BMI [24].

The presence of these variations in elderly population exposes them to a greater risk for TIA. Hence knowledge of these variations is pertinent for the surgeons, neurologists and radiologists who deal with cerebrovascular diseases.

REFERENCES

1. Henle J Handbuch der Gefäßlehre des Menschen, vol. III. Braunschweig: Vieweg und Sohn.1868.
2. Von Lanz T, Wachsmuth W. Praktische Anatomie. Kopf, vol II, Berlin: Springer.1955.
3. Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice, Vascular Supply and Drainage of the Brain, 41st Ed., Churchill Livingstone London; 2008; pp-455.
4. Cairney J. Tortuosity of the cervical segment of the internal carotid artery. Journal of Anatomy. 1924; 59: 87-96.
5. Metz H, Murray-Leslie RM, Bannister RG, Bull JWD, Marshall J. Kinking Of The Internal Carotid Artery In Relation To cerebrovascular disease. Lancet.1961; 1: 424-426.
6. Herrschaft H. Zerebrale Durchblutungsstörungen bei extremer Schlingenbildung der Arteria carotis interna. Münchener Medizinische Wochenschrift. 1968; 110: 2694-2702.
7. Herrschaft H Abnorme Schlingenbildungen der A. carotis interna und ihre klinische Bedeutung bei Operationen im Halsbereich. Zeitschrift für Laryngologie und Rhinologie. 1969; 2: 85-98.
8. Brosig HJ, Vollmar J. Chirurgische Korrektur der Knickstenosen der A. carotis interna. Münchener Medizinische Wochenschrift. 1974; 116: 969-982.
9. Tillmann B, Christofides C. Die gefäßliche Schleife der Arteria carotis interna. HNO. 1995; 43: 601-604.
10. Desay B, Toole JF. Kinks, coils, and carotids: a review. Stroke. 1975; 6: 649-653.
11. Ghilardi G, Longhi F, De Monti M, Bortolani E. Kinking carotideo ed ipertensione arteriosa. Risultati preliminari del programma OPI. Minerva Cardioangiologica. 1993; 41: 287-291.
12. Koskas F, Bahnini A, Walden R, Kieffer E. Stenotic coiling and kinking of the internal carotid artery. Annals of Vascular Surgery. 1993; 7: 530-540.
13. Leipzig TJ, Dohrmann GJ. The tortuous or kinked carotid artery: pathogenesis and clinical considerations. A historical review. Surgical Neurology. 1986; 25: 478-486.
14. Scilleri PG. Anomalous internal carotid artery and its clinical significance in operations on tonsils. Journal of the American Medical Association. 1913; 60: 172-173.
15. Fisher AGT. Sigmoid tortuosity of the internal carotid artery and its relation to tonsil and pharynx. Lancet. 1915; 2: 128-130.
16. Jackson JL. Tortuosity of the internal carotid artery and its relation to tonsillectomy. Canadian Medical Association Journal. 1933; 29: 475-479.
17. Swoboda H, Czech T, Schindler E. Aberrierende Strombahn einer Arteria carotis interna durch das Mittelohr. Hals-Nasen-Ohrenheilkunde, Kopf- und Hals-Chirurgie. 1991; 39: 315-320.
18. Herrmann A. Gefahren bei Operationen am Hals, Ohr und Gesicht und die Korrektur fehlerhafter Eingriffe. Berlin: Springer.1965.
19. Jackel M. Verlaufsvarianten der A. carotis interna als Differentialdiagnose parapharyngealer Raumforderungen. Hals-Nasen-Ohrenheilkunde, Kopf- und Hals-Chirurgie. 1997;45: 1018-1021.
20. Schumacher WA, Schafig A, Kehrl W, Pau HW. Verlaufsvarianten der Arteria carotis interna: Mögliche Risiken bei sogenannten Standardoperationen im Pharynxbereich.

- Laryngologie, Rhinologie, Otologie. 1998; 77: 517-520.
21. Schenk P, Temmel A, Trattig S, Kainberger F. Aktuelle Aspekte in der Diagnostik und Therapie des Karotiskinking. Hals-Nasen-Ohrenheilkunde. Kopf and Hals Chirurgie. 1996; 44:178-185.
22. Friedrich P, Bernhard T, Christos C, Walburga R, Jurgen K. Curving and looping of the internal carotid artery in relation to the pharynx: frequency, embryology and clinical implications. *J. Anat.* 2000; 197: 373-381.
23. Lijun W, Feng Z, Daming W, Shen H, Jiachun L, Zhilun Z, Jun L, Peng Q, Shiyong S. Pressure Drop in Tortuosity/Kinking of the Internal Carotid Artery: Simulation and Clinical Investigation. *BioMed Research International.* 2016; 2016, Article ID 2428970, 8 pages <http://dx.doi.org/10.1155/2016/2428970>
24. Wang HF, Wang DM, Wang JJ, Wang LJ, Lu J, Qi P, Hu S, Yang ZM, Chen KP. Extracranial Internal Carotid Artery Tortuosity and Body Mass Index. *Frontiers in Neurology.* 2017; 8: Article 508.

Original Article

EFFECT OF MOBILE PHONE RADIATION ON ADRENAL GLAND OF MALE ALBINO RATS

Shalini Gupta¹, Shilpi Jain², Satyam Khare², Prateek Gautam¹

1. Department of Anatomy, BRD Medical College and Hospital, Gorakhpur, U.P.

2. Department of Anatomy, Subharti Medical College, Meerut, U.P.

ABSTRACT

Introduction: The tremendous growth in telecommunication world has increased the number of mobile phone users to many folds. The benefits of cell phones are just half the picture. The other half may be a darker one. The main aim of this study is to observe the effect of electromagnetic radiation being emitted by mobile phones on adrenal gland microanatomy and the hormones released by the gland on male albino rats.

Materials and methods: Forty-two male albino rats of Spargue-Dawley species were divided into two equal groups. The experimental group rats were exposed to mobile phone radiation operating at 900 MHz while the control group rats were not. At the end of every two months, seven rats were sacrificed to analyse histological and hormonal changes.

Results: No changes were seen at the cellular level of the adrenal glands even after six months of radiation exposure. Hormonal assay showed a variation in the cortisol levels of the rats but the changes were within normal range.

Conclusions: Lack of appreciable changes in the cellular morphology and hormonal levels even after six months of radiation exposure signify that the adrenal glands are not affected by exposure to mobile phones.

Keywords: Mobile Phone, Albino Rats, Adrenal Gland, Cortisol.

INTRODUCTION

GSM stands for Global System for Mobile communications. It is a digital mobile telephone system used in most parts of the world. GSM uses a time division multiple access which

enables more people to communicate simultaneously with a station. According to GSM world, there are now more than 3 billion GSM mobile phone users worldwide with China referenced as the largest single GSM market with more than 370 million users [1].

Address for Correspondence:

Dr Shalini Gupta, Assistant Professor, Department of Anatomy, BRD Medical College, Gorakhpur, U.P., India. 273013
Mob: 8874014992, Email - guptashalini22@yahoo.com

Date of Receiving: 12 August 2020

Date of Acceptance: 07 September 2020

0970-1842/Copyright © JAS 2020

Tremendous growth in the use of cell phones has led to more demand for land to site telecommunication base stations and related infrastructures. However, as cell phone usage skyrockets, the concern over potential health risks rises as well. This is a consequence of the radiation emitted by handsets and base stations that receive and transmit the signals. Although some scientists and researchers across the globe claim there is no adverse effect from the use of mobile phones and its base stations, others in different countries in different laboratories, are finding disturbing results that point to far greater health implications than anyone is ready for [2].

Having suggested the potentially harmful effects of EMW radiation on some biological systems, recent studies have dealt with the concerns regarding the safety of radio frequency (RF)-EMW exposure. For example, the microwaves emitted by mobile phones have been linked to several genetic defects [3-5].

Microwave radiation may induce chromosomal instability and may lead to increased risk of cancer as suggested by Sykes et al. in 2001 and 2002, by Mashevich et al. in 2003 and Agarwal in 2007 [6-8]. Scientific researches have highlighted some extremely hazardous effects of exposure to radiation emitted from cell phones on the human body. These effects range from those at the molecular level manifested as an increase in single and double strand DNA breakages [9], change in Ornithine decarboxylase activity [10], increased risk of brain tumors [11] to disruption of learned behavior, dysaesthesia, etc. [12] and an increase in chick embryo mortality [13].

So according to the above effects of microwave radiation, the risk on adrenal gland as an essential organ becomes most important in the study of this issue [14]. Results from epidemiological studies indicate that cell phone radiation power density even below the standard level can cause symptoms such as headache, heat sensation in the ears, memory loss and fatigue and show significant relationship with the duration of call / time of the day [15-20].

Regarding the endocrine system, the sensitivity of pineal gland, pituitary gland, adrenal gland and thyroid gland as well as of the endocrine pancreas, testicles and ovaries to EMWs have been investigated [21]. Various papers were published on different endocrine glands but adrenal gland was the least explored. Hence, considering the lack of data on the effects of GSM mobile phone-induced electromagnetic fields on the adrenal gland and cortisol hormone in humans, the aim of the present study was to assess the potential alterations of cortisol hormones and microanatomy of adrenal gland after exposure to microwave radiation emitted by mobile phones.

MATERIALS AND METHODS

VENUE: The entire study was conducted in the department of Anatomy, BRD Medical College, Gorakhpur in collaboration with the department of Pharmacology of the institute. **STUDY MODEL:** Forty-two male albino rats of Spargue-Dawley species were chosen for the experiment. **INCLUSION CRITERIA:** A) Male rats B) Knowingly disease-free C) Age about 1.5 months-2 months D) Weight about 100-150 gms.

Mobile Phone Radiation Effect on Adrenal Gland

PROCUREMENT: All the rats were procured from Central Drug Research Institute, Lucknow along with their health certificates. After the procurement of the rats they underwent the process of acclimatization for one week during which they were fed with recommended pellet diet and water ad libidum. Twelve-hourly day and night cycle was maintained with appropriated temperature and humidity. Ethical clearance was taken from institutional animal ethical committee and experiment was performed as per the recommended guidelines.

GROUP DIVISION: The rats were divided into 2 groups having 21 rats each. Group A was the control group and Group B was the experimental group. Both the groups of rats were given exactly the same conditions and environment. The only difference was in the fact that Group-B rats were exposed to mobile phone radiation while Group A rats were not. In fact, the control group of rats were kept in different room in order to avoid any exposure to radiation.

RADIATION SET UP: Plastic cages normally available for rat housing were used and the base of the cage was floored with thermocol sheet. A slot was cut at the corner of the cage in thermocol sheet to adjust the mobile phone in it. The cage was partitioned using a wooden plank in order to restrict the movement of rats during the experiment. A GSM model mobile phone with frequency bandwidth of 900 MHz and power of 2 watt with a SAR value of 0.38 W/Kg was used to carry out the experiment. When the experiment was 'ON', a call was made from another cell phone on the mobile phone being kept inside the cage and the call was received in order to make the phone on answering mode for the next one hour. During this period, the rats remained in

touch with the mobile phone and were receiving the radiations just like humans [22-25]. The entire experiment was repeated for 6 months and at the end of every two months, seven rats from both the group were scarified and the tissue of adrenal gland and their blood sample were collected for analysis.

HORMONAL ANALYSIS: After the sacrifice of rats from both the groups, the blood sample of each rat was collected directly from the heart and was sent immediately to the lab for hormonal analysis of cortisol. Reports were collected and the data obtained was tabulated and analysed.

HISTOLOGICAL ANALYSIS: Just after the sacrifice of rats the adrenal gland was procured and was kept in 10% formalin solution. The tissues collected were processed using routine tissue processing technique used for Hematoxylin and Eosin staining methods. Slides were prepared and visualized under microscopes.

RESULTS

A. MICROSCOPIC ANALYSIS

CONTROL GROUP: (Fig. 1-a)

- The interior of the adrenal gland was divided into outer cortex and inner medulla.
- Cortex further exhibited three concentric zones: - zona glomerulosa, zona fasciculata and zona reticularis.
- Zona glomerulosa was a thin zone interior to the adrenal gland capsule. It consisted of cells arranged in small clumps.
- Zona fasciculata was intermediate and the thickest zone of the adrenal cortex. This zone exhibited vertical columns of one cell thickness adjacent to straight capillaries. It

consisted of pale staining cells due to increased lipid droplets.

- Zona reticularis was the innermost zone that was adjacent to the medulla. The cells here were arranged in cords or clumps.
- Medulla lied toward the centre of the gland, cells here were also arranged in small cords and were secretory in nature (epinephrine and nor-epinephrine).
- Medulla contained a lot of capillary network.

EXPERIMENTAL GROUP:

At the time of 2nd month of sacrifice: (Fig. 1-b)

- No appreciable changes were observed after 2nd month of radiation doses to the rats.
- The microscopic picture observed was more or less similar to the control group of rats.

At the time of 4th month of sacrifice: (Fig. 1-c)

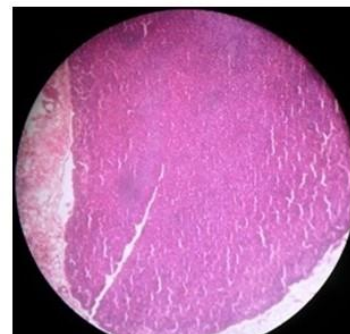
- No appreciable changes were observed after 4th month of radiation doses to the rats.

At the time of 6th month of sacrifice: (Fig. 1-d)

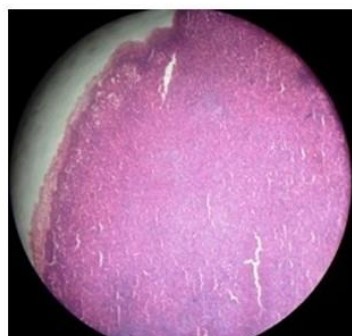
- No appreciable changes were observed after 6th month of radiation doses to the rats.
- Lack of changes at the cellular level in adrenal gland even after the exposure of 6 months was a clear indication of the fact that whatever other changes in parameter observed were not because of stress. This fact was very well supported by the level of corticosteroid hormones which showed no rise during the experiment.



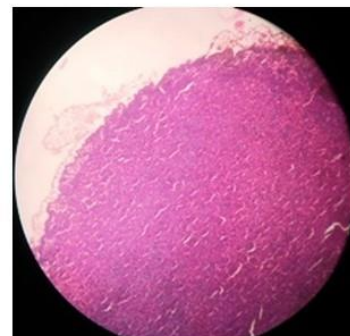
(a)



(b)



(c)



(d)

Fig. 1. Microscopic picture of Adrenal gland (40x) (a) Control group, (b) Experimental group at 2 months (c) Experimental group at 4 months and (d) Experimental group at 6 months

B. .HORMONAL ANALYSIS

- The analysis done from the data obtained for the cortisol level suggested that there were no changes occurring in the level of cortisol throughout the experiment.
- After 2nd month of experiment, the tables and bar diagram showed that there was variation in the level of cortisol in both the groups of rats but the data obtained from both the groups remained within the normal range. (Fig. 2).
- The same result was obtained from the data analysis after four months (Fig. 3) and after six months of the experiment (Fig. 4).
- Whether it was the control or the experimental group of rats, the level of cortisol remained within the limits of normal range.
- This data also indicated that throughout the experiment there was no increase in the stress of rats.
- Hence the changes being observed at any level were not due to any stress to the rats.

DISCUSSION

Various researches have suggested that electromagnetic radiation emitted from base stations and cell phones have destructive effects on tissues in two ways. To begin with, warm impacts happen by means of increment in bodily warmth by electromagnetic vitality, which is consumed by the body. Second, non-warm impacts show up as changes in cerebrum capacities and headaches [26].

Studies concentrating on the impacts of EMR radiated by mobile phones have yielded

dubious outcomes. Past investigations have detailed that radiofrequency waves produced especially by the third era mobile phones may affect the immunological status, sensory system, hematological status, cardiovascular capacities, urinary framework, typical development and genes [27], cells [28], tissues [29], organs and embryonic improvement [30]. Alongside this, EMR may likewise prompt DNA damage.

However, on the other hand there are studies in the literature reporting that cell phones do not have an effect on blood-brain barrier, testes, sperm morphology, seminiferous tubules and Leydig cells of the rats and do not cause a significant change in mean fetal heart rate [31].

Similarly, in comprehensive studies conducted in the USA and Denmark, it was reported that cell phone use was not associated with increased risk of brain tumor [32], direct genotoxic, mutagenic or cytotoxic effects [33]. To date such studies reporting hazardous as well as non-hazardous effects have used different experimental animal models like rats [34], mice [35], chick [36], etc.

In our study, we investigated the effect of mobile phone radiation operating at 900 MHz upon one important organ, that is the adrenal gland, over a period of 6 months and found that there was not much appreciable change occurring in the histology or physiology of the adrenal gland. However, Sima and Imam et al found alterations in the cortisol level of rats after exposure for 6 hours daily for 8 weeks. They also reported that the zona fasciculata layer of adrenal cortex eventually thickened following mobile RF radiation. The quantity of cells in

	1 st day		2 nd month	
R.no	Control	Experimental	Control	Experimental
1	0.29	1.42	0.22	1.29
2	0.31	1.38	0.26	0.87
3	0.44	0.76	0.34	0.44
4	2.01	0.82	1.44	0.57
5	1.46	0.97	1.32	0.78
6	0.91	2.10	0.72	1.88
7	1.78	1.21	1.66	1.09
Mean	1.028571	1.237143	0.85142857	0.988571
SD	0.72299	0.46046	0.61197572	0.488106
P value	0.5278		0.6676	

Table 1. Comparison of Cortisol in Experimental and Control Group of rats after 2nd month

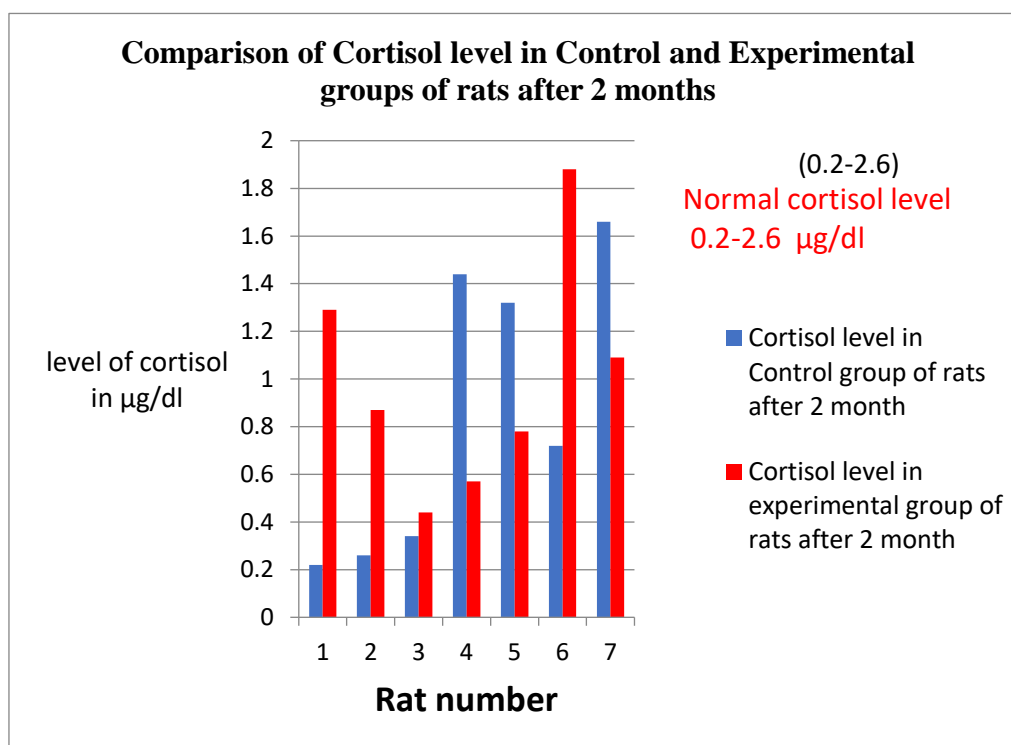


Fig. 2. Comparison of Cortisol in Experimental and Control groups of rats after 2nd month

R.No	1 st day		4 th month	
	Control	Experimental	Control	Experimental
1	2.10	1.43	1.78	1.23
2	2.20	1.92	2.01	1.65
3	1.89	1.94	1.77	1.74
4	1.32	2.56	0.76	2.00
5	1.40	2.53	0.87	2.32
6	1.23	1.38	1.02	1.09
7	1.86	2.52	1.65	2.34
Mean	1.714286	2.04	1.408571	1.76714286
S.D	0.392762	0.512022	0.508312	0.49151854
Pvalue	0.1989		0.1987	

Table 2. Comparison of Cortisol in Experimental and Control groups of rats after 4th month

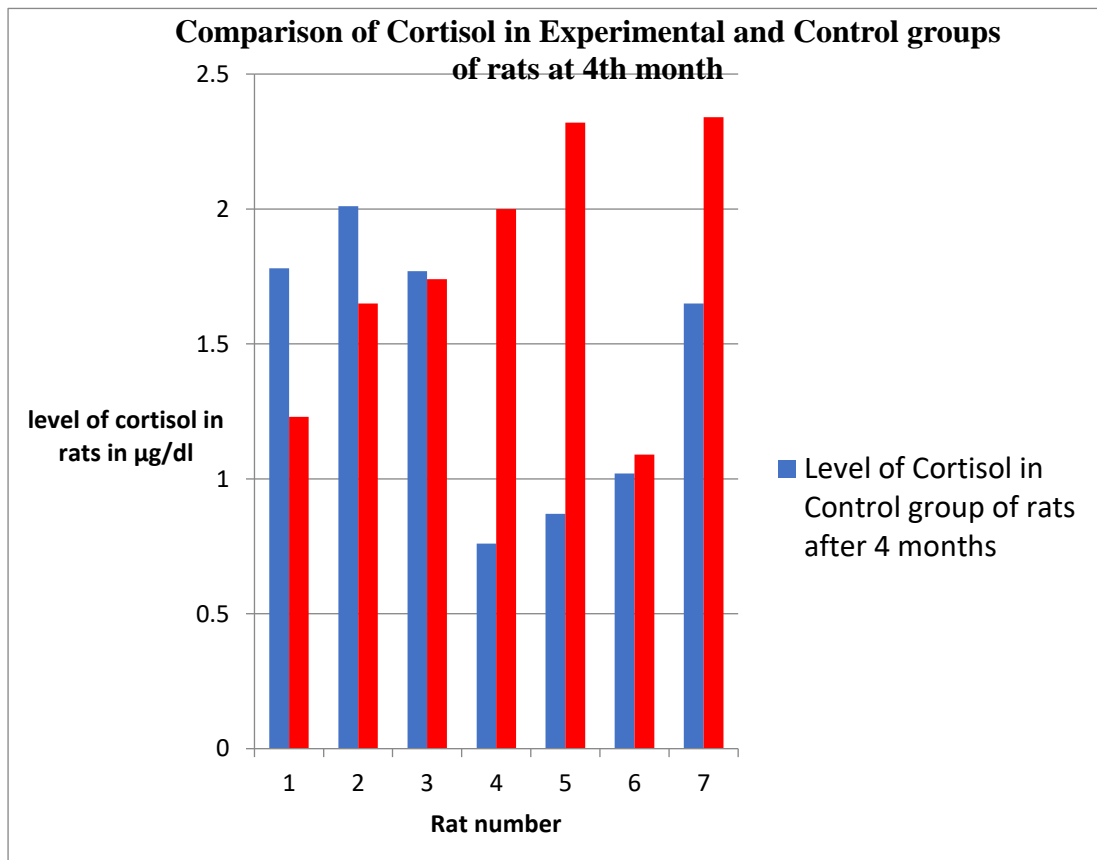


Fig. 3. Comparison of Cortisol in Experimental and Control groups of rats after 4th month

	1 st day		4 th month	
R.No	Control	Experimental	Control	Experimental
1	2.56	2.34	2.31	2.01
2	2.39	2.56	2.12	2.34
3	2.32	2.30	2.03	2.10
4	2.09	1.12	1.67	0.98
5	1.96	2.51	1.89	2.33
6	1.81	2.48	1.65	2.08
7	1.54	2.55	0.87	2.31
Mean	2.095714	2.265714	1.791429	2.02142
S.D	0.356224	0.515165	0.470334	0.478589
Pvalue	0.4811		0.3780	

Table 3. Comparison of Cortisol in Experimental and Control groups of rats after 6th month

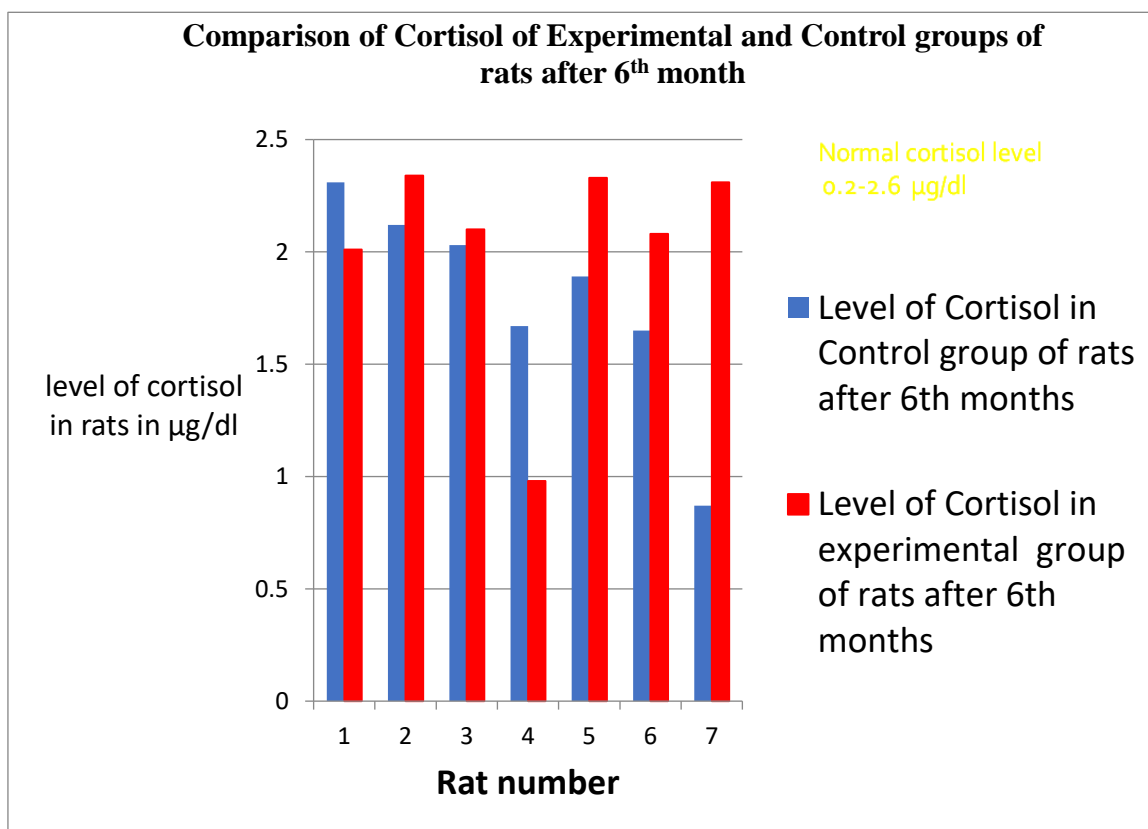


Fig. 4. Comparison of Cortisol in Experimental and Control groups of rats for 6th month

zona fasciculata stayed steady, in spite of the expanding phone size and edge during RF presentation.

Alteration in results may be due to the species of rats, their morphology, environmental conditions, amount and duration of exposure to radiation, etc. Any conclusive result to be quoted requires more extensive study with more parameters.

CONCLUSION

The results obtained from our experiment showed that even after an exposure of rats to mobile phone radiation for 6 months, there were no significant changes obtained in adrenal gland morphology at microscopic level and even the hormonal level. Though variation in the level of the hormone was very well reported but the data obtained after the analysis was all within the limit of normal range of cortisol level. This also proves that the rats were not stressed during the experiment and hence, any other parameter studied will have minimum chances of error due to stress factor.

REFERENCES

1. Friedhelm, H; (2002) "GSM and UMTS, the Creation of Global Mobile Communications", John Wiley and Sons, Inc., NY.
2. Gutierrez, D (2008): Mobile Phone Radiation to Unleash Epidemic of Brain Tumors, Natural News. www.naturalnew.com.
3. Pacini S., Ruggiero M., Sardi I., Aterini S., Gulisano F., Gulisano M., 2002. Exposure to global system for mobile communication (GSM) cellular phone radiofrequency alters gene expression, proliferation, and morphology of human skin fibroblasts. *Oncol. Res.*, 13, 19-24.
4. Aitken R., Bennetts L., Sawyer D., Wiklendt A., King B., 2005. Impact of radiofrequency electromagnetic radiation on DNA integrity in the male germline. *Int. J. Androl.*, 28, 171-179.
5. Tice RR., Hook GG., Donner M., McRee DI., Guy AW., 2002. Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells. *Bioelectromagnetics*, 23, 113-126.
6. Sykes PJ., McCallum BD., Bangay MJ., Hooker AM., Morley AA., 2001. Effect of exposure to 900 MHz radiofrequency radiation on intrachromosomal recombination in pKZ1 mice. *Radiat. Res.*, 156, 495-502.
7. Mashevich M., Folkman D., Kesar A., Barbul A., Korenstein R., Jerby E., Avivi L., 2003. Exposure of human peripheral blood lymphocytes to electromagnetic fields associated with cellular phones leads to chromosomal instability. *Bioelectromagnetics*, 24, 82-90.
8. Agarwal A., 2007. Cell phones and male infertility: dissecting the relationship. *Reprod. Biomed.*, 15, 266-270.
9. Lai H. and Singh N. P, Single and double strand DNA breaks in rat brain cells after exposure to radio frequency electromagnetic radiation. *International Journal of Radiation I Biology* 1996; 521.

10. Penafiel, M., Litovitz, T., Krause, D., Desta, A, Mullins, J.M., Role of modulation on the effect of microwaves on ornithine decarboxylase activity in L929 cells, *Bioelectromagnetics* 1997; 18 : 132-141.
11. Hardell L, Nasman A, Pahlson A., Hallquist A. and Mild K.H, Use of cellular telephone & the risk for brain tumours: A case control study. *International Journal of Oncology* 1999;15:11.3.
12. Hocking B, Preliminary report: Symptoms associated with mobile phone use, *Occup Med* 1998; 48 (6) 357.
13. Magras I.N. and Xenos T.D, RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics* 1997;18: 455-461.
14. Jadidi, M., M. Firouzabadi, A. Rashidipour, et al. 2005. Effects of acute exposure to radiation 950 MHz cellular systems consolidation of spatial memory in rats, *Journal of Semnan University of Medical Sciences*, 6(4): 305-311.
15. Yioultzis, T.V., E.P. Kosmanias, T.T. Kosmidou, T.T. Zigiridis, N.V. Kantartzis, T.D. Xenos, et al. 2002. A comparative study of the biological effects of various mobile phone and wireless LAN antennas. *IEEE Transaction on Magnetic*, 38(2): 777-80.
16. Sandstrom, M., J. Wilen, G. Oftedal, M.K. Hansson, 2001. Mobile phone use and subject symptoms. Comparison of symptoms experienced by users of analogue and digital mobile phones. *Occup Med.*, 51(1): 25-35.
17. Oftedal, G., J. Wilen, M. Sandstrom, K.H. Mild, 2000. Symptoms experienced in connection with mobile phone use. *Occup Med.*, 50(4): 237-45.
18. Hocking, B., 1998. Preliminary report: Symptoms associated with mobile phone use. *Occup Med*, 48(6): 357-60.
19. Hocking, B., R. Westerman, 2001. Neurological abnormalities associated with CDMA exposure. *Occup Med.*, 51(6): 410-3.
20. Hocking, B., R. Westerman, 2001. Neurological effects of radiofrequency radiation. *Occup Med.*, 53: 123-7.
21. Stevens RG. Electric power use and breast cancer: a hypothesis. *Am J Epidemiol* 1987. Apr;125(4):556-561.
22. Löscher W, Mevissen M. Animal studies on the role of 50/60-Hertz magnetic fields in carcinogenesis. *Life Sci* 1994;54(21):1531-1543 10.1016/0024-3205(94)90024-8.
23. Brainard GC, Kavet R, Kheifets LI. The relationship between electromagnetic field and light exposures to melatonin and breast cancer risk: a review of the relevant literature. *J Pineal Res* 1999. Mar;26(2):65-100 10.1111/j.1600-079X.1999.tb00568.x.
24. Graham C, Cook MR, Gerkovich MM, Sastre A. Examination of the melatonin hypothesis in women exposed at night to EMF or bright light. *Environ Health Perspect* 2001. May;109(5):501-507 10.1289/ehp.01109501.
25. Ossenkopp KP, Koltek WT, Persinger MA. Prenatal exposure to an extremely low frequency-low intensity rotating magnetic field and increases in thyroid and testicle weight in rats. *Dev Psychobiol* 1972;5(3):275-285 10.1002/dev.420050312.

26. Zagorskaya EA. Endocrine responses to low frequency electromagnetic fields of continuous and intermittent generation. *Kosm Biol Aviakosm Med* 1989;23:4-14.
27. Picazo ML, Miguel MP, Leyton V, Franco P, Varela L, Paniagua R, et al. Long-term effects of ELF magnetic fields on the mouse testis and serum testosterone levels. *Electro-Magnetobiol* 1995;14:127-134.
28. Zagorskaya EA, Klimovitsky VY, Melnichenko VP, Rodina GP, Semyonov SN. The effect of low frequency electromagnetic fields on physiological systems: a review. *Kosm Biol Aviakosm Med* 1990;24:3-11.
29. Forgács Z, Thuróczy G, Paksy K, Szabó LD. Effect of sinusoidal 50 Hz magnetic field on the testosterone production of mouse primary Leydig cell culture. *Bioelectromagnetics* 1998;19(7):429-431 [10.1002/\(SICI\)1521-186X\(1998\)19:7<429::AID-BEM4>3.0.CO;2-3](https://doi.org/10.1002/(SICI)1521-186X(1998)19:7<429::AID-BEM4>3.0.CO;2-3).
30. Burchard JF, Nguyen DH, Block E. Progesterone concentrations during estrous cycle of dairy cows exposed to electric and magnetic fields. *Bioelectromagnetics* 1998;19(7):438-443 [10.1002/\(SICI\)1521-186X\(1998\)19:7<438::AID-BEM6>3.0.CO;2-2](https://doi.org/10.1002/(SICI)1521-186X(1998)19:7<438::AID-BEM6>3.0.CO;2-2).
31. Feria-Velasco A, Castillo-Medina S, Verdugo-Díaz L, Castellanos E, Orozco-Suárez S, Sánchez-Gómez C, et al. Neuronal differentiation of chromaffin cells in vitro, induced by extremely low frequency magnetic fields or nerve growth factor: a histological and ultrastructural comparative study. *J Neurosci Res* 1998. Sep;53(5):569-582 [10.1002/\(SICI\)1097-4547\(19980901\)53:5<569::AID-JNR7>3.0.CO;2-7](https://doi.org/10.1002/(SICI)1097-4547(19980901)53:5<569::AID-JNR7>3.0.CO;2-7).
32. Uscebrka G, Zikic D, Matavulj M, Rajkovic V, Gledic D. Electromagnetic field effects on the morphometrical characteristics of rat adrenal glands. In: Bersani, F. (Ed.), *Electricity and Magnetism in Biology and Medicine*. Kluwer Academic/Plenum Publishers, New York, pp. 485–488, 1999.
33. Matavulj M, Rajkovic V, Uscebrka G, Lukac T, Stevanovic D, Lazetic B. Studies on the possible endocrinological effects of an 50 Hz electromagnetic field. *Centr. Europ. J. Occup. Environ. Med* 2000;6:183-188.
34. Friedhelm, H; (2002) "GSM and UMTS, the Creation of Global Mobile Communications", John Wiley and Sons, Inc., NY.

Original Article

CORRELATION OF SKELETAL MATURATION STAGES OF MP3 WITH ONSET OF MENARCHE AMONGST RURAL AND URBAN SCHOOL GIRLS

Munish C Reddy¹, Ambati Dharanija¹, Shalu Jain¹, Pradeep Raghav¹

1. Department of Orthodontics and Dentofacial Orthopaedics, Swami Vivekanand Subharti University, Meerut (U.P.), India.

ABSTRACT

Introduction: The purpose of this study was to evaluate and correlate skeletal maturation stages of Middle phalanx of third finger (MP3) with the onset of menarche in rural and urban school girls.

Materials and methods: 100 urban school girls and 100 rural school girls were randomly selected comprising of 50 menarche unattained girls and 50 menarche attained girls respectively for each group. For each subject, radiographs of middle phalanx of middle finger and record about onset of menarche were taken after every three months for a total duration of one and half year comprising a total of 6 visits.

Results: The results showed onset of menarche at HI MP3 stage for 50%, HMP3 stage for 47.5% and GMP3 stage for 2.5% in rural girls (subgroup D2) whereas onset of menarche was at HMP3 stage for 41.6%, HI MP3 stage for 50% and GMP3 stage for 8.33% in urban girls (subgroup B2). No significant difference in the MP3 skeletal stage distribution of two groups was seen after applying Chi-square test ($P>0.05$). The mean menarche attaining age of the rural girls was $12.6\pm.84$ years and urban girls was $11.8\pm.79$ years.

Conclusions: The correlation between MP3 skeletal maturation and onset of menarche, established the onset of menarche at H and HI stage for both rural and urban school girls. The results show earlier mean menarche-attaining age for urban girls than rural girls.

Keywords: Middle phalanx third finger (MP3), Menarche, Peak height velocity, Skeletal maturity indicators, Growth

Address for Correspondence:

Dr.Ambati .Dharanija, Junior Resident, Department of orthodontics and dentofacial orthopaedics, Swami Vivekanand Subharti University, Meerut (UP), INDIA,250002

Date of Receiving: 04 August 2020

Date of Acceptance: 27 August 2020

0970-1842/Copyright © JAS 2020

INTRODUCTION

Skeletal maturation is the metamorphosis of the cartilaginous and membranous bones of the foetus to the fully ossified bones of the adult [1] or can be defined as the degree of development of ossification in bone [16]. As a person grows from foetal life through child hood, puberty and finishes growth as a young adult, the part of bone, the epiphysis changes in size and shape. There is initial appearance of epiphysis and subsequent ossification of epiphyseal cartilage and finally its fusion which can be appreciated in the radiographs. These sequences of changes in bone is consistent for every individual since everyone has his own biologic clock.

The introduction of radiography by Roentgen was of great utility in various fields. Hand and wrist radiographs for skeletal maturation assessment were first utilized by Greulich and Pyle [17] followed by Grave and Brown [13], Fishman [11] and Hagg and Taranger [15]. Similarly, lateral cephalograms for skeletal maturation assessment were first utilized by Lamparski [26] followed by Hassel and Farman [16] and Baccettie et al. [5]. Skeletal maturation assessment with the middle phalanx of the third finger (MP3) was studied by Hagg and Taranger [15] which was later modified by Rajgopal and Kansal [27]. They described the various stages of development of the middle phalanx of the third finger as FMP3, FGMP3, GMP3, HMP3, HIMP3 and IMP3 (Fig. 1) and concluded that it is a simple, accurate, easy to interpret, practical and economical method with minimal radiation exposure for making a

decision on treatment timing when compared to Cervical Vertebrae Maturation Index staging.

Menarche is a distinct benchmark for sexual maturation. The age at menarche, an easily recallable event, is an important biologic indicator in assessing the physiologic maturity in girls. The relationship between the growth spurt in body height and onset of menarche has been investigated [25,28]. It has been seen that the peak height velocity is attained a year before menarche [8] and so, it occurs after the initiation of the adolescent growth spurt. It is known to be influenced by genetics, ethnic origins, socioeconomic status, general living conditions, and environmental factors [19].

The identification of skeletal maturation levels and its correlation with onset of menarche provides a very useful means of identifying specific periods along the path of adolescent growth that provides a new dimension for evaluating general and individual growth including facial growth with the help of middle phalanx of third finger (MP3) radiographs. This identification of peak growth period helps in treating orthopaedic problems such as mandibular retrognathism effectively by myofunctional appliance therapy. These are designed to alter the position of mandible both sagittally & vertically inducing lengthening of the mandible and stimulating increased growth at the condylar cartilage. Hence the aim of this study is to evaluate and correlate skeletal maturation stages of MP3 (Middle phalanx of third finger) with the onset of menarche in rural and urban school girls.

MATERIALS AND METHODS

This was a prospective longitudinal study consisting of 200 girls randomly divided into 100 urban school girls (Group I) and 100 rural school girls (Group II). 100 urban girls (Group I) further consisted of 50 menarche unattained girls (Sub group B) and 50 menarche attained girls (Sub group A). Out of 50 menarche unattained urban girls (Sub group B) 25 remained unattained (Subgroup B1), 24 had attained menarche (Subgroup B2) and there was 1 drop out. Similarly, 100 rural girls (Group II) further consisted of 50 menarche unattained girls (Sub group D) and 50 menarche attained girls (Sub group C) Out of 50 menarche unattained rural girls (Sub group D) 10 remained unattained (Subgroup D1) and 40 had attained menarche (Subgroup D2). The age group of the sample was taken from 10 years to 14 years. A written consent from the parents of school children was taken for taking third finger Xray for the study.

For each subject, radiographs of middle phalanx of middle finger and record about onset of menarche were taken after every three months and were taken for total duration of one and half year comprising total of 6 visits. For taking X-ray, armamentarium used for the study was Portable X ray machine (Genoray portable X-ray system Power output: 180W, Tube Voltage: 60KV, Tube Current: 2mA, Focal Spot: 0.8mm, Exposure time set: 0.1-2.0 sec, Power requirement: 22VDC), RVG (Digital Radiovisiography, Kodak RVG 5100 system resolution: 14 lp/mm.) and customized portable X ray box.

For taking X-ray, the RVG sensor was placed over the finger and sensor stabilizing unit in the X ray box. Then the moving glass slide was placed over the sensor and individual was asked to pass her hand inside the portable X-ray box keeping their third finger on glass slide which was placed over the stand. Then this was exposed to X-rays by passing the X-ray tube above it. The MP3 Xrays were evaluated and staged according to the system given by Rajgopal and Kansal [27] (Fig. 1). Our study showed that Spearman's rank correlation of interobserver reliability ranged from 0.997 to 0.999 for the MP3 staging system. The correlation for intraobserver reliability was 1.000 and all correlations were found to be statistically significant.

Descriptive statistics were used to calculate the means and standard deviations of the chronological age of onset of menarche. Unpaired T test for comparison of mean menarche attaining age and for comparison of MP3 stages at onset of menarche between rural and urban girls were carried out.

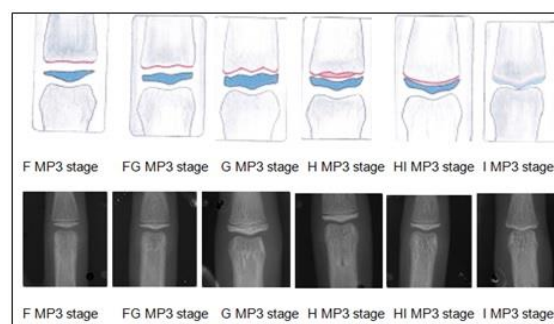


Fig. 1. Skeletal developmental stages of the middle phalanx of the third finger.

RESULTS

The mean age of the girls in our study was 12.19 ± 1.01 years. The mean age of the rural girls (Group I) was 12.24 ± 1.04 years and urban girls (Group II) was 12.15 ± 1 years (Table 1 & Fig. 2). The mean menarche attaining age of the rural girls was 12.6 ± 0.84 years and urban girls was 11.8 ± 0.79 years (Table 2 & Fig. 3).

The age of attaining menarche was higher in rural girls (subgroup D2) as compared to urban girls (subgroup B2) and the difference was statistically significant ($P < 0.01$) as shown in (Table 2 and Fig. 3).

When comparing the menarche attaining age at various modified skeletal MP3 maturation stages for rural and urban group i.e. subgroup D2 and B2, it showed onset of menarche at HI MP3 stage for 50%, HMP3 stage for 47.5% and GMP3 stage for 2.5% in rural girls (subgroup D2) whereas onset of menarche was at HMP3 stage for 41.6%, HIMP3 stage for 50% and GMP3 stage for 8.33% in urban girls (subgroup B2).

No significant difference in the MP3 skeletal stage distribution of two groups was seen after applying Chi-square test ($P > 0.05$). (Table 3 and Fig. 4).

The urban and rural girls who had already attained menarche (subgroup C and D) showed HI and I MP3 stages and unattained menarche girls (subgroup B1 & D1) showed FG MP3 and G MP3 stage.

DISCUSSION

The knowledge of growth, its effect on development of dentofacial complex in particular and the body in general leads to early prevention and interception of dentofacial deformities. This further depends upon accurate interpretation of the inherent facio-skeletal pattern and overall growth and development.

Since several studies [2, 6, 27, 22, 18] showed high correlation of MP3 developmental stages when compared with CVMI stages or hand-wrist assessment or with dental maturity indicators, so MP3 stages can be used as sole indicator for skeletal maturation assessment of an individual. MP3 radiograph show high degree of clarity, with no superimposition of bones or variations in posture as in evaluation of the cervical vertebrae. They show discrete, easily identifiable stages of development, unlike the more subtle changes in CVMI stages as described by Raj Gopal Kansal [27]. They show good reliability and reproducibility [27]. CVMI methods requires elaborate equipment and the radiation exposure time and dose are also high. Digital radiography was used instead of using conventional film in the present study since Abdel-Kader 1998 [3] concluded that digitized radiographic images of the MP3 have five times less exposure than conventional approach. These digital images also increase the scope for cross-sectional and longitudinal studies.

The age of attainment of menarche is influenced by various factors such as Socio-economic status, diet, nutrition, genetic factors

and physical activity [19]. The mean menarche attaining age for rural girls was 12.60 ± 0.84 years (subgroup D2) and 11.8 ± 0.79 years for urban girls (subgroup B2) showing statistically significant difference. The mean rural menarche attaining age (12.04 ± 0.89 years) was in accordance with study done by Banerjee I et al (2007) [4], Khatoon (2011) [19], Khadgawat et al (2016) [20] and Pandey M and Pradhan A (2017) [23] in which the mean age at menarche was 12.3 years, 12.43 ± 1.49 years, 12.4 years and 12.52 years respectively. Whereas the present results are contrary to the study of Pathak et al [24].

This reduction of menarche attaining age in our study was due to improvement in the field of scientific and technological advancement, economic growth, agriculture, food supply, public health systems and hygiene, which markedly help to improve the general health, nutritional level and over all standard of living of the population when compared to past several decades.

The results show earlier mean menarche attaining age for urban girls (subgroup B2 11.8 ± 0.79 years) than mean menarche attaining age for rural girls of (12.60 ± 0.84 years in subgroup D2) showing statistically significant difference. This is in accordance with the study of Chidiebere et al [9] and Khatoon et al [19]. Since rural girls do more physical activity, have low socioeconomic status and are less nourished hence show less fat accumulation. Thus, there is release of androgen hormones (aldosterone) which delays menarche.

When comparison was done for menarche attaining age at various modified skeletal MP3 maturation stages given by Rajagopal and Kansal [27] for rural and urban group i.e. subgroup D2 and B2. It was seen that menarche was attained in HI MP3 stage for 50%, HMP3 stage for 47.5% and GMP3 stage for 2.5% in rural girls (subgroup D2) whereas menarche was attained in HMP3 stage for 41.6%, HIMP3 stage for 50% and GMP3 stage for 8.33% in urban girls (subgroup B2). The increased per cent of earlier skeletal MP3 stage in urban girl (sub group B2) compared to rural girl (sub group D2) attributed to earlier menarche attaining age in urban girls compared to rural girls. According to Rajagopal and Kansal [27] modified 6 MP3 stage can be compared to 6 CVMI stages. Therefore, our results are in accordance to the study of Moradinejad et al where highest incidence rates of menarche were noted in the fourth and fifth stages of the development of cervical vertebrae.

The results are in contradictory to the study of Vichare et in which Menarche occurred during SMI 7-8 and CVM Stage III-IV which may be due to overall poor reproducibility of the CVM method according to Gabriel et al [14], Baptista et al [7] and Nestman et al [21]. So there is variation in staging done from MP3 stage.

CONCLUSION

Several studies [10,12,29] support the hypothesis that the peak height velocity is attained one year before menarche and then it

Age (in years)	Group		Total (n=124)	P value
	Rural(n=94)	Urban(n=94)		
10-11 years	16 (17.0%)	13(13.8%)	29 (15.5%)	0.615
11-12 years	16 (17.0%)	24 (25.5%)	40 (21.3%)	
12-13 years	38 (40.5%)	31 (32.9%)	69 (36.7%)	
>13 years	24 (25.5%)	26(27.6%)	50 (26.5%)	
Total	94 (100.00%)	94(100.00%)	188 (100.00%)	
Mean ± Stdev	12.24 ± 1.04	12.15 ± 1	12.19 ± 1.01	0.787
Median (IQR)	12.49 (11.519 - 13.014)	12.38 (11.253 - 13.116)	12.43 (11.352 - 13.036)	

Table 1. Comparison of age distribution between rural (Group I) and urban (Group II) girls

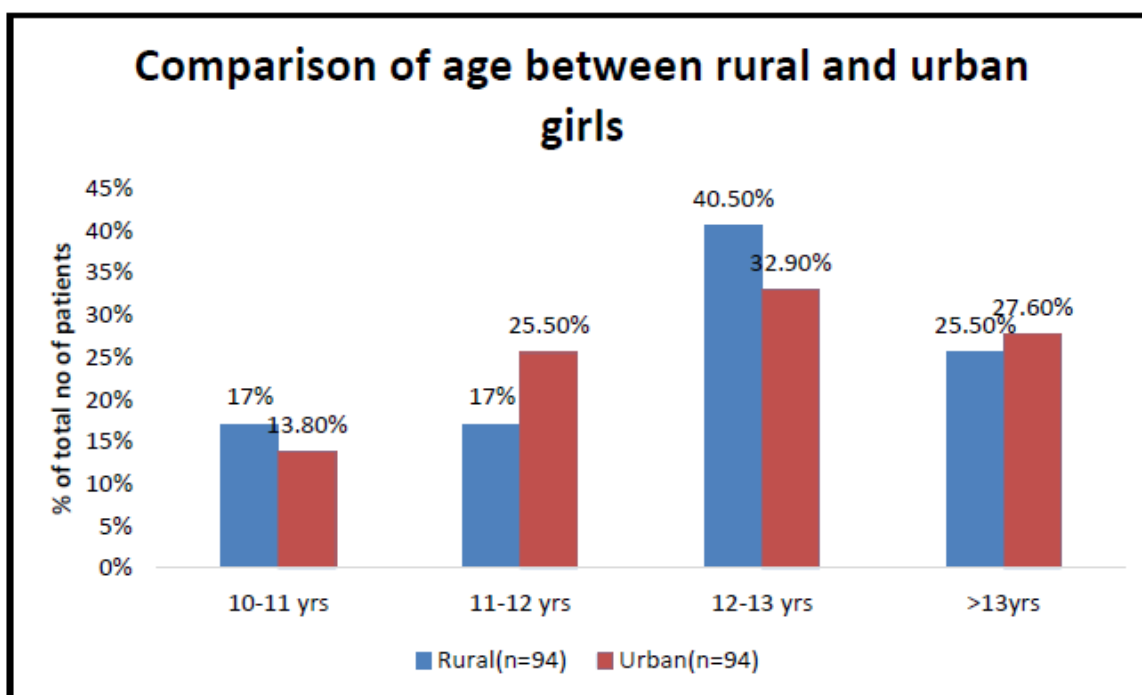


Fig. 2. Comparison of age distribution between rural (Group I) and urban (Group II) girls

Menarche attaining age in years	Rural (n=40)		Urban (n=24)		P value
	Mean ± Stdev	Median (IQR)	Mean ± Stdev	Median (IQR)	
	12.60 ± 0.85	12.50(12.229 - 13.104)	11.91 ± 0.79	11.87(11.167 - 12.458)	

Table 2. Comparison of menarche attaining age between rural and urban girls (subgroup B2 & subgroup D2)

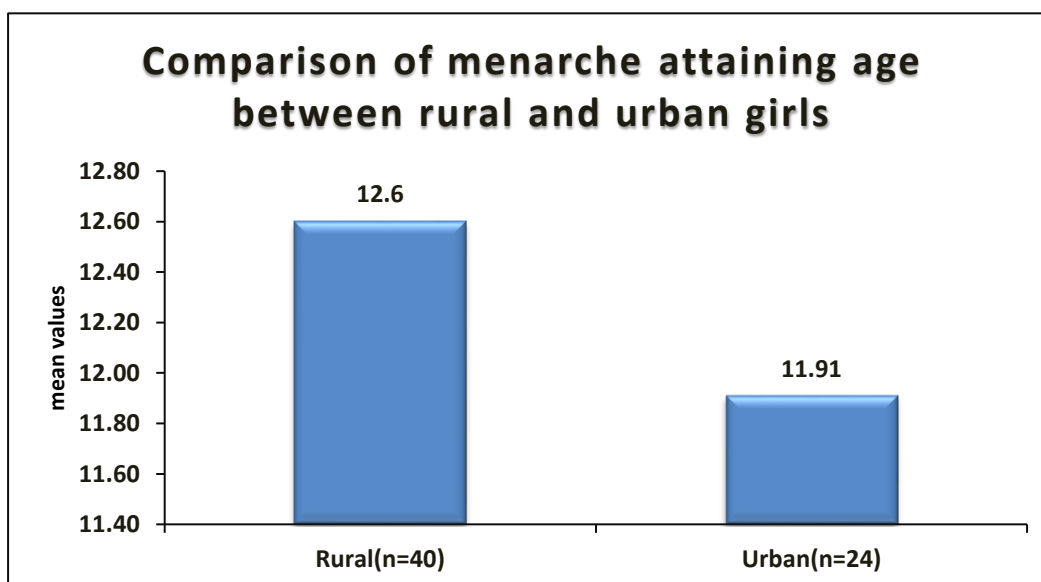


Fig. 3. Comparison of menarche attaining age between rural and urban girls (subgroup B2 & subgroup D2)

MP3 Stages	Group		Total	P value
	Rural(n=40)	Urban(n=24)		
G MP3	1 (2.5%)	2 (8.33%)	3 (4.69%)	0.514
H MP3	19 (47.5%)	12 (50.00%)	31 (48.44%)	
HI MP3	20 (50.00%)	10 (41.67%)	30 (46.87%)	
Total	40 (100.00%)	24 (100.00%)	64 (100.00%)	

Table 3. Comparison of MP3 Stages at onset of menarche between rural and urban girls (subgroup D2 & B2)

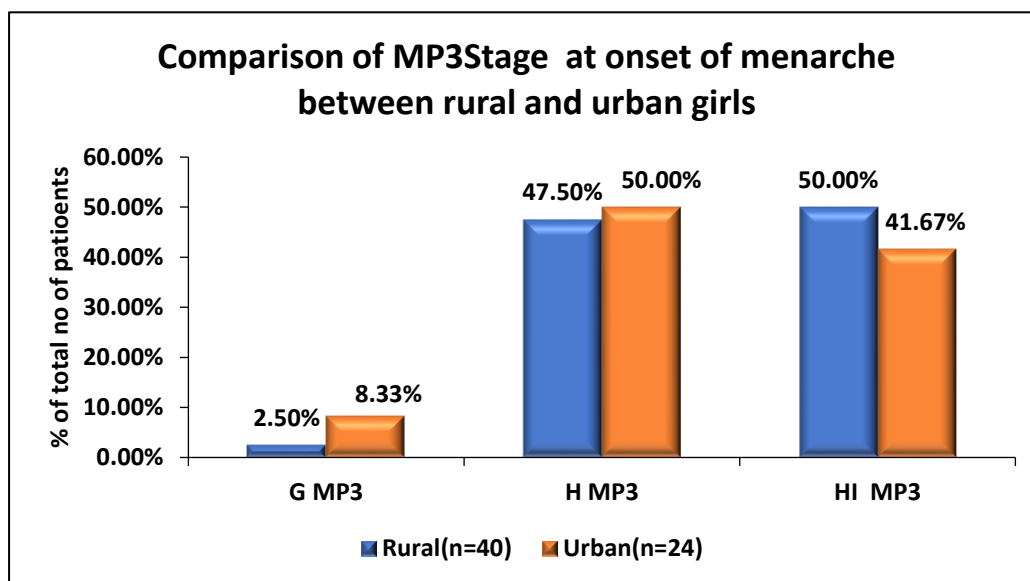


Fig. 4. Comparison of MP3 Stages at onset of menarche between rural and urban girls (subgroup D2 & B2)

slows down thereafter and stops within 1 year after menarche because of the closing of epiphyses of long bones. In our study the correlation between MP3 skeletal maturation and onset of menarche showed onset of menarche at H and HI stage, So this helps in timing the functional appliance which are most effect when given at mandible's maximum growth potential and after onset of menarche. After HI MP3 stage, the treatment planning moves towards orthognathic surgeries. Hence correlation of skeletal MP3 stages with onset of menarche helps in identifying growth status of a person by diagnosing MP3 radiographs which further helps in deciding various treatment modalities.

REFERENCES

1. Acheson RM (1954) A method of assessing skeletal maturity from radiographs: a report from the Oxford Child Health Survey. *J Anat* 88: 498–508.
2. A Tikku T, Khanna R, Sachan K, Agrawal S. Correlation of improved version of cervical vertebral maturation indicator with other growth maturity indicators. *J Indian Orthod Soc.* 2013;47(1):28-32. *Cad Forensic Med.* 2011;33(5):971-3.
3. Abdel-Kader HM. The potential of digital dental radiography in recording the adductor sesamoid and the MP3 stages. *J Orthod.* 1999;26(4):291-4.
4. Banerjee I, Chakraborty S, Bhattacharya NG, Bandopadhyay S, Saiyed HN, Mukherjee D. A cohort study of correlation between body mass index and age at menarche in healthy Bengali girls. *J Indian Med Assoc.* 2007;105(2):75-8.
5. Baccetti T, Franchi L, McNamara Jr JA. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod.* 2005;11(3):119-29.
6. Bala M, Pathak A, Jain RL. Assessment of skeletal age using MP 3 and hand-wrist radiographs and its correlation with dental and chronological ages in children. *J Indian Soc Pedod Prev Dent.* 2010;28(2):95-102.

7. Baptista RS, Quaglio CL, Mourad LM, Hummel AD, Caetano CA, Ortolani CL, et al. A semi-automated method for bone age assessment using cervical vertebral maturation. *Angle Orthod.* 2012;82(4):658-62.
8. Chang SH, Tzeng SJ, Cheng JY, Chie WC. Height and weight change across menarche of schoolgirls with early menarche. *Arch Pediatr Adolesc Med.* 2000;154(9):880-4.
9. Chidiebere I, Ikaroaha M, Chidi I, Dennis A, Okoye M, Golden I et al. Menarchial Age of Secondary School Girls in Urban and Rural Areas of Rivers State, Nigeria. *J Health Allied Scs.* 2005;4(2):56-63.
10. Chang SH, Tzeng SJ, Cheng JY, Chie WC. Height and weight change across menarche of schoolgirls with early menarche. *Arch Pediatr Adolesc Med.* 2000;154(9):880-4.
11. Fishman LS. Radiographic evaluation of skeletal maturation: A clinically oriented method based on hand-wrist films. *Angle Orthod.* 1982;52(2):88-112.
12. Forbes GB. Body size and composition of premenarchal girls. *Am J Dis Child.* 1992;146(5):63-6.
13. Grave KC, Brown T. Skeletal ossification and the adolescent growth spurt. *Am J Orthod.* 1976;69(6):611-9.
14. Gabriel DB, Southard KA, Qian F, Marshall SD, Franciscus RG, Southard TE. Cervical vertebrae maturation method: Poor reproducibility. *Am J Orthod Dentofacial Orthop.* 2009;136(1):478-84.
15. Hagg U, Taranger J. Maturation indicators and the pubertal growth spurt. *Am J Orthod.* 1982;82(4):299-309.
16. Hassel B, Farman A. Skeletal maturation evaluation using cervical vertebrae. *Am J Orthod Dentofacial Orthop.* 1995;107(2):58-66.
17. Iannaccone G, Greulich WW and Pyle SI: Radiographic atlas of skeletal development of the hand and wrist. Stanford University Press, Stanford, California, 1959. *Acta Genet Med Gemellol.* 1959;8(4):513-8.
18. Joshi M, Rao D, Shubha AB, Panwar S, Franklin S. A radiographic assessment of the correlation between the calcification stages of the mandibular second molar and the middle phalanx of the third finger of 9–16 years old children. *Egypt J Forensic Sci.* 2018;8(1):35.
19. Khatoon T, Verma AK, Kumari R, Rupani R, Singh M, Rizvi A. Age at menarche and affecting bio-social factors among the girls of Lucknow, Uttar Pradesh. *J Indian Acad Forensic Med.* 2011;33(5):971-3.
20. Khadgawat R, Marwaha RK, Mehan N, Surana V, Dabas A, Sreenivas V et al. Age of onset of puberty in apparently healthy school girls from Northern India. *Indian Pediatr.* 2016;53(5):383-7.
21. Nestman TS, Marshall SD, Qian F, Holton N, Franciscus RG, Southard TE. Cervical vertebrae maturation method morphologic criteria: Poor reproducibility. *Am J Orthod Dentofacial Orthop.* 2011;140(7):182-8.
22. Prasad M, Ganji VS, George SA, Talapaneni AK, Shetty SK. A comparison between cervical vertebrae and modified MP3 stages for the assessment of skeletal maturity. *J Nat Sci Biol Med.* 2013;4(1):74-7.
23. Pandey M, Pradhan A. Age of attainment of menarche and factors affecting it amongst school girls of Gangtok, Sikkim, India. *Int J Contemp Pediatr.* 2017;4(6):187-92.
24. Pathak PK, Tripathi N, Subramanian SV. Secular trends in menarcheal age in India-evidence from the Indian human development survey. *Plos One.* 2014;9(11):1-13.
25. Richey HG. The relation of accelerated, normal and retarded puberty to the height and weight of school children. *Monographs of the Society for Research in Child Development.* 1937;2(1):i-67.

26. Roman PS, Palma JC, Oteo MD, Nevado E. Skeletal maturation determined by cervical vertebrae development. *Eur J Orthod.* 2002;24(3):303-11.
27. Rajgopal R, Kansal S. A Comparison of modified MP3 stages and the cervical vertebrae as a growth indicator. *Am J Orthod Dentofacial Orthop.* 2002;36(3):398-406.
28. St George IM, Williams S, Silva PA. Body size and the menarche: the Dunedin study. *J Adolesc Health.* 1994;15(2):573-6.
29. Tanner JM, Davis PSW. Clinical longitudinal standards for height and height velocity for North American children. *J Pediatr.* 1985;107(3):317-29.

Original Article

SIGNIFICANCE OF SACRAL INDEX IN ESTIMATION OF SEX IN NORTH INDIAN POPULATION

**Kanchan Bisht¹, Rakesh K. Verma¹, Archana Rani¹,
Navneet Kumar¹, Baibhav Bhandari²**

1. Department of Anatomy, King George's Medical University, Lucknow, Uttar Pradesh, India
2. Urban Community Health Centre, N.K Road, Hazratganj, Lucknow, Uttar Pradesh, India

ABSTRACT

Introduction: For the assessment of sexual dimorphism of human skeleton, pelvis has been used with great accuracy by anthropologists and forensic experts. Sacrum, being an integral part of pelvis, has therefore gained importance. Among the various parameters of sacrum, sacral index is the most reliable one, calculated by the formula: $\text{Sacral index} = \frac{\text{max breadth} \times 100}{\text{max length of sacrum}}$. This study aimed to determine the significance of sacral index in estimation of sex in north Indian population.

Materials and methods: For the present study, 35 dry human sacrum bones were obtained from the Department of Anatomy, KGMU, Lucknow, out of which 32, free of deformity, were used in study. The bones were first separated as male and female on the basis of their gross features. Maximum length and breadth of sacra were measured using digital sliding Vernier calliper and sacral index was calculated.

Results: Mean sacral index was significantly higher in females (109.52) as compared to males (92.37). Sex determination done on the basis of gross features were comparable to that done by calculation of sacral index, except in sacrum no. 5,13,14,15 &16. Sacrum no. 5,13,14 &15 were more curved forwards (female feature) while their sacral indices were much lesser (male feature). Sacrum no. 16 had a uniform curvature (male feature) while its sacral index was >105 (female feature). Sacrum no. 16 also had only 3 dorsal and ventral foramina, which was a variation.

Conclusions: Sacral index is a reliable criterion for sex determination, useful for anatomical, medicolegal and anthropological purposes.

Keywords: Dimorphism, Sacral index, Foramina, Variation, Pelvis, Anthropology

Address for Correspondence:

Dr Rakesh K Verma, Additional Professor, Department of Anatomy, King George Medical University, Lucknow, Uttar Pradesh, Mobile no: 9455252213 Email - rakesh_gsvm@yahoo.co.in

Date of Receiving: 12 July 2020

Date of Acceptance: 06 August 2020

0970-1842/Copyright © JAS 2020

INTRODUCTION

Sacrum is a flattened triangular bone formed by the fusion of five sacral vertebrae. It forms the posterosuperior part of bony pelvis [1]. As stated by Krogman, accuracy of sex determination can be 95% with pelvis alone. Sacrum being an integral part of pelvis has thus gained importance [2]. However it is still recommended to use multiple bones for sex determination [3]. Among the various parameters of sacrum, sacral index method has always been the most reliable one [4]. Sacral index is calculated by multiplying the breadth of sacrum with 100 and then dividing with length of the sacrum [3].

MATERIALS AND METHODS

For the present study, 35 dry human sacrum bones were obtained from the Department of Anatomy, King George's Medical University, Lucknow, Uttar Pradesh, out of which 32 were used which were free of deformity. The bones were first separated as male or female sacra on the basis of gross features. Maximum length and breadth of sacra were measured using Vernier callipers and sacral index was calculated using the formula:

Sacral index = $\frac{\text{maximum breadth} \times 100}{\text{maximum length}}$

Maximum length is the distance between middle points on anterosuperior margins of promontory to middle of anteroinferior margin of last sacral vertebrae (Fig. 1). Maximum breadth is the distance between the most distant points on sides of ala of sacrum (Fig. 2).



Fig. 1. Measurement of maximum length of sacrum using Vernier calliper.



Fig. 2. Measurement of maximum breadth of sacrum using Vernier calliper.

RESULTS

In this study, mean maximum sacral length of males (111.53) was found to be greater than that of females (93.46). Mean maximum sacral breadth was more or less equal in males and females (102.54 in males and 102.05 in females). However, mean sacral index was observed to be greater in females (109.52) than that in males (92.37). From our study, we can say that sex determination done on the basis of gross features were comparable to that done by calculation of sacral index, except in five sacra.

Sacra no. 5, 13, 14 & 15 were more curved forwards (which is a female feature) while their sacral indices were much lesser (which suggests male feature). Sacrum no. 16 had a uniform curvature (male feature) while its sacral index was >105 (female feature). This sacrum had only 3 dorsal and ventral sacral foramina, which was a unique variation.

DISCUSSION

Although various parameters of sacrum can be used for sex estimation, sacral index has always been the most reliable one. In our study, we observed the mean sacral length of males to be greater than that of females, which is in accordance with various studies done in many



Fig. 3. Bones no. 33, 34 & 35 fragmented and deformed



Fig. 4. Sacra with sacral indices not comparable to their gross features



Fig. 5. Sacrum with abnormal sacral foramina

different populations. Increased incidence of six-piece sacrum in males has been proposed to be one of the causes behind the same [3].

Maddikunta et al. recorded the mean sacral breadth in males to be 104.2 and 103.4 in females in his study on the population of Andhra Pradesh [5]. Ravichandran et al. carried out a study in Tamil Nadu and found this value to be 93.7 in males and 92.91 in females [3]. A similar study done by Yadav et al. in Maharashtrian population also observed comparable values of mean sacral breadth in males (102.93) and females (104.7) [1]. Values obtained by Somesh et al. in Mangalore were

also not very much different (105.21 in males and 102.66 in females)[6]. Two different studies were conducted in Madhya Pradesh in the same year 2016 in which one conducted by Dubey et al. on 60 sacra found almost similar mean sacral breadth in males and females [2]. In the second one, conducted by Punase et al. on 77 sacra, mean sacral breadth of females was found to be significantly higher than that of males (113.27 in females and 105.05 in males) [7].

Findings of Masih et al. and Parashuram et al. in different studies performed in Rajasthan and Karnataka, also agree with that of our present study, showing almost similar mean sacral breadth in both the sexes [4,8]. However, Sachdeva et al. in 2011, found a significantly higher mean breadth of sacra in males than that in females, which is in contrast to our present study [9].

All the above-mentioned studies, however, are in accordance with our study if we compare the sacral index of both the sexes, implying that

Study	Place	Total bones	Males (L)	Males (B)	Females (L)	Females (B)	SI in males	SI in females
Sachdeva et al.	Amritsar	50	104.1	111.8	91.8	104.4	100.24	111.74
Maddikunta et	Andhra	60	113.9	104.2	90	103.4	91.8	116.3
Ravichandran et	Tamil Nadu	123	97.8	93.7	90.96	92.91	96.32	102.29
Yadav et al.	Maharashtra	140	104.7	102.93	92.6	104.7	98.44	113.23
Somesh et al.	Mangalore	87	113.88	105.21	91.29	102.66	92.71	113.06
Dubey et al.	Madhya	60	113.5	105.85	94.6	104.33	93.8	110.63
Punase et al.	Madhya	77	111.86	105.05	99.10	113.27	95.66	115.10
Masih et al.	Rajasthan	75	107.44	104.63	97.88	102.77	97.88	112.69
Parashuram et	Karnataka	100	120.13	124.61	103.78	118.45	101.26	116.18
Present study	Lucknow	32	111.53	102.54	93.46	102.05	92.37	109.52

Table 1. Comparative analysis of sacral measurements

sacral index of females is almost always higher than that of males [10,11].

CONCLUSION

It is evident from the present study that sacral index is a reliable and significant criterion for estimation of sex in a given population. However, it is still recommended to use multiple bones and parameters for this purpose. Thus, regional and racial differences in sacrum along with the sacral index can be useful for anatomical, medico-legal and anthropological purposes.

REFERENCES

1. Yadav N, Saini K, Patil K. Determination of sex using dry adult human sacrum- a morphometric study. *Int J Cur Res.*2015;7(3):22-27.
2. Dubey A, Roy SS, Verma S. *International Journal of Anatomy and Research.* 2016; 4(1):2096-98.
3. Ravichandran D, Shanthi KC, Shankar K, Chandra H. A study on sacral index in Tamil Nadu and Andhra Pradesh population of Southern India. *Journal of Clinical and Diagnostic Research.* 2013;7(9): 1833-1834
4. Masih WF, Singh AP, Rathore KB. Significance of sacral index in estimation of sex of sacrum Inhadoti Rajasthan. *Acta Scientific Dental Sciences.* 2017; 02-05.
5. Maddikunta V, Ravinder M. *International Journal of Research in Medical Sciences.*2014;2(1):164-174.
6. Somesh MS, Sridevi HB, Murlimanju BV. An anatomical study of adult sacrum with its emphasis on its sexual dimorphism in South Indian population. 2015;3(4):1491-96.
7. Punase VK, Agrawal NL, Shrivastava SK. A morphometric study on dry adult human sacrum for determination of sex. *Paripex Indian journal of research.* 2016;5(3):368-9.
8. Parashuram R, Dakshayani KR, Manjunatha SN. A study of sacral index: A basis for determination of sex of sacrum. *Int J Anat Res.*2018; 6(4.2):5873-77.
9. Sachdeva K, Singla RK, Kalsey G, Sharma G. Role of sacrum in sexual dimorphism- A morphometric study. *J Indian Acad Forensic Med.* 2011; 33(3):206-210.
10. Arora AK, Gupta P, Mahajan S, Kapoor SS. Significance of sacral index in estimation of sex in sacra of cadavers in Punjab. *J Indian Acad Forensic Med.*32(2).
11. Patel S, Nigam M, Mishra P, Waghmare CS. A study of sacral index and its interpretation in sex determination in Madhya Pradesh. *J Indian Acad Forensic Med.* 2014; 36(2).

Case Report

ACCESSORY PERONEUS BREVIS TENDON - A CASE REPORT

Mahendra Kathole¹, Krishna S Patil¹, Shobhit Raizaday², Sadiq Syed³

1. Department of Anatomy, VMMC & Safdarjung Hospital, New Delhi, India

2. Department of Anatomy, Subharti Medical College, Meerut, India

3. Department of Anatomy, Government Medical College, Miraj, India

ABSTRACT

Introduction: The development of limb musculature takes place between the fifth and seventh weeks of intrauterine life. The genes MYO-D and MYF5 regulate the limb musculature development and any defect in these may lead to either a partial or complete loss or an addition to the normal muscle morphology. This case report presents the observation of an accessory tendon of the Peroneus brevis muscle in the left lower limb of a 70 year old male cadaver during the routine dissection for undergraduate students at Government Medical College, Miraj. The variant insertion of the Peroneus brevis tendon on the calcaneal tubercle is clinically important to note in cases of lateral ankle pain and instability. The presence of an accessory tendon of the peroneus brevis muscle may also be a cause of the longitudinal splitting of the muscle which should be taken into consideration while making a diagnosis and planning surgeries around the lateral aspect of the ankle.

Keywords: Peroneus brevis, Accessory tendon, Ankle pain

INTRODUCTION

The peroneus brevis muscle is a small and short muscle which lies under cover of peroneus longus muscle. It takes origin from the lateral surface of the body of the fibula in the lower two-thirds and the peroneus longus muscle lies medial to it in the peroneal compartment of the leg. The tendon of peroneus brevis runs behind the lateral malleolus along with the peroneus longus

tendon and lies in front of the peroneus longus tendons. Peroneus brevis tendon runs downward, forward and on lateral side of the calcaneus bone, in close relation to the calcaneal tubercle and terminates by inserting on the lateral side of the base of the fifth metatarsal tuberosity. The peroneus brevis muscle is a weak plantar flexor and also helps in eversion of the foot and is supplied by the superficial peroneal nerve [1].

Address for Correspondence:

Dr Krishna S. Patil, Post Graduate Student, Department of Anatomy, VMMC & Safdarjung Hospital, New Delhi
Mob: 9738679296 Email - drkrishnaspatil@gmail.com

Date of Receiving: 23 August 2020

Date of Acceptance: 16 September 2020

0970-1842/Copyright © JAS 2020

Embryology: Limb development begins between the 5th and 7th weeks of intrauterine life where in most of the limb muscles develop from the paraxial mesoderm under the influence of specific genes MYO-D and MYF5. Any factors affecting them may lead to various anomalies. For example, the partial or complete absence of muscles [2].

OBSERVATIONS

During the routine academic cadaveric dissection for undergraduate students at Government Medical College, Miraj, we found an accessory tendon of Peroneus Brevis muscle in the left lower limb of a 70 years old male cadaver (Fig. 1). This accessory tendon originated 2cm proximal to the tip of the lateral malleolus. It was lying between the main tendon of peroneus brevis anteriorly and peroneus longus tendon posteriorly. It descended on the lateral surface of calcaneal bone and inserted on the peroneal tubercle measuring 3.5cm in length and 0.4cm in thickness. There was no additional slip to any other tendons or bone. Peroneus brevis in the right leg was normal.

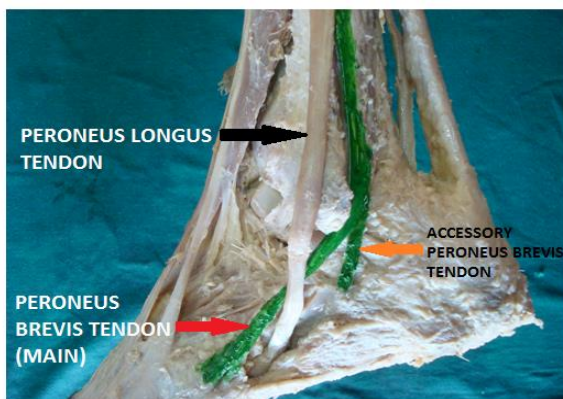


Fig. 1. Dissected left ankle showing accessory Peronius brevis muscle coloured green

DISCUSSION

The variations in insertion and multiple split tendons are due to a developmental anomaly. Many authors have reported their finding based on how many tendons does the peroneus brevis muscle has. It may be a single tendon with abnormal insertion or may have multiple tendons, inserting at different aspects of the foot bones.

Similar to our case report many authors reported the accessory and other variants of peroneus brevis muscle. Cecava et al, reported a congenital variant insertion of the peroneus brevis tendon on the calcaneal peroneal tubercle with the absence of the tendon distal to the calcaneus. It was observed incidentally in a 24-year old male in magnetic resonance imaging for the evaluation of pain for a suspected ligament injury [3].

Clarkson et al, reported two variants of the peroneus muscle in a 70-year-old white male cadaver and termed them peroneocuboideus muscle and peroneocalcaneocuboideus muscle which were found in the right and left leg respectively and both muscles inserted

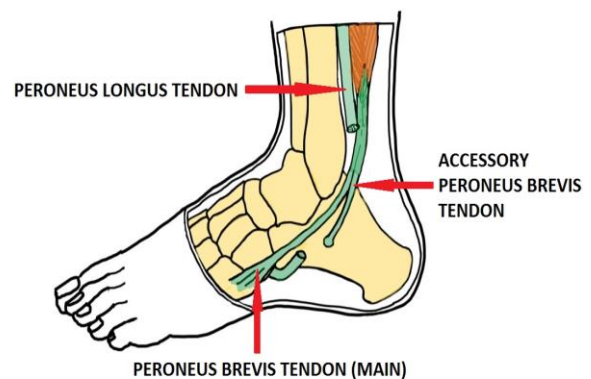


Fig. 2. Schematic representation of Accessory Peroneus brevis Tendon Inserting on peroneal tubercle

onto the distal lip of the peroneal sulcus of the cuboid bone [4].

Taser et al observed a longitudinal tear in the peroneus brevis tendon and commented that one of the possible causes of the longitudinal tear in the peroneus brevis tendon can be due to an anomalous peroneus tertius muscle with its different origin and insertion points, causing a change in the ankle motion mechanism [5]. It is important to recognise the normal variants of the peroneal tendons, peroneus brevis tendon pseudosubluxation, a bifurcated peroneus brevis tendon, the presence of os perineum and insertion of other accessory muscle-tendon into the peroneus brevis tendon [6].

Prevalence of an accessory muscle (peroneus quartus) was studied by Cheung et al using 136 consecutive ankle magnetic resonance images. They found 14 cases (10%) having an accessory muscle and the tendon was lying medial and posterior to the other peroneal tendons. The muscle had the variable site of insertion on the peroneus longus tendon, peroneus brevis tendon, calcaneus, and cuboid bone [7].

Accessory tendon inserted on the peroneal tubercle can be used for reconstructive procedures about the lateral aspect of the ankle, especially in anterior dislocation of the peroneal tendons and reconstruction of lateral ligaments [8].

Saupe et al, studied the prevalence of accessory peroneus quartus muscles in 65 volunteers consisting 30 males and 35 females whose age range was between 23–70 years using MR images. 11 (17%) cases had the

peroneus quartus muscle, 19% of the cases had the musculotendinous junctions of the peroneus brevis muscle. They concluded that anatomic variants may predispose for the peroneal tendon disorders [9].

CONCLUSION

The Variant congenital insertion of the peroneus brevis tendon on the calcaneal tubercle should be acknowledged. The lateral ankle pain, stenosis, ankle instability, fibular tenosynovitis, subluxation of the peroneal tendons, and longitudinal splitting of the fibularis brevis tendon in radiologic and case studies may be due to presence of a variant peroneus muscles. Therefore, radiologists, clinicians, and surgeons should take into consideration these variations of peroneus brevis muscle while interpreting radiographs, considering various diagnoses, and planning a surgical intervention in and around the lateral ankle.

REFERENCES

1. Standring S. Gray's Anatomy: The Anatomical basis of Clinical practice. 41st ed., London: Churchill Livingstone 2016;40:1408.
2. Sadler TW. Langman's medical embryology. 12th ed., Philadelphia : Wolters Kluwer Health/Lippincott Williams & Wilkins 2012:199-207.
3. Cecava ND, Campbell SE. Peroneus Brevis Tendon Variant Insertion on the Calcaneus. J Radiol Case Rep. 2015;9(5):22-29.
4. Clarkson MJ, Fox JN, Atsas S, Daney BT, Dodson SC, Lambert HW. Clinical implications of novel variants of the fibularis

- (peroneus) quartus muscle inserting onto the cuboid bone: peroneocuboideus and peroneocalcaneocuboideus. *J Foot Ankle Surg.* 2013;52(1):118-121.
5. Taşer F, Shafiq Q, Toker S. Coexistence of anomalous m. peroneus tertius and longitudinal tear in the m. peroneus brevis tendon. *Eklemler Hastalıkları Cerrahisi.* 2009;20(3):165-168.
 6. Wang XT, Rosenberg ZS, Mechlin MB, Schweitzer ME. Normal variants and diseases of the peroneal tendons and superior peroneal retinaculum: MR imaging features [published correction appears in *Radiographics.* 2005 Sep-Oct;25(5):1436].
 7. Cheung YY, Rosenberg ZS, Ramsinghani R, Beltran J, Jahss MH. Peroneus quartus muscle: MR imaging features. *Radiology.* 1997;202(3):745-750.
 8. Sobel M, Levy ME, Bohne WH. Congenital variations of the peroneus quartus muscle: an anatomic study [published correction appears in *Foot Ankle* 1991 Apr;11(5):342]. *Foot Ankle.* 1990;11(2):81-89.
 9. Saupe N, Mengiardi B, Pfirrmann CW, Vienne P, Seifert B, Zanetti M. Anatomic variants associated with peroneal tendon disorders: MR imaging findings in volunteers with asymptomatic ankles. *Radiology.* 2007;242(2):509-517.

Case Report

ANOMALOUS PERITONEAL FOLDS OF LIVER WITH INCOMPLETE FISSURE FOR LIGAMENTUM TERES - A CASE REPORT

Arpita Gupta¹, Jasbir Kaur¹, Hitendra Loh¹, Vandana Mehta¹

1. Department of Anatomy, VMMC & Safdarjung Hospital, New Delhi, India

ABSTRACT

Liver is the largest organ in the human body occupying right hypochondrium, epigastrium and left hypochondrium. The organ develops in the ventral mesogastrium dividing the latter into a cranial part which forms the falciform ligament and lesser omentum and the caudal part which normally degenerates but may persist occasionally in the form of accessory fissures, ligaments and folds. The present case report describes the occurrence of exceptional and multiple abnormal peritoneal ligaments extending between the liver, diaphragm and abdominal wall. In concurrence, an incomplete fissure for ligamentum teres hepatis is reported which resulted in a communication between the left lobe and quadrate lobe of liver. The knowledge of the normal and the variant anatomy of such peritoneal reflections of liver is of colossal significance for surgeons performing the segmental resection of the liver and radiologists interpreting radiological findings related to liver.

Keywords: Hepatophrenic ligament, Hepatocolic ligament, Peritoneal folds, Ligamentum teres hepatis, Quadrate lobe, Left lobe

INTRODUCTION

The peritoneum is the most extensive and an intricately arranged serous membrane of the abdomen. It invests the viscera partially or completely resulting in the formation of various peritoneal folds and spaces which include ligaments, omenta and mesenteries. Functionally these modifications allow mobility and serve as a channel to carry neurovascular

structures to the viscera and give some mechanical support to them. These folds and ligaments determine the route of spread of intraperitoneal fluid and serve as conduit for various disease processes [1]. Persistence of remnants of embryonic mesenteries which usually disappear may result in the formation of the abnormal peritoneal folds.

Address for Correspondence:

Dr Hitendra Loh, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi – 110028
Mob: 91-9350809434, E-Mail - drhitendra3@gmail.com

Date of Receiving: 06 September 2020

Date of Acceptance: 03 October 2020

0970-1842/Copyright © JAS 2020

Liver is the largest gland of abdominal cavity which develops in the ventral mesogastrium. It occupies right hypochondrium, epigastrium and a part of left hypochondrium. The organ is divided into anatomical right and left lobes by the attachment of falciform ligament anteriorly, fissure for ligamentum venosum posteriorly and fissure for ligamentum teres inferiorly [2,3]. The anatomical right lobe includes caudate lobe superiorly, quadrate lobe inferiorly along with porta hepatis lying transversely between the two lobes transmitting portal triad which includes bile duct, hepatic artery and hepatic portal vein. Each segment drains independently by either secondary or tertiary branch of portal triad respectively [4]. This classification is also accepted by the federative committee on anatomical terminology [5,6]. Segmentation of right and left lobes of liver pave way for the surgeons to resect the diseased segments independently without damaging other segments [4].

Anomalies of liver may present as agenesis of lobes, absence of segments, decrease in the size of lobes, lobar atrophy, hypoplastic lobes, transposition of gall bladder, Riedels lobe, deformed lobes and abnormal peritoneal folds. The presence of accessory lobes and fissures might result in clinical misdiagnosis and give a picture of internal trauma during post mortem study [7].

CASE REPORT

During a routine cadaveric dissection hall teaching of medical students at the Department of Anatomy, Vardhman Mahavir Medical College, New Delhi, the authors came across multiple anomalous peritoneal folds, incomplete

fissure for ligamentum teres and an unusual communication between the quadrate and the left lobe of liver. One of the peritoneal folds was inverted 'Y' shaped having a stem, medial limb and a lateral limb [Fig. 1]. The stem, 1.8 cm in length was superior and attached to the visceral surface of right lobe of liver at the junction of right and inferior borders. The lateral limb of the fold measured 2.1 cm and formed the lateral hepatophrenic ligament which was attached to the lateral abdominal wall and the diaphragm. The medial limb measured 3.3 cm, enveloped the hepatic flexure of colon and was named as hepatocolic ligament. Another interesting, slender, cylindrical peritoneal fold measuring 1.9 cm in length and 1.6 cm in diameter was observed on the right side of the falciform ligament [Fig. 2]. This fold was 3.5 cm from the inferior border of the liver/cystic notch in the midclavicular line. It connected the anterior surface of right lobe of liver to the undersurface of diaphragm and was named as anterior hepatophrenic ligament. The position and size of gall bladder were customary. The course and relations of common bile duct were configured normally. The other peritoneal reflections of the liver were not significant.

Another striking finding in this cadaver was that the ligamentum teres was partially embedded in the liver parenchyma making the fissure for ligamentum teres incomplete [Fig. 3]. The distance travelled by the ligamentum teres from the inferior border of liver to the porta hepatis was 5.6 cm. However, the fissure for ligamentum teres measuring 2.8 cm was seen only in the inferior part of visceral surface, rest of the ligament was embedded and sunk into the hepatic parenchyma up to the porta hepatis

for a distance of 2.8 cm. By virtue of the above presentation of incomplete fissure for ligamentum teres, the parenchyma of quadrate lobe was directly in continuation with the parenchyma of left lobe [Fig.3].

DISCUSSION

The liver develops in the ventral mesogastrum during third week of intrauterine life dividing it into a cranial part which forms the falciform ligament (extending from the liver to the ventral body wall) and the lesser omentum (extending from oesophagus, stomach and upper portion of duodenum to the liver). The caudal part usually gets degenerated [8, 9] but rarely it may fail to degenerate and persists as accessory fissures, ligaments and folds [1].

The present case report describes the presence of such accessory folds including hepatocolic, lateral and anterior hepatophrenic ligaments along with the presence of incomplete fissure for ligamentum teres. Hepatocolic ligament extended between the visceral surface of right lobe of liver to the hepatic flexure of colon. The authors also observed lateral and anterior hepatophrenic ligaments. The former extended between the visceral surface of right lobe of liver near the junction of right and inferior borders to the lateral abdominal wall and merged with the diaphragm. The latter was observed to stretch between the anterior surface of right lobe of liver to the undersurface of diaphragm. In the previous studies, peritoneal folds have been reported extending between greater omentum and falciform ligament [10], jejunum to the root of mesentery [11], inferior surface of liver to the gastropylorus junction [12]. Though such folds

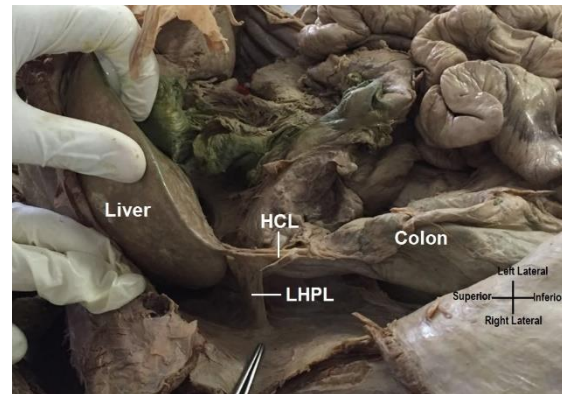


Fig. 1. Liver showing LHPL- Lateral Hepatophrenic Ligament. HCL- Hepatocolic Ligament.

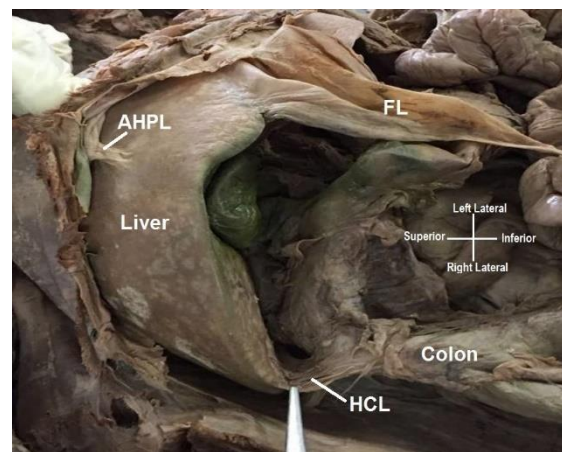


Fig. 2. Right sided abdominal cavity showing liver along with various ligaments. AHPL-Anterior Hepatophrenic Ligament. HCL- Hepatocolic Ligament. FL- Falciform Ligament.



Fig. 3. Inferior view of liver showing direct continuity (*) of liver parenchyma between quadrate lobe and left lobe. LL- Left Lobe. *- Pons Hepatis. QL- Quadrate Lobe. LT- Ligamentum Teres Hepatis.

have been reported in previous studies, but the presence of multiple peritoneal folds in the same subject has not been reported thus far to the best of the knowledge of authors making the present case report unique. The presence of accessory lobes and fissures is common in the perinatal age group, thereafter the organ undergoes postnatal reformation with the increasing age, so the occurrence of such lobes and fissures in the elderly is very rare [13].

The major folds and fissures related to liver are in use as important landmarks during hepatic imaging techniques for interpretation of anatomy of lobes and pathologies related to them. When occurring anomalously, these may act as source of errors in understanding radiologic images [14]. Hepatic imaging helps us to locate primary or metastatic liver diseases [15]. As the procedures like laparoscopic thermal ablation and hepatic resection for hepatic tumors has been increasing recently, sound knowledge of normal and variant anatomy of the folds of liver is of immense importance for the surgeons [16].

Occasionally these folds might carry blood vessels and may encircle the intestine causing obstruction as reported in a case of duodenal constriction by Low [17]. Further, collection of fluid in such fissures and folds may be misdiagnosed for a cyst, liver abscess or intrahepatic hematoma. Abnormal fissures may be misdiagnosed as pathologic liver nodules on computerized tomography [14]. These folds help us to differentiate pathological constrictions due to ulcerations from anatomical constrictions caused by such folds [1].

The current case also reported the occurrence of an incomplete fissure for ligamentum teres that never reached uphill the porta hepatis, this fact resulted in a communication between the quadrate and the left lobe of liver by a transversely placed tissue of liver parenchyma termed as pons hepatis [18].

The ligamentum teres contained in the free margin of falciform ligament is a fibrous remnant of left umbilical vein carrying oxygenated blood from the placenta to the fetus. The fissure for ligamentum teres ascends backwards and upwards from inferior border to the left end of fissure for ligamentum venosum separating the quadrate lobe from the left lobe. Incomplete fissure leads to a communication between quadrate and the left lobe as observed in the present study. The authors correlated this communication with segmental anatomy of the organ. There was noted a direct communication between the segments II (left lateral superior), III (left medial inferior) and IV (left medial superior) as classified by Couinaud in the year 1957 [4, 19]. Knowledge of segmental variations of liver is important for surgeons in planning liver transplant surgeries, Laparoscopic hepatectomy and thermal ablation. To improve the postsurgical outcome in patients with hepatocellular carcinoma, the segmental resection of liver is indicated. The latter involves the removal of the whole segment containing the tumor along with the vasculature invaded by the tumor [20, 21, 22, 23]. As in the present case report, there is a communication between III and IV segments it will pose a threat to the surgeon for removing the segments in isolation.

CONCLUSION

The present case report emphasizes on the presence and clinical aspect of anomalous peritoneal folds of liver with incomplete fissure for ligamentum teres. This knowledge may be utilized by anatomists and morphologists for reporting new anomalies, embryologists for developmental variations, surgeons for scheduling of hepatic surgeries and radiologists for preventing misdiagnosis of CT and MRI. Further such information is a prerequisite for safe surgical approaches and diagnostic imaging.

REFERENCES

1. Pamidi N, Nayak S, Vollala VR. Cystogastrocolic fold and associated atrophy of the gall bladder. *Singapore Med J* 2008 Sep; 49(9): e250-1.
2. Chhabra N, Shrivastava T, Garg L, Mishra BK. An anatomic variant caudate lobe in a cadaver. *Int J Res Med Sci.* 2014; 2:759-61.
3. McMinn RMH. *Last's Anatomy Regional and Applied.* In: *Liver and Biliary Tract.* 8th ed. Edinburg: Churchill Livingstone; 1990. p. 342-345
4. Kieth LM, Arthur FD, Anne MR. *Clinically Oriented Anatomy.* 6th ed. Lippincott Williams & Wilkins. 2010: 268-76.
5. Rutkauskas S, Gedrimas V, Pundzius J, Barauskas G, Basevicius A. Clinical and anatomical basis for the classification of the structural parts of liver. *Medicina (Kaunas)* 2006; 42: 98-106.
6. Standring S, Ellis H, Healy JC et al. Liver. In: Standring S, ed. *Gray's Anatomy: The Anatomical Basis of Clinical Practice.* 39th ed. London: Elsevier Churchill Livingstone, 2005: 1213-25.
7. Khedekar DN, Hattangdi SS. Some interesting morphological features of liver lobes in Mumbai population. *Int J Med Res Health Sci.* 2014;3(3):656-659.
8. Moore KL, Persaud TVN. *The developing human- clinically oriented embryology.* 7th ed. Philadelphia: Saunders; 2003: p256-75.
9. Sadler TW. *Langman's Medical Embryology.* In: *Digestive System.* 13th ed. Philadelphia: Wolters Kluwer; 2015. P. 236.
10. Colak T, Dalcik C, Ozbek A, Filiz S, Sahin M, Dalcik H. A rare multiple variation of the greater omentum. *Okajimas Folia Anat. Jpn.* 2002 Dec; 79(5):159-62.
11. Liu C, Wu TC, Tsai HL, Chin T, Wei C. Obstruction of the proximal jejunum by an anomalous congenital band- a case report. *J Pediatr Surg.* 2005 Mar; 40(3): E27-9.
12. Sridevi NS, Bhaskaran A, Roopa Kulkarni, Nandish C, Sangeeta M. An unusual anomalous peritoneal fold around the gall bladder- a case study. *Anatomica Karnataka.* 2011; Vol5 (2): p66-68.
13. Alexey Pryakhin, Sergey Yukhimets, Elena Chernomortseva, Ainory P Gesase. Accessory lobes, accessory fissures and prominent papillary process of the liver. *Anatomy Journal of Africa.* 2015. Vol 4(2): 611-616.
14. Auh YH, Rubenstein WA, Zirinsky K, Kneeland JB, Pardes JC, Engel IA et al. Accessory fissures of the liver: CT and sonographic appearance *AJR. Am J Roentgenol.* 1984 Sep; 143(3):565-72.

15. Sahni DV, Kalva SP. Imaging the liver. *Oncologist* 2004; 9: 387-97.
16. Kaneko H, Takagi S, Shiba T. [The current state of laparoscopic surgery for abdominal parenchymatous organs]. *Nippon Geka Gakkai Zasshi* 2002; 103: 746-51. Japanese.
17. Low VH, Davis SJ, Yoong MF. Anomalous peritoneal folds of the duodenum- a normal variant simulating disease. *Australas Radiol.*1992 May; 36(2): 135-6.
18. Phad VV, Syed SA, Joshi RA. Morphological variations of liver. *Int J Health Sci Res.* 2014;4(9):119-124.
19. Susan Stranding. *Grey's Anatomy, The anatomical basis of clinical practice. Liver.* 41st ed. Elsevier's. 2016: 1162-1164
20. Billigsley KG, Jarnagin WR, Fong Y, Blumgart LH. Segment- oriented hepatic resection in the management of malignant neoplasms of the liver. *J Am Coll Surg.* 1998 Nov; 187(5): 471-81.
21. Casting D, Garden J, Bismuth H. Segmental liver resection using ultrasound- guided selective portal vein occlusion. *Ann Surg.* 1989; 210, 20-23.
22. Kiyoshi Hasegawa, NorihiroKokudo, Hiroshi Imamura, Yukata Matsuyama, Masami Minagawa, Keiji Sano, Yasuhiko Sugawara, Tadatoshi Takayama, Masatoshi Makuuchi. Prognostic impact of anatomical resection for hepatocellular carcinoma. *Ann Surg.* 2005; 242, 252-59.
23. Makuuchi M, Hasegawa H, Yamaxaki S. Ultrasonically guided subsegmentectomy. *SurgGynecol Obstet.* 1986; 161, 346-359.

Case Report

A RARE CASE OF HETEROTAXIA: FETAL AUTOPSY FINDINGS

Daisy Dwivedi¹, Bal Chander¹

1. Department of Anatomy, Dr Rajendra Prasad Government medical College, Kangra at Tanda, H.P., India

ABSTRACT

Visceral organs are asymmetrically distributed in thoracic and abdominal cavities but there is definite left right orientation along the midline. At times there may be disturbance of the same resulting from malrotation and/or movement during embryological development. We are presenting autopsy findings of a 20 weeks old male fetus wherein the stomach along with spleen and pancreas are on the right side. Rest of the thoracoabdominal viscera are in the anatomically correct locations. Such cases qualify for heterotaxia, denoting status somewhere between situs solitus which is the normal placement of organs and situs inversus which denotes mirror image of solitus. Heterotaxia can have a range of features. Such cases usually come to light within first year of birth but some cases remain asymptomatic till adulthood and are diagnosed incidentally. This article discusses the nomenclature with diagnostic criteria and points out the lacunae which make the present case difficult to classify.

Keywords: Heterotaxia, Fetal autopsy, Situs solitus

INTRODUCTION

Malrotation of intestinal loops with or without cardiac apex is referred to as situs inversus or situs ambiguus. Malrotation is a challenge for surgeons both diagnostically and therapeutically. Most of the cases come to clinical attention within first year of life. [1] However there are reports of such cases diagnosed in adult life. [2] The spectrum of features can range from complete mirror image of normal placement of viscera (situs inversus) to incomplete wherein a few organs are on the

opposite side and the others are on the normal side (situs ambiguus). [3] We are presenting a case that does not appear to fall under either of these two.

CASE REPORT

A 26 years old primigravida had presented for normal follow up. The mother had no adverse history and all routine investigations were normal. Ultrasound of the fetus did not reveal any abnormality. Following abdominal pains, the mother was brought to hospital where on

Address for Correspondence:

Dr. Daisy Dwivedi, Senior Resident, Department of Anatomy, Dr Rajendra Prasad Government medical College, Kangra at Tanda, H.P., India
Email - drdaisyd@gmail.com

Date of Receiving: 14 August 2020

Date of Acceptance: 05 September 2020

0970-1842/Copyright © JAS 2020

ultrasound, a diagnosis of intrauterine death was made. The fetus was sent for autopsy after informed consent of the parents.

RESULTS

A 20 weeks old male fetus weighing 390 grams and crown rump length of 17 cm was received for autopsy. There were no external malformations. A midline incision from neck to pubic region showed normal thoracic contents with no discernible gross abnormalities of the heart or lungs.

On autopsy, the stomach was seen to be lying opposite to its normal position, in the right hypogastrium and epigastric region. The head of pancreas was on the left side with its tail directed upwards towards right hypochondrium where spleen was also located. There were no signs of duodenal obstruction. Appendix, caecum and colon were in their normal position ruling out malrotation of midgut. There was no dextrocardia. (Fig. 1) All the organ weights were within normal range and were grossly normal. Umbilical cord stump showed three vessels. A diagnosis of situs ambiguous or heterotaxia was considered.

DISCUSSION

Situs solitus refers to the normal positions of cardiac apex, stomach, spleen, pancreas and intestinal loops and aorta on the left whereas liver and inferior vena cava is situated on the right of the midline. Situs inversus is the mirror opposite of solitus. It is of two types. Situs inversus with dextrocardia is more common and congenital heart disease occurs in 3 to 5% of the cases. Situs inversus with levocardia is extremely rare and congenital cardiac anomalies are seen in almost all the cases.

Situs ambiguous or heterotaxia is the third category which falls somewhere between solitus and inversus with congenital heart disease between 50 to 100% of the cases. [3, 4]. Heterotaxia is further classified as SA with polysplenia or with asplenia [5]. Incidence of heterotaxia is estimated to be between 1 in 10,000 to 40,000 live births [6]. In our centre this is the first case 1 in 10,000 pregnancies including abortions. The present case qualifies for heterotaxia since with the exception of stomach, spleen and pancreas all other thoracic and abdominal viscera are on the correct sides as in solitus. However, it fails to fit either in heterotaxia with polysplenia or asplenia since there is a right sided single spleen.

There are cases in literature similar to our case that do not fit into sub classification of heterotaxia. Isolated intestinal malrotation without other complications has been reported albeit without the benefit of complete autopsy and the authors have not commented on spleen or pancreas [7, 8]. Another case pertains to levocardia without defects with right sided stomach, spleen and colon and left liver. Information regarding pancreas is missing. [9]

Present case might come across as a first of its kind but from putative prognostic perspective it appears to be similar to other cases of heterotaxia. Vast majority of cases of malrotations come to clinical attention post birth within one year owing to pain abdomen and bilious vomiting. Management almost invariably involves major surgery. [7, 8, 9] But it should be noted that similar cases can also come to clinical attention during adult life, mostly as incidental findings [10].

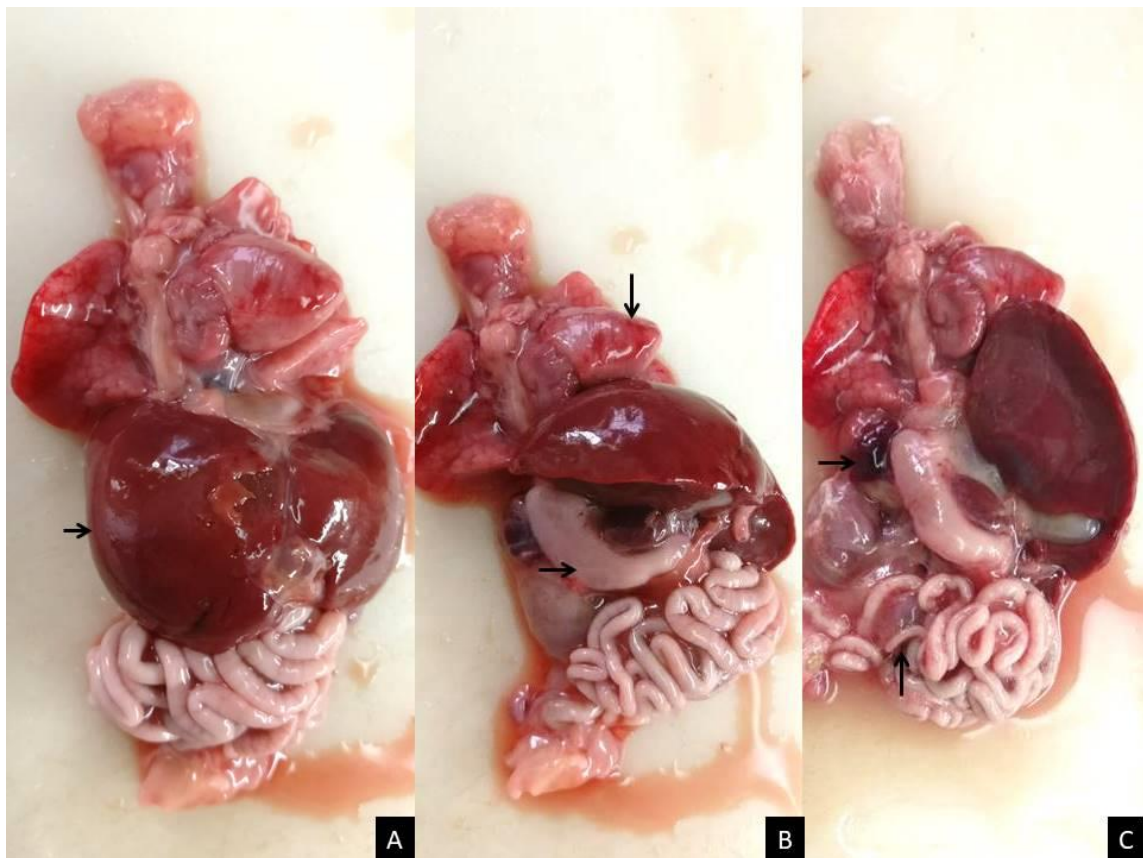


Fig. 1. A: Right lobe, liver (right arrow); B: Heart (down arrow), Stomach (right arrow); C: Spleen (right arrow) and Pancreas (arrowhead)

CONCLUSION

The purpose of this case with extremely rare features is to highlight the importance of fetal autopsies. It is imperative that every intrauterine death be investigated and an attempt made to establish a diagnosis as per the established criteria or highlight the cases that do not conform to the same.

REFERENCES

1. Hernanz-Schulman M. Imaging of neonatal gastrointestinal obstruction. *Radiol Clin North Am.* 1999;37(6):1163-vii.
2. Fulcher AS, Turner MA. Abdominal manifestations of situs anomalies in adults. *Radiographics.* 2002;22(6):1439-1456.
3. Peoples, W.M., Moller, J.H. & Edwards, J.E. Polysplenia: A review of 146 cases. *Pediatr Cardiol* 4.1983; 129–137
4. Tonkin IL. The definition of cardiac malpositions with echocardiography and computed tomography. In: Friedman WF, Higgins CB, eds. *Pediatric cardiac imaging.* Philadelphia, Pa: Saunders, 1984; 157–187.
5. Winer-Muram HT. Adult presentation of heterotaxic syndromes and related complexes. *Journal of thoracic imaging.* 1995;10(1):43-57.
6. Lambert TE, Kuller J, Small M, Rhee E, Barker P. Abnormalities of fetal situs: an overview and literature review. *Obstetrical & gynecological survey.* 2016 Jan 1;71(1):33-8.

7. Biyyam DR, Dighe M, Siebert JR. Antenatal diagnosis of intestinal malrotation on fetal MRI. *Pediatric radiology*. 2009 Aug 1;39(8):847-9.
8. Cassart M, Massez A, Lingier P, Absil AS, Donner C, Avni F. Sonographic prenatal diagnosis of malpositioned stomach as a feature of uncomplicated intestinal malrotation. *Pediatric radiology*. 2006 Apr 1;36(4):358-60.
9. Tryfonas GI, Chaidos C, Avtzoglou PP, Zioutis J, Klokari A, Papanastasopoulos A. Partial situs inversus: duodenal obstruction in a neonate with isolated levocardia. *Journal of pediatric surgery*. 1992 Dec 1;27(12):1584-6.
10. Fulcher AS, Turner MA. Abdominal manifestations of situs anomalies in adults. *Radiographics*. 2002 Nov;22(6):1439-56

Short Communication

TAPETUM - A MISUNDERSTOOD TOPIC

P K Sharma¹, Sonia Jaiswal¹

1. Department of Anatomy, Era's Lucknow Medical College, Lucknow, India

ABSTRACT

Quite frequently students are asked to explain tapetum. We found that various books of anatomy have different explanations. Students are confused as to which book must be followed for its explanation. We are therefore writing an inference drawn by consulting books and also by observing the human brain in cadavers.

Keywords: Tapetum, Corpus Callosum, Lateral Ventricle, Posterior Horn, Inferior Horn

DEFINITION

The tapetum was described by Johann Christian Reil (1759–1813). It is formed primarily by decussating fibers in the splenium of the corpus callosum that arch over the atrium of the lateral ventricle and course inferiorly in the lateral wall of the posterior, and somewhat into the temporal horns of the lateral ventricle.[1]

WHAT DO THE BOOKS SAY ABOUT TAPETUM

1. "Those fibres of the trunk and splenium of corpus callosum which together form the roof and lateral of the posterior horn and lateral wall of the inferior horn of the lateral ventricle constitute the tapetum." [2]
2. "A large number of fibres from the trunk of corpus callosum run transversely to intersect

with the fibres of the corona radiata. Some fibres of the trunk and adjacent splenium which do not intersect with corona radiata are known as tapetum. The tapetum is closely related to the inferior horn and posterior horn of the lateral ventricle." [3]

3. "The tapetum is a thin lamina of white fibres (2cm thick) which forms the roof and lateral wall of the posterior horn and lateral wall of the inferior horn of the lateral ventricle. The tapetum is formed by those fibres of the trunk and splenium of corpus callosum which are not intersected by the fibres of corona radiata. In the coronal section, the tapetum looks whiter than the surrounding white matter because section passes parallel to the fibres of the tapetum." [4]
4. "Some of the fibres of the corpus callosum form the roof and lateral wall of the posterior

Address for Correspondence:

Prof PK Sharma, HOD Anatomy, Era's Lucknow Medical College, Lucknow, (U.P.), India – 226003
Email - drpksharma_50@yahoo.com

Date of Receiving: 27 August 2020

Date of Acceptance: 11 September 2020

0970-1842/Copyright © JAS 2020

horn of the lateral ventricle and the lateral wall of the inferior horn of the lateral ventricle; these fibres are referred to as tapetum.” [5]

5. “The roof and lateral wall is formed by the tapetum of the corpus callosum, with the optic radiation lying against the tapetum in the lateral wall.” [6]

CONCLUSION

Tapetum literally means a reflective layer. In the human brain tapetum consists of those fibres of splenium of corpus callosum which form the roof, lateral and inferior wall of the posterior horn and lateral wall of the inferior horn of the lateral ventricle. They look whiter than the white matter because they are cut parallel to the fibres it contains [7].

In many animals, it is a reflective layer of the choroid of the eye causing them to shine in the dark.

REFERENCES

1. Levent Sarikcioglu, Umut Ozsoy & Guray Unver (2007) Tapetum Corporis Callosi: Carpet of the Brain, *Journal of the History of the Neurosciences*, 16:4, 434-436, DOI: 10.1080/09647040600719013
2. Standring, S., Borley, N. R., & Gray, H. *Gray's anatomy: the anatomical basis of clinical practice*. 40th ed., anniversary ed. Edinburgh: Churchill Livingstone/Elsevier; 2008
3. Pritha S Bhuiyan, Lakshmi Rajgopal, K Shyam Kishore. *Inderbir Singh's Textbook of Human Neuroanatomy*. 10th ed. Jaypee Brothers Medical Publishers (P) Ltd; 2018

4. Vishram Singh. *Textbook of Clinical Neuroanatomy*. 2nd ed. Elsevier; 2010
5. Richard S Snell. *Clinical Neuroanatomy*. 7th ed. Wolter Kluwer Health/Lippincott Williams &Wilkins; 2010.
6. Chummy S. Sinnatamby. *Last's Anatomy*. 12th ed. Elsevier; 2011
7. G.J Romanes. *Cunningham's Manual of Practical Anatomy Vol 3*. 15th ed. Oxford University Press; 1986.

Guest Submission

IMPACT OF RELIGIOUS PRACTICES ON HEALTH AND HYGIENE: A CRITICAL OBSERVATIONAL STUDY WITH SPECIAL REFERENCE TO ARTICLE 25 OF THE CONSTITUTION OF INDIA

Vaibhav Goel Bhartiya¹, Prem Chandra¹, Himani Sharma²

1. Faculty of Law, Subharti Law College Swami Vivekanand Subharti University Meerut, U.P., India
2. Department of Periodontology, School of Dental Sciences, Sharda University, Greater Noida, India

ABSTRACT

Since the beginning of human civilization, hygiene, health, medicine religious practices and law, are found to be interwoven around each other. On one hand, ancient legal system or religion preaches us about an ideal way of living life, on the other hand, the health care providers, try to identify and observe the religious practices and faith of the patient for providing better treatment. These practices may include prayer, meditation, bathing and cleanliness, dietary needs and astrological beliefs of patient. The history of alliance of law in the religious preaching and religious practices, medicine, and healthcare is very interesting to look at. Since ages, to make people take up cleanliness as a habit, it has been linked to Godliness, for example in Hinduism it is often said that “Swachchta hi Prabhuta hai”. Also, for hundreds of years, religious institutions were responsible for licensing physicians to practice medicine. Thus, religious practices are external activities or functions of human civilizations which works as code of conduct for them. The present piece of work is an attempt to identify the relevance of Article 25 of Indian Constitution for the medical practitioners while treating patients with orthodox patients with deep rooted religious practices which may create hindrances in the treatment too.

Keywords: Hygiene, Medical Practitioners, Article 25, Religion, Taboo

INTRODUCTION

India is a home for 1.4 billion people which are about one-sixth of the total world's population [1]. The population of India belongs to diverse ethnic and religious groups.[2] There is substantial size of the population of Hindus (79.8%), Muslims (14.2%), Christians (2.3%), Sikhs (1.7%), Buddhists (0.7%), Jains (0.4%)

and adherents to folk culture in India[3,4]. According Art 25 of the Constitution of India, all the people belonging to different religion have liberty and full freedom to follow their religious practices which should not be contrary to the public health and policy.

Life beliefs and well-being of an individual in a

Address for Correspondence:

Prof. Vaibhav Goel Bhartiya, Dean Faculty of Law, Subharti Law College Swami Vivekanand Subharti University Meerut.
Mobile - +91-8958440240 Email - hnlu@gmail.com

Date of Receiving: 20 July 2020

Date of Acceptance: 05 August 2020

0970-1842/Copyright © JAS 2020

society are indivisible and interdependent. As the life without belief and faith can never be visualized, similarly well-being is also one of the pre-conditions of life as per the essence of Art 21 of the Constitution of India. The concept of belief is the central part of human life and it determines one's life style. It is a proper combination of religious practices and routine hygiene practiced by an individual.

However, taking care of the body and soul always remains an integrated aspect of well-being of an individual in all religions across the world. For example, taking Hinduism/ '*Sanatan Dharm*' into consideration, one may agree to the fact that, it is very liberal in its core and it provides liberty to an individual to practice and follow any lifestyle according to one's own belief, faith and choice. Even in the judicial pronouncement apex court affirmed *Hindutva* as way of life. However, the concept of purity is deeply rooted among Hindu ideologies according to '*Srimad Bhagwat Geeta*', "*swacham*" is one of the divine qualities which one must practice for the purpose of overall cleanliness of both body and soul. Moreover, '*Dharmshastras*' suggests an ideal routine in which, after waking up early in the morning, the ritual of cleanliness and prayers which includes cleaning the teeth immediately followed by bathing, prayer and then taking meals should be done. For mental and emotional cleaning, early morning meditation/Yoga sessions are also stressed upon. Other practices like, washing hands with clean water, taking off shoes outside homes before entering, constructing toilets outside the dwelling houses, performing '*Janeyusanskar*' to make the *Janeyu* bearer follow every ritual of

cleanliness, etc. is habitually followed among Hindus since ages. This works as a running system of hygiene. Therefore, it can be said that, religious practices also acts as a measure for observance of the health measures for a healthy mind and body. Here it can be considered the reasons that are why the freedom of belief is subject to health and morality.

To follow and propagate religious belief and faith, Article 25 of the Constitution provides constitutional protection to the individuals belonging to any of the ethnic groups. However, in recent times, this system of cleanliness has been relatively compromised by many corrupt practices which are often associated with religion. For the purpose of present article, the few practices among Hindus and Muslims have been discussed. The rationale behind the selection of only these religions as above is the size of the followers is higher in comparison of other. Thus, this study aims to identify such unhygienic religious practices which may create problem for the medical practitioners and compromises the treatment. This study also discusses about the general awareness about Article 25 among medical practitioners and general population.

METHODOLOGY

The present article attempts to explore the complexities of religious practices; the reason behind it and its impact on health and hygiene of an individual. The present observational study was conducted in the hospitals in Delhi-NCR with subjects of Hindu and Muslim religion. The study has a quasi-disciplinary

Impact of Religious Practices on Health and Hygiene

approach with a socio-legal view point and here it has been tried to check the impact of various religious practices on the patients while treatment. The data was collected and compiled by the authors and various religious practices compromising the treatment of the subjects were listed.

Health & religious practices among Hindus

Hinduism, (synonymous to *Hindutva*) is not a religion, but a way of life and a state of mind.⁸It gives complete liberty to the individuals to follow and practice his own belief and faith, may be termed as religion, according to his choice. This way of life holds so many religious practices such as prayer, meditation, bathing, cleanliness, dietary needs & habits. These religious practices are directly related to the health and hygienic system that might have compelled the judges of the apex court to re-establish Hinduism as a way of life before this modern global society.

However, globalization and rapid transformation of the society has raised various issues which has created a clash in between health care and religion. For the purpose of cleanliness, Hindus prefer to skirmish their teeth daily in the morning using *Neem Datun* (twigs). It has been concluded in various researches that using twigs can have similar cleaning effects as a conventional toothbrush. But the sticks can't reach areas between the teeth, and if they aren't used properly, they can damage the gums and abrade the teeth.^[5] Hindus have a tradition to eat with hands and not with spoon and washing hands prior to eating, is very important for Hindus because of

Purity is a core element of Hindu religion and philosophy. This very fact of old Hindu philosophy was much appreciated by WHO during Covid19, when advisories on hand wash were issued to prevent and stop pandemic. However, avoidance of the same results in various gastric diseases associated with the microorganisms present in the dirty hands.^[6] In ancient time, Hindus necessarily followed the practice of showering or bathing after defecation, the purpose is to minimize the chance of any infection due to ancient open defecation practices.^[7]

This is also considered helpful to prevent COVID-19. However, with the continuation of this open defecation practice, which is still prevalent, though law exists on the prohibition of the same, in some rural areas, various human excrement linked infectious diseases have been found associated with it.^[8] Most of the Hindus prefer to bath and pray in the morning but view of the orthodox society is different for a menstruating women who is considered impure and unclean and is not allowed to take bath and is often forced to opt for methods of management which can be unhygienic and inconvenient, particularly in poorer settings as even talking about this issue is considered as taboo in some areas^[9]. This very religious practice is not seen in any of the religious scripture and has been developed as a corrupt practice by our society which makes menstruating women prone to fatal urogenital infectious diseases^[10]. Religiously, Hindus are vegetarians and they do not take meat, fish and eggs. Most of the Hindus follow a vegetarian diet because they have a strong faith and belief in the concept of non-violence and they strictly

follow pure vegetarian life style throughout their life [11]. However, as vegetarian diet is more restrictive, intake of adequate daily energy and of n-3 fatty acids, essential amino acids, vitamin B12, zinc, calcium and iron becomes more difficult to achieve, which is particularly challenging in children who have higher nutrient requirements relative to body weight than adults [12]. Here it is essential to mention that no religion restricts human being to have non vegetarian diet.

Therefore, when ethnicity comes, it creates problem to treat such patient. Fasting may be considered good for a healthy one and fatal for some humans with specific health issues. Among Hindus fasting on a particular day of the week or occasion is very common practice for Hindus. Scientifically, fasting is important for avoiding food poisoning. Basically, the scientific object of the fasting is to purify the body and soul as well to promote the concept of self-discipline too. One study in 11 healthy adults showed that fasting for 24 hours significantly increased levels of Human Growth Hormones.[13] However, the denial of having necessary medication during fasting is wrong and is not acceptable. Some Hindus do not prefer to take garlic or onion in their food because they believe that these foods upset spiritual practices but both the substance has their high medicinal values. Most of the Hindus believe that all types of illnesses, whether it may be physical or mental illness, have a biological, psychological and spiritual element and therefore it must be treated accordingly keeping all elements in mind [14]. As a part of Karma, pain and suffering is accepted and encouraged among Hindus. Pain and suffering in life is a

natural consequence of negative behavior and Karma. Thus, defer to seek any medical help for the same.[15]. Hinduism places great emphasis on purity, in both physical and spiritual terms [16]. In fact, the religious practices among Hindus are almost in consonance with the medical science still it is required to isolate accurate and erroneous practices in the name of the religion for the better execution of medical advices.

ISLAMIC PRACTICES

Islam is considered as one of the most scientific religion on the earth since its inception is latest in calendar. But in practice, illness in Islamic followers is considered as a test from God. They respond to illness, patiently and with prayer. Death is ultimate journey of human life. It is the duty of individual to maintain his health properly. Illness is the part of human life but the preservation of life is main objectives of Islamic law. Caring of sick people is a collective social responsibility. Health services providers are honored in Islamic law.

They observed the fasting in holy month of Ramzan for whole month, but exceptions are there on the basis of health condition, age, pregnant ladies, children etc. This is again in consonance to the medical science. Muslims rinse their mouth and nose early in the morning. They wash their hands, face, arms and feet with the water properly. The object is to remain physically clean and healthy [17]. Smoking and drinking is not allowed and it is strictly prohibited among Hindus and Muslims both. It is found that restriction on drinking and smoking are very helpful for reducing most of the dangerous

diseases. Still the practice of 'Haki' and 'Zarra' the quacks in Muslims are observed quite common. They used to visit the doctor after deterioration the health after illness being relying upon unprofessional advices. They usually consult with religious leaders or Imams for their health issues. Imams are morally duty bound to provide moral and spiritual support. This is invaluable to Muslim patients and families. Macro display of few of the Islamic practices is getting change with educational advancement among these families which resulted drop off the patient rate among Muslims. The opinion of the health care professional is that education and recovery rate from illness is directly proportionate. The families where belief is deeply roots in orthodox religious practices, it is difficult to treat the ailment.[18]

LAW, RELIGION AND HUMAN WELL BEING

In a lawyer's view point Article 21 of the Indian Constitution which states about the freedom of life and personal Liberty with due process of law; it establishes the cardinal principals of human dignity along with Article 25 and both contain no value for a lunatic, unhealthy one. The person who was assigned the task to take care of an individuals' physical well-being, was also expected to attend the spiritual needs of the subject. This becomes the obligation of law makers in general and the responsibility of medical practitioners in particular. During Covid-19, this vary preposition is being witnessed by all the stake holders including medical practitioners.

In the ancient time religious leaders were regarded as not only as healer of the body but

mind and spirituality too. For example, in Christianity, Jesus, the savior of human race and spiritual leader, was also considered curer of overall well-being of all. Unfortunately, in course of time the requirement of body & mind along with the meaning of spirituality transformed in a wholesome manner. This transformation developed a line of separation among religious practices and health measures resulting two separate needs of the people. At one side religiosity is solely dedicated for spirituality whereas on the other side physicians, scientists or experts of medicinal science are dedicated to the physical needs or well beings of individuals [19].

However, the fact that religion as well as religious practices, connected to a particular religion, influences public health cannot be denied. Many a times, patient delays in obtaining medical health due to its cultural, social and religious belief. [20] At the time of illness a person feels and experiences the stress in the life. For those diseases, where medical system fails to give the solution to the ailments or physical/ mental disorders, one starts looking toward the spiritual bodies for the same. And when various religious organizations, *Dharmarth Chkitsyalay* through *Trust* or *Waqf*, jumps in the business of health care that too at door step and with no cost, those who are not religious earlier may also turn to spirituality for their cure.

Today all over the world, many religious organizations, groups and NGO's are providing good public health facilities which include rehabilitation of unwell, nutritional food, treatment for HIV, counseling services, clean drinking water etc [21]. At the same time, a few

religious practices are affecting the system of public health negatively. For example, opposition for vaccination by various religious groups which influences the people following them, and compromises with their health.

Thus, it is very clear that religion and religious practices are connected with the public health. However, the constitutional relation between religious practices and public health in books and in practice is entirely diverse.

ARTICLE 25 AND RELIGIOUS PRACTICES IN INDIA

Indian Constitution establishes world's largest secular democracy with freedom of belief and faith. It includes right to religion is subject to public order, morality and health'. It is evident that Article 25 and health are associated with each other in one form or the other. According to this fundamental right, every citizen has the opportunity to practice and spread their religion peacefully, but after health assurance. Article 25(1) of the Constitution protects and covers only the relationship linking the followers with the deity. But, if any incidence of religious intolerance occurs in want of health care, it is the duty of the government to curb such incidence [22] and maintain peace and harmony between two.

Indian Constitution has been framed with scientific vigour to have a just society. Be it with regard to individual liberty or any specific command. In the public interest the State may interfere in any manner with due procedure and this is applicable even in the religious matters too, although Constitution embarks individual supremacy while practicing religious beliefs. The State is authorized to regulate such

type of secular activities which are closely connected with religious practices [23] and which may affect health and public peace and tranquility.

During 2020 pandemic it has been crystallized that religion and religious practices are secondary for want of health measures imposed by the Govt. through legal mechanism. Invariably during pandemic 2020, morality and public order is remained vital for health attainment. Consequently, this religious freedom can never be at the cost of health. Be it euthanasia or any other incurable health problem all the religion already contains clear mandates and then such parameters have been adopted and accepted by law and medical sciences. Religion and health care both are for the pleasant survival not for the pain and agony. Hence it can be drawn that practice of Article 25 of the Constitution is possible only after the fulfillment of pre-requisites health conditions.

CONCLUSION

Health is a precondition for life whereas belief is the precondition for a meaningful life. Accordingly, for a healthy and meaningful life health and religious beliefs both are equally important. Divergence between two generates alarming situation; being religion the most sensitive issue. This creates a vacuum between patient and doctor. This has been identified that most of the tangible religious practices are important for purpose of hygiene and good health however, few of them leads to many compromised situations. Even the same has been witnessed during CoVID-19 pandemic. These religious practices results in many health

care beliefs and practices amongst general population which should be known to medical professionals, so providing treatment in such patients becomes easier.

REFERENCES

1. <https://www.pewresearch.org/fact-tank/2018/06/29/5-facts-about-religion-in-india/> accessed on 07/07/2020 at 1.50 pm At Subharti University Campus Meerut.
2. <https://www.pewresearch.org/fact-tank/2018/06/29/5-facts-about-religion-in-india/> accessed on 07/07/2020 at 1.55 pm At Subharti University Campus Meerut.
3. <https://www.pewresearch.org/fact-tank/2018/06/29/5-facts-about-religion-in-india/> accessed on 07/07/2020 at 2.45 pm At Subharti University Campus Meerut.
4. See <https://www.firstpost.com/india/india-has-79-8-percent-hindus-14-2-percent-muslims-2011-census-data-on-religion-2407708.html> accessed on 16/07/2020 at 19.35 pm at Subharti University Meerut.
5. <https://www.dailymail.co.uk/indiahome/india-news/article-3872368/Hindutva-not-religion-way-life-state-mind-Supreme-Court-refuses-overturn-1995-judgement.html> accessed on 18.07.2020 at 12.00 noon Subharti Law College Subharti University Meerut.
6. <https://www.sciencealert.com/how-effective-are-these-traditional-teeth-cleaning-techniques>, accessed on 07/07/2020, at 19.35 at Subharti University Campus Meerut.
7. Ray SK, Amarchand R, Srikanth J, Majumdar KK. A study on prevalence of bacteria in the hands of children and their perception on hand washing in two schools of Bangalore and Kolkata. *Indian J Public Health* 2011;55:293-7.
8. Ambesh P, Ambesh SP. Open Defecation in India: A Major Health Hazard and Hurdle in Infection Control. *J ClinDiagn Res.* 2016;10(7):IL01-IL02. doi:10.7860/JCDR/2016/20723.8098
9. Cairncross S, Hunt C, Boisson S, Bostoen K, Curtis V. Water, sanitation and hygiene for the prevention of diarrhea. *Int J Epidemiol.* 2010;39:193–205. doi: 10.1093/ije/dyq035.
10. Queensland Health, Health Care Providers' Handbook on Hindu Patients; division of the Chief Health Officer, Queensland Health, Brisbane 2011; available at www.creativecommons.org/licenses/by-nc-sa/2.5/au/deed.en.
11. Wasserheit JN, Harris JR, Chakraborty J, Kay BA, Mason KJ. Reproductive tract infections in a family planning population in rural Bangladesh. *Stud Fam Plann.* 1989 Mar-Apr; 20(2):69-80.
12. Hollins S. Religions, Culture and Healthcare: A Practical Handbook for Use in Healthcare Environments second edition. Second edition ed: Radcliffe Publishing Ltd; 2009 available at www.creativecommons.org/licenses/by-nc-sa/2.5/au/deed.en.
13. Stanic S, Markovic V, Sarcevic D, Kilibarda N et al. Being a Vegetarian: Health Benefits and Hazards. *Meat Tach* 2018; DOI: 10.18485/meattech.2018.59.1.8.
13. <https://pubmed.ncbi.nlm.nih.gov/22386777/> accessed on 18.07.2020, at 14.00 Hrs at Subharti law College Subharti University Meerut.

14. Kang C. Hinduism and Mental Health: engaging British Hindus. *Mental Health, Religion & Culture* 2010;13:587-593. As cited in. as cited in Queensland Health. *Health Care Providers' Handbook on Hindu Patients*. Division of the Chief Health Officer, Queensland Health. Brisbane 2011, available at www.creativecommons.org/licenses/by-nc-sa/2.5/au/deed.en.
15. Whitman SM. Pain and Suffering as Viewed by the Hindu Religion. *The Journal of Pain* 2007;8:607-613.
16. Url:
https://www.health.qld.gov.au/__data/assets/pdf_file/0024/156255/hbook-hindu.pdf
accessed at 19.35 at Subharti University Meerut.
17. https://ca.cair.com/sacval/wp-content/uploads/sites/9/2018/08/Healthcare-Handbook_web.pdf?x62983; accessed on: 09/07/2020 at 9.55 AM. Subharti law College Subharti University Meerut.
18. <https://www.ncbi.nlm.nih.gov/books/NBK493216/> accessed on: 09/07/2020 at 9.55 AM. Subharti law College Subharti University Meerut.
19. Puchalski CM (2001). Spirituality and health: the art of compassionate medicine. *Hospital Physician* 37: 30-36 5 as cited by HenaJawaid: Impact of Religion/Spirituality on Health: What are the Evidences? *Journal of Psychiatry*, Volume 17, Issue 6-2014; doi: 10.4172/1994-8220.
20. Worthington RP, Gogne A. Cultural aspects of primary healthcare in india: A case- based analysis. *Asia Pac Fam Med.* 2011;10(1):8. Published 2011 Jun 16. doi:10.1186/1447-056X-10-8
21. Christopher Ogolla, The Public Health Implications of Religious Exemptions: A Balance Between Public Safety and Personal Choice, or Religion Gone Too Far?, *25 Health Matrix* 257 (2015) <https://scholarlycommons.law.case.edu/healthmatrix/vol25/iss1/11>. Accessed on 07/07/2020.
22. https://shodhganga.inflibnet.ac.in/bitstream/10603/77961/9/09_chapter%2004.pdf accessed on 13/07/2020 at 9.30 AM.
23. Gandhi v. State of Bombay, 1954 SCR 1035, 1062.

Original Article – Student Authors

MICROORGANISMS COLONIZING THE CADAVERS: THE NEED OF INFECTION CONTROL PROTOCOLS DURING DISSECTION

Tanya Sharma¹, Siddhant Sharma¹, Anita Pandey², Shobhit Raizaday³, Satyam Khare³, Mahima Tomar¹

1. MBBS student, Subharti Medical College, Meerut (U.P.), India.
2. Department of Microbiology, Subharti Medical College, Meerut (U.P.), India.
3. Department of Anatomy, Subharti Medical College, Meerut (U.P.), India.

ABSTRACT

Introduction: Microorganisms can colonize the surfaces of cadavers and may pose health hazards to the students and the staff handling them. The objective of the study was to study the spectrum of bacteria and fungi colonizing the surfaces of cadavers and to determine the need to follow infection control protocols during their handling.

Materials and methods: A total of 100 swabs were collected from superficial and deep surfaces of the cadavers and its surroundings. The swabs were cultured on blood agar and Mac Conkey's agar plates for isolation of bacterial species and Sabourauds Dextrose Agar (SDA) slants for isolation of fungal species. Identification of the bacterial and fungal isolates was done using standard bacteriological and mycological methods respectively.

Results: Overall culture positivity rate was 78%. There was predominance of isolation of bacterial species (50%). *Escherichia coli* and Coagulase negative Staphylococci [CoNS] (23.07 % each) were the predominant bacteria isolated and *Aspergillus* species (37.50%) was the predominant fungus isolated from human cadavers.

Conclusions: Various bacteria and fungi colonized the surface of cadavers. Therefore, the study emphasizes the need for practicing "Standard infection control protocols" in the dissection hall while handling the cadavers.

Keywords: Cadaver, Bacteria, Fungus, Standard precautions, Microorganisms

Address for Correspondence:

Dr. Anita Pandey, Professor & Head, Department of Microbiology, Subharti Medical College, Swami Vivekanand Subharti University, Meerut 250005 (U.P.), India.
Mob - 9837717720 Email - anipanmicro@gmail.com

Date of Receiving: 15 September 2020

Date of Acceptance: 04 October 2020

0970-1842/Copyright © JAS 2020

INTRODUCTION

Dissection of the cadavers is a preferred method for training and skill development in learning anatomy. It is a part and parcel of first year MBBS training that every medical student has to undergo as part of their undergraduate curriculum [1,2,3]. Previous studies by Dinsmore *et al* in 2001 [4] and Shalika *et al* [5] have reported that working with cadavers in dissection hall (DH) creates an emotional stress among the medical students which induces both positive and negative experiences in these students. However, besides the emotional turmoil another aspect of unseen stress that persists while working in close proximity with the cadavers is the risk of transmission of infection. Previous studies have shown that microorganisms, both bacteria and fungi have a tendency of colonizing the surfaces of cadavers [6,7,8]. Another study by Tabaac *et al.* (2013) [9], also showed the presence of pathogenic bacteria in 10 fixed cadavers used in anatomy practices and teaching. However, only a few studies have addressed the biological risk of fixed cadaver manipulation and the likelihood of dissemination of microorganisms during dissection which may pose serious threat to the students, staff and the environment [10].

The 1st year medical students, who have just entered the course, howsoever, are unaware about the various microorganisms that colonize the cadaveric surfaces, their risk of transmission and the various infection control practices which must be followed by them during dissection. To the best of our knowledge, the infection hazards of handling human

cadavers are underreported in India. So, this study was carried out to determine the profile of microorganisms colonizing the cadavers and highlight the need to practice infection control protocols during their handling.

MATERIALS AND METHODS

The prospective study was carried out for a period of 3 months in the dissection hall of the Department of Anatomy in collaboration with the Department of Microbiology, Subharti Medical College, Meerut. The approval from the Institutional Ethical and Research Committee was obtained before conducting the study.

A total of 100 swabs were collected from superficial and deep surfaces of the cadavers and their surroundings. The samples were collected using pre-sterilized cotton swabs dipped in sterile saline before collection to preserve moisture. The regions sampled included both the axilla, ears, eyes, oral cavity, nasal cavities, inguinal and perianal region of 4 different cadavers and the dissection table.

The swabs collected (minimum of two cotton swabs) were immediately transported to the Clinical Microbiology laboratory under aseptic precaution for isolation and identification of bacterial and fungal species. First swab was cultured on blood agar (BA) and Mac Conkeys (MAC) agar plates and incubated at 37°C for 24 hours for isolation of bacteria. Identification of bacterial species was done by standard bacteriological technique [11]. The second swab was cultured on slants of Sabouraud Dextrose Agar (SDA) with chloramphenicol

(0.05%) and incubated at 25°C and 37°C for isolation of fungi. The fungal growth was identified by standard mycological technique [12]. (Fig.1)

RESULTS

A total of 78 (78 %) surface swabs were culture positive. Among the culture positive swabs, pure bacterial species was isolated in 39/78 (50 %) followed by pure fungal species in 24/78 (30.76%) and mixed organism (both bacteria and fungus) in 15/78 (19.23%) [Figure 2]. A variety of microorganisms were recovered and identified from superficial and deep surfaces of the cadavers and the surrounding table by culture and identification methods. *Escherichia coli* and Coagulase negative Staphylococci

(23.07 % each) was the predominant bacteria isolated followed by *Bacillus* species (15.38%). *Aspergillus* species was the predominant fungus growing on human cadavers (37.50%) followed by *Candida* species (25.00 %). Even in mixed growth *Aspergillus* was the predominant species (80%). Distributions of various other bacterial and fungal species isolated are shown in [Table 1]. However, association of two bacterial or two fungal pathogens were not seen in the present study.

DISCUSSION

Cadavers allotted to the students and the surrounding table are colonized with viable microorganisms on their surfaces. These microorganisms can be a source of

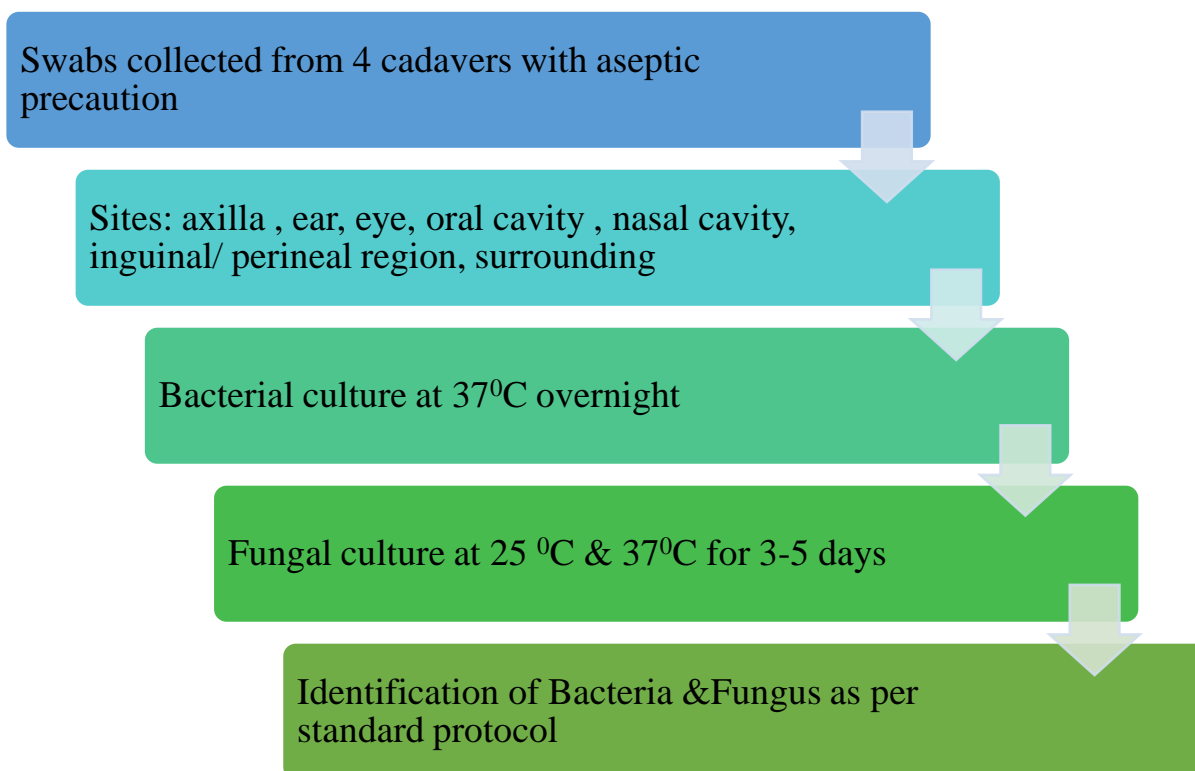


Fig. 1. Flow chart showing the processing of samples collected from the cadavers

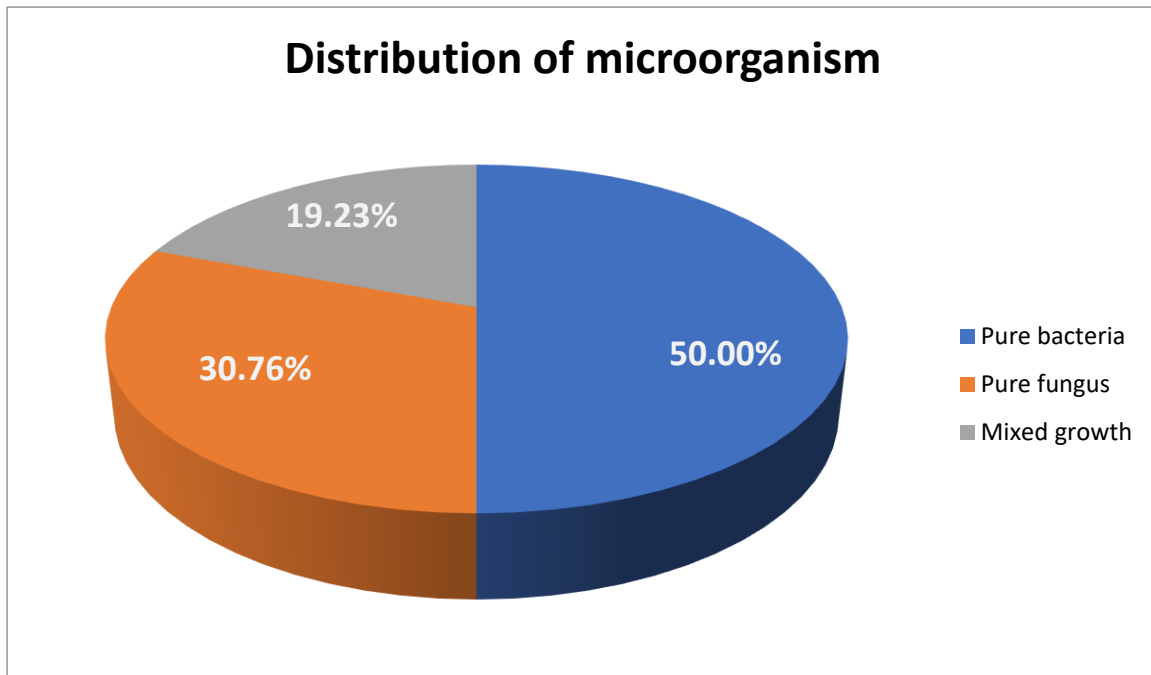


Fig. 2. Distribution of microorganisms grown in cadaver surfaces (n=78)

contamination of hands, equipment and clothing and can pose as a health hazard to the students and staff. Similar finding published by Molina *et al* [6] identified bacterial and fungal species in human cadavers which can eventually compromise the health of the manipulators and students. Another study carried out by Kabadi *et al* in 2013 [13] have identified potentially pathogenic microorganisms like *Staphylococcus aureus*, *Enterococcus faecalis*, and *Streptococcus pyogenes* by sampling the clothes of students who handled the cadavers, but this study does not directly associate these microorganisms with cadavers.

The result of our study demonstrates that fixed cadavers have viable bacteria & fungi on its surfaces. *E. coli* and CoNS were the predominant bacteria; *Aspergillus* and *Candida*

species was the predominant fungi isolated from surface of cadavers and its surroundings both as pure culture and even as mixed etiology (Table 1). Similarly presence of fungal species like *Aspergillus*, *Trichophyton*, *Microsporum*, *Candida* and *Cryptococcus* in fixed cadavers has also been reported by previous workers [10].

Given the diversity of bacterial species cultured, preserved cadavers used for anatomy education must be considered a possible source for dissemination of microorganisms and they may pose hazards to those handling them [14]. Our study shows the colonization of cadaver surfaces by various microorganisms and emphasizes the need to practice infection control protocols during their handling. Both, the staff and the students, handling the bodies, should be adequately trained regarding the

Microorganism isolated		Number of samples	Percentage %
Bacterial species isolated (n=39)			
1.	<i>Escherichia coli</i>	9	23.07%
2.	<i>Coagulase negative Staphylococci</i>	9	23.07%
3.	<i>Bacillus species</i>	6	15.38%
4.	<i>Staphylococcus aureus</i>	5	12.82%
5.	<i>Micrococcus species</i>	5	12.82%
	<i>Streptococcus species</i>	3	7.70%
6.	<i>Enterococcus species</i>	2	5.13 %
	Total	39	100%
Fungal species isolated (n=24)			
1.	<i>Aspergillus species</i>	9	37.50%
2.	<i>Candida species</i>	6	25.00%
3.	<i>Alternaria species</i>	3	12.50%
4.	<i>Mucour species</i>	3	12.50%
5.	<i>Penicillum species</i>	3	12.50%
	Total	24	100%
Mixed Pathogen (Bacteria+Fungus) Isolated (n=15)			
1.	<i>Aspergillus+ Escherichia coli</i>	9	60.00%
3.	<i>Aspergillus +Bacillus species</i>	3	20.00%
4.	<i>Candida spp. + S. aureus</i>	3	20.00%
	Total	15	100%

Table 1. Profile of microorganism isolated from cadaveric surfaces and surroundings (n=78)

basic infection control protocols as part of the induction training.

As per the new competency based curriculum introduced by the Medical Council of India (MCI) and the stress on early clinical exposure (ECE) , the students of MBBS 2019 batch onwards, undergo such training as part of the foundation course which is a turning milestone in medical education in India [1]. The significance of undergraduates being introduced to “standard infection control protocols” at the commencement of their course is extremely relevant for their safety. MCI has recently introduced a pandemic management module for undergraduate students in August 2020 [15]. The 80-hour longitudinal module on pandemic management stresses on the development of different skill sets in medical students including Infection Control practices such as i) Hand washing [16] ii) PPE Donning & Doffing iii) Disinfection besides many other skills [17].

CONCLUSION

The surfaces of the cadavers are colonized with spectrum of microorganisms. This study intends to enlighten, the naïve 1st semester medical students and staff, regarding risks to which they are exposed during handling of Cadavers; reinforcing the importance of practicing “Standard Precautions”.

REFERENCES

1. Medical Council of India, Competency based Undergraduate curriculum for the Indian Medical Graduate, 2018. Vol. 1; AN pg.41

<https://www.mciindia.org/cms/information-desk/for-colleges/ug-curriculum>

2. Korf HW, Wicht H, Snipes RL et al. The dissection course - necessary and indispensable for teaching anatomy to medical students. *Annals of Anatomy.* 2008; 190(1):16-22.
3. Kumar V, Martin LA, Kumar V, Kulal P. Attitude of first year Indian medical students towards cadaver dissection. *Int J Anat Res* 2015;3(3):1255-1258. DOI: 10.16965/ijar.2015.196.
4. Dinsmore CE, Daugherty S, Zeitz HJ. Student responses to the gross anatomy laboratory in a medical curriculum. *Clinical Anatomy.* 2001; 14(3): 231-236.
5. Sharma S, Gupta V . A Study on the Approach of Medical Students Towards Cadaver in the Dissection hall. *JK SCIENCE* . 2017 Vol. 19 No. 3 July.-Sept p187-190.
6. Molina C, Berrocal L, Jofré MR , Rosas C , Rojas XS. Identification of Bacterial and Fungal Species in Human Cadavers Used in Anatomy Teaching. *Int. J. Morphol* 2019; 37(2):473-476.
7. Mathur M, De A, Goew M. Microbiological assessment of cadaver skin grafts received in a Skin Bank. *Burns.* 2009, Vol. 35 (1) :104-106.
8. Kiyoshilshii , Hitosugi M, Kido M, Yaguchi T, Nishimura K, Hosoya T, Tokudome S. Analysis of fungi detected in human cadavers. *Legal Medicine* . 2006; Vol 8 (3): 188-190.
9. Tabaac B, Goldberg G, Alvarez L, Amin M, Shupe-Ricksecker K, Gomez F. Bacteria detected on surfaces of formalin fixed anatomy cadavers. *Ital J Anat Embryol.* 2013;118(1):1-5.
10. Osman NA, Abdeen SM, Edriss AA, Sulieman AA. Identification of fungal growth in formalin fix human cadaver among Faculties of Medicine at Khartoum Stat. *Nat. Sci.*, 12(11):64-7, 2014.

11. Colle JG, Miles RS, Watt B. Tests for the identification of Bacteria. In: Mackie and McCartney (ed.). Practical Medical Microbiology. 14th ed. Edinburgh: Churchill Livingstone; 1996. p66-67.
12. Chander J, Textbook of Medical Mycology, 4th edition Jaypee Brothers Medical publisher: 2017.
13. Kabadi CJ, Smith CR, Gomez F. Potential pathogen transmission on medical student anatomy laboratory clothing. Medical Student Research Journal. 2013 VOL: 02. Issue: Spring : epub May 2013.
14. Hoffman PN, Healing TD. Ed. Shaheen Mehtar. Book chapter. The infection hazards of human cadavers. Guide to infection control in the healthcare setting. Chapter last updated: February 2018.
15. New MBBS Curriculum: MCI Releases New Pandemic Management Module For Medical Students. Published On 27 Aug 2020 <https://medicaldialogues.in/news/health/mci/new-mbbs-curriculum-mci-releases-new-pandemic-management-module-for-medical-students-68968>.
16. WHO guidelines on hand hygiene in health care. Authors: World Health Organization 2009. pgs. 262 <https://www.who.int/gpsc/5may/tools/9789241597906/en/>
17. Health care workers. Using Personal Protective Equipment (PPE). CDC updated August 19, 2020 <https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html>.

TABLE OF CONTENTS

Volume 28 Issue 1 (June 2020)

Sl. No.	Title	Page No.
Original Articles		
1.	Study of variations of cervical segment of internal carotid artery <i>Mahendra Kumar Pant, Jayanti Pant</i> https://doi.org/10.46351/jas.v28i1pp01-06	1-6
2.	Effect of mobile phone radiation on adrenal gland of male albino rats <i>Shalini Gupta, Shilpi Jain, Satyam Khare, Prateek Gautam</i> https://doi.org/10.46351/jas.v28i1pp07-17	7-17
3.	Correlation of skeletal maturation stages of mp3 with onset of menarche amongst rural and urban school girls <i>Munish C. Reddy, Ambati Dharanija, Shalu Jain, Pradeep Raghav</i> https://doi.org/10.46351/jas.v28i1pp18-27	18-27
4.	Significance of sacral index in estimation of sex in north indian population <i>Kanchan Bisht, Rakesh K. Verma, Archana Rani, Navneet Kumar, Baibhav Bhandari</i> https://doi.org/10.46351/jas.v28i1pp28-32	28-32
Case Reports		
5.	Accessory peroneus brevis tendon - a case report <i>Mahendra Kathole, Krishna S. Patil, Shobhit Raizaday, Sadiq Syed</i> https://doi.org/10.46351/jas.v28i1pp33-36	33-36
6.	Anomalous peritoneal folds of liver with incomplete fissure for ligamentum teres - a case report <i>Arpita Gupta, Jasbir Kaur, Hitendra Loh, Vandana Mehta</i> https://doi.org/10.46351/jas.v28i1pp37-42	37-42
7.	A rare case of heterotaxia: fetal autopsy findings <i>Daisy Dwivedi, Bal Chander</i> https://doi.org/10.46351/jas.v28i1pp43-46	43-46
Short Communication		
8.	Tapetum - a misunderstood topic <i>P. K. Sharma, Sonia Jaiswal</i> https://doi.org/10.46351/jas.v28i1pp47-48	47-48
Guest Submission		
9.	Impact of religious practices on health and hygiene: a critical observational study with special reference to article 25 of the constitution of India <i>Vaibhav Goel Bhartiya, Prem Chandra, Himani Sharma</i> https://doi.org/10.46351/jas.v28i1pp49-56	49-56
Original Article – Student Authors		
10.	Microorganisms colonizing the cadavers: the need of infection control protocols during dissection <i>Tanya Sharma, Siddhant Sharma, Anita Pandey, Shobhit Raizaday, Satyam Khare, Mahima Tomar</i> https://doi.org/10.46351/jas.v28i1pp57-63	57-63