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Original Article

Histological changes in the human cervix uteri with advancing age: A cross-sectional tertiary care hospital-based study from Assam.

Santosh Kumar Sahu[1*], Joydev Sarma[2], Rup Sekhar Deka[3], Pradipta Ray Choudhury[4], Kunja Lal Talukdar[5]

1. Assistant Professor, Department of Anatomy, Jorhat Medical College and Hospital, Jorhat, Assam, India
2. Professor, Department of Anatomy, Gauhati Medical College and Hospital, Guwahati, Assam, India.
3. Professor, Department of Anatomy, Nalbari Medical College and Hospital, Nalbari, Assam, India.
4. Associate Professor, Department of Anatomy, Silchar Medical College and Hospital, Silchar, Assam, India.
5. Former Professor, Department of Anatomy, Gauhati Medical College and Hospital, Guwahati, Assam, India.

Abstract

Introduction

The uterine cervix is a dynamic biological barrier that undergoes significant structural changes due to aging and hormonal shifts. This study aims to quantify mucosal thickness and histological variations in the human cervix across different life stages in the Assamese population.

Materials and methods

A cross-sectional observational study was conducted using 30 cervical specimens divided into three groups: Group A (25–35 years), Group B (36–49 years), and Group C (50+ years). Histological processing was performed using Hematoxylin and Eosin staining. Mucosal thickness was quantified digitally using ImageJ software.

Results

Mean mucosal thickness was 2.920 mm in Group A, 2.750 mm in Group B, and a statistically significant reduction was observed in Group C, where the mean mucosal thickness was 1.820 mm. Younger specimens showed thicker mucosa and well-developed cervical glands, whereas older specimens showed glandular atrophy and mucosal thinning. The squamocolumnar junction was identified in most specimens.

Conclusion

The cervix shows progressive mucosal thinning and glandular atrophy with advancing age, particularly after 50 years. These observations may serve as baseline histological data for future studies on cervical pathology in North-Eastern India.

Recommendation

The findings provide baseline histological data on age-related cervical changes and may assist anatomists, pathologists, and gynecologists in distinguishing normal aging changes from pathological alterations. Further studies with larger sample sizes and multicentric participation are recommended.

Keywords: *Histology, Cervix uteri, Mucosal thickness, Squamocolumnar junction, Aging, Assam*
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Corresponding author: Santosh Kumar Sahu*
Email: dr.santoshgmc@gmail.com
Department of Anatomy, Jorhat Medical College and Hospital, Jorhat, Assam, India

Introduction

The human cervix uteri is a complex fibromuscular organ that undergoes significant histological transformation throughout a woman's life. In India, the cervix is a focal point of clinical research due to the high burden of cervical cancer [1]. Recent epidemiological studies emphasize the gravity of this issue, with data indicating substantial years of life lost and high disability-adjusted life years across various

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Indian states [2]. Histologically, the squamocolumnar junction is the most critical area for study, as a distinct population of cells at this site is identified as the origin for neoplastic transformation [3]. These tissues are subject to predictable remodelling influenced by the aging process and systemic hormonal changes [4]. The objective of this study was to quantify histological changes in cervical mucosal thickness across three age groups to establish regional anatomical standards.

Materials and methods

Study design

This study employed a cross-sectional observational design to evaluate age-related histological changes in the human cervix uteri. The study focused on the quantitative assessment of cervical mucosal thickness and associated histological variations among different age groups.

Study setting

The study was conducted in the Department of Anatomy, Gauhati Medical College and Hospital (GMCH), Guwahati, Assam, India, between January 2012 and December 2014. GMCH is a tertiary care teaching institution that provides specialized healthcare services and serves as a major referral center for the northeastern region of India. Histological processing and microscopic analyses were performed in the departmental histology laboratory.

Participants

Thirty cervical specimens obtained from unclaimed female cadavers were included in the study.

Inclusion criteria

- Female cadaveric cervical specimens aged 25 years and above.
- Well-preserved specimens without evidence of decomposition.
- Specimens with an intact cervix suitable for histological examination.

Exclusion criteria

- Specimens showing gross pathological lesions of the cervix.
- Presence of cervical tumors, fibroids, or traumatic injury.
- Poorly preserved tissues unsuitable for histological processing.

The specimens were divided into three groups:
Group A: 25–35 years (n=10)
Group B: 36–49 years (n=10)
Group C: 50 years and above (n=10)

Data collection

Cervical specimens were harvested following standard anatomical dissection procedures. Tissue samples were fixed in 10% buffered formalin, processed routinely, embedded in paraffin wax, sectioned at appropriate thickness, and stained using Hematoxylin and Eosin (H&E). Histological slides were examined under a light microscope. Digital images were captured and analyzed using ImageJ software. Mucosal thickness was measured at multiple representative points, and average values were calculated for each specimen to improve measurement reliability and comparability.
Additional histological observations included:

- Presence and morphology of cervical glands.
- Appearance of squamous and columnar epithelium.
- Identification of the squamocolumnar junction.
- Evidence of glandular atrophy and mucosal thinning.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using standard statistical procedures. Continuous variables were expressed as mean ± standard deviation (SD). Comparisons of mean mucosal thickness between age groups were performed using Student's t-test. A p-value less than 0.05 was considered statistically significant.
No missing data were observed because all collected specimens fulfilled the study requirements, and complete measurements were obtained for all samples.

Ethical considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of Gauhati Medical College and Hospital, Guwahati, Assam, India. The study utilized cervical specimens collected from unclaimed cadavers after completion of all medico-legal formalities. Confidentiality and ethical standards for handling human tissues were maintained throughout the study. The approval date and ethical clearance number should be added if available from institutional records.

Results

Histological analysis revealed distinct age-related changes. Mean mucosal thickness was highest in Group A and lowest in Group C. There is a sharp decline in mucosal thickness

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after the age of 50, decreasing from 2.750 mm in Group B to 1.820 mm in Group C. Younger age groups demonstrated numerous cervical glands and thicker mucosa, while elderly specimens showed atrophic glands and thinning of the mucosa, consistent with the effects of estrogen withdrawal. The squamocolumnar junction was clearly identified in most specimens.

Table 1: Mean mucosal thickness and statistical significance

Age Group	n	Mean Thickness (mm)	SD
25–35 years	10	2.920	0.123
36–49 years	10	2.750	0.178
≥50 years	10	1.820	0.436

Table 1 shows a progressive reduction in cervical mucosal thickness with advancing age. The highest mean thickness was observed in Group A (2.920 mm), while the lowest mean thickness was observed in Group C (1.820 mm).

Table 2 demonstrates statistically significant thinning of the cervical mucosa among women aged 50 years and above. No significant difference was observed between Groups A and B.

Table 2: Statistical significance of mucosal thinning

Comparison	p-value	Interpretation
Group A vs Group C	<0.001	Highly Significant
Group B vs Group C	<0.05	Significant
Group A vs Group B	>0.05	Not Significant

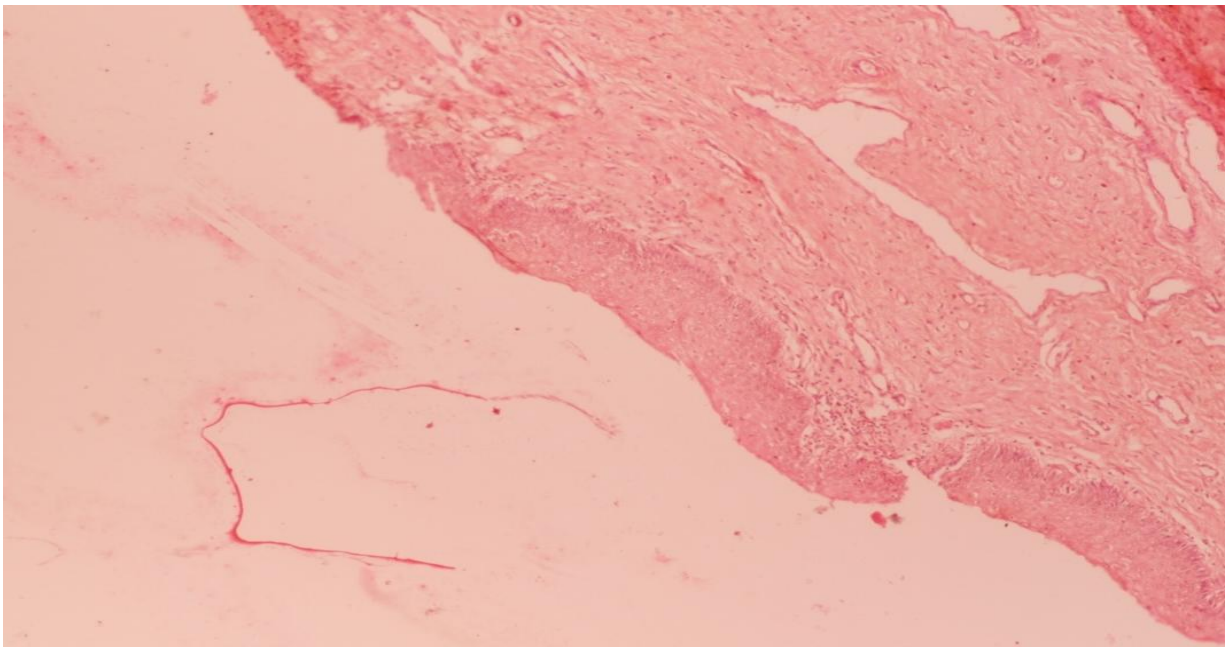

FIGURE 1: Photomicrograph of a 26-year-old cervix showing numerous active cervical glands and thick epithelial lining (hematoxylin and eosin, 10x).

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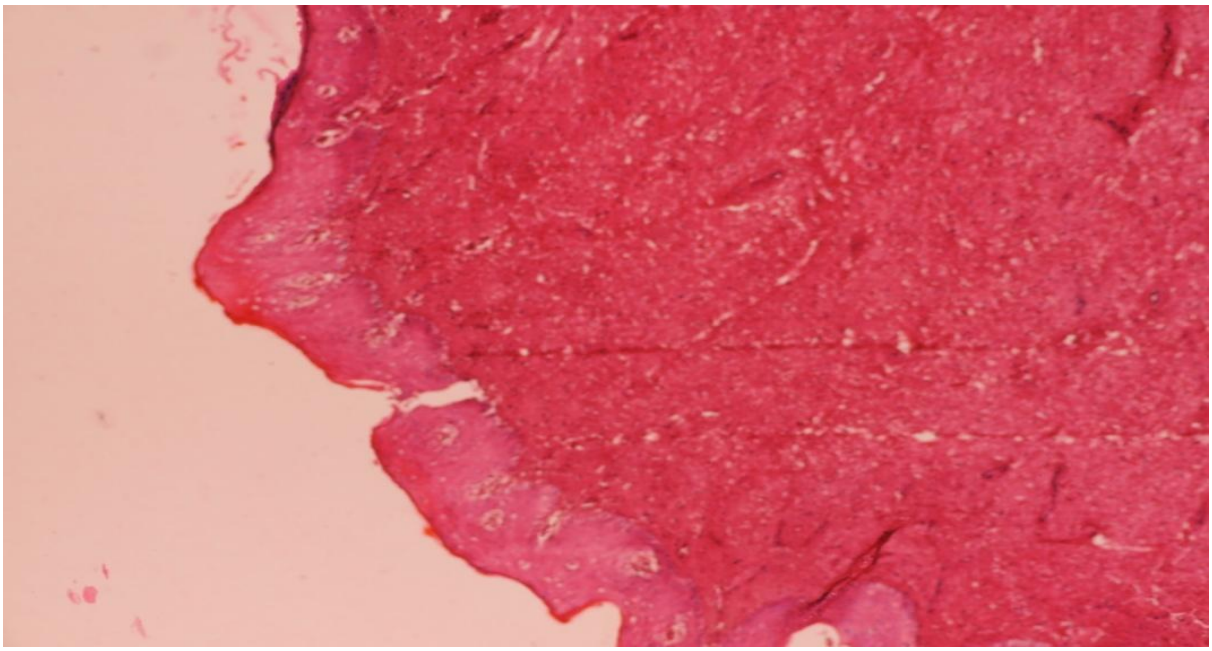

FIGURE 2: Photomicrograph of a 60-year-old cervix showing atrophic glands and thinning of the mucosal layer (hematoxylin and eosin, 10x).

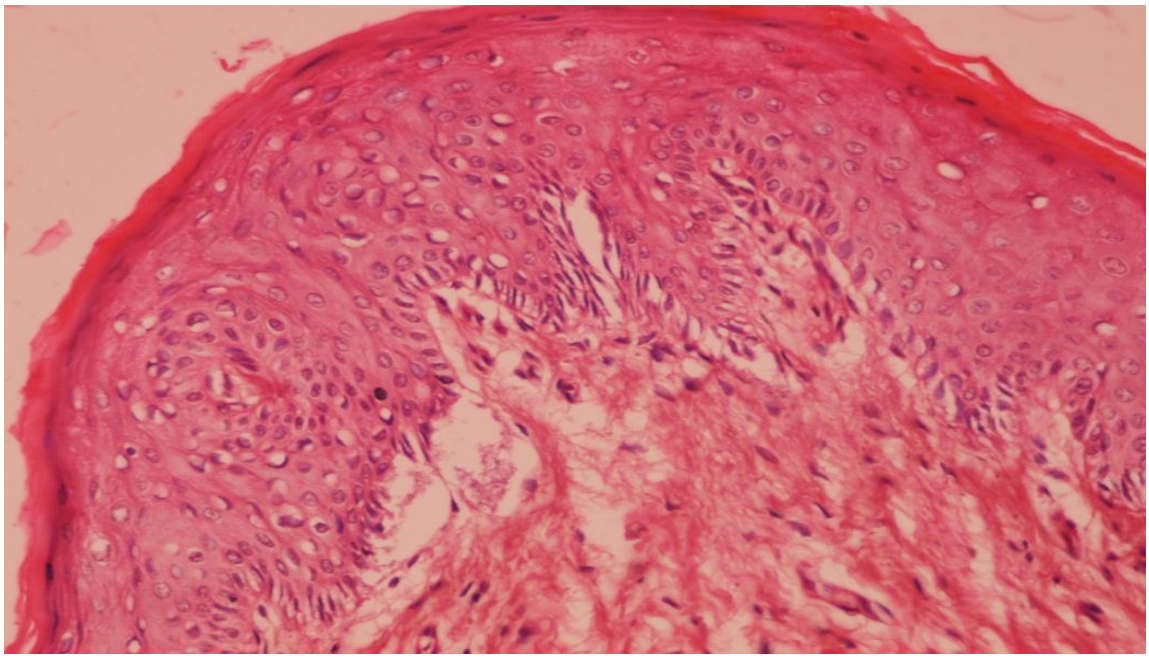

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FIGURE 3: Photomicrograph of a 45-year-old cervix showing non-keratinized stratified squamous epithelium.

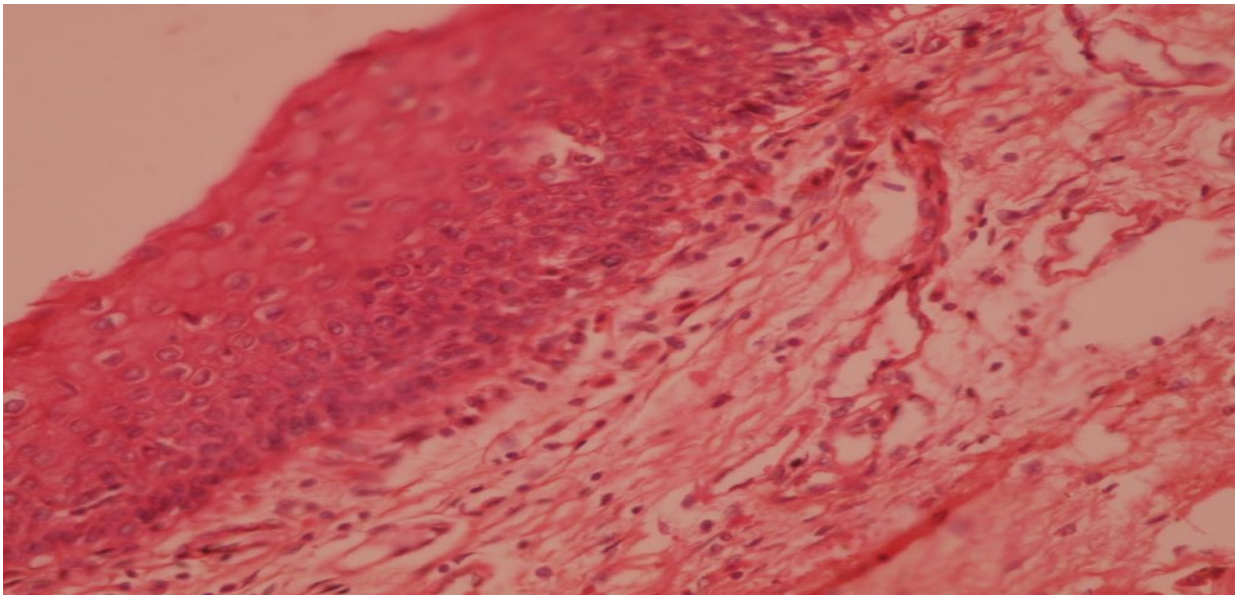

FIGURE 4: Photomicrograph of a 26-year-old cervix showing non-keratinized stratified squamous epithelium.

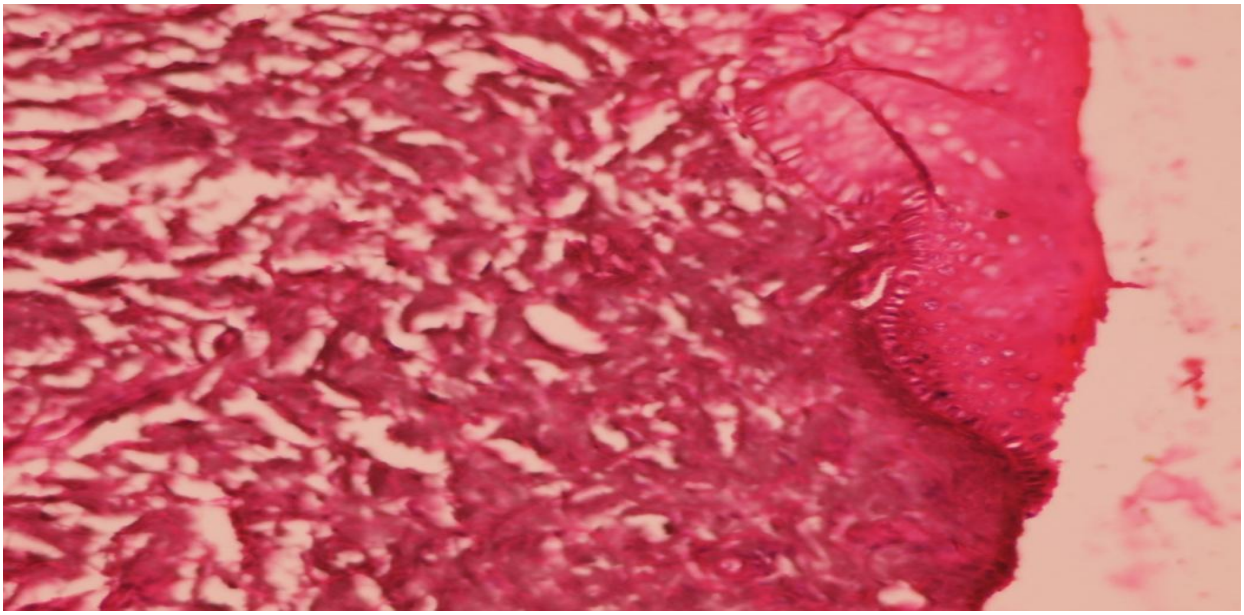

FIGURE 5: Section showing the squamocolumnar junction with abrupt transition from stratified squamous epithelium to simple columnar epithelium.

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Discussion

The findings demonstrate a clear age-dependent reduction in cervical mucosal thickness, with the most pronounced decline occurring after 50 years of age. This observation is likely attributable to postmenopausal estrogen deficiency, which results in epithelial atrophy, reduced glandular activity, and diminished stromal support. The preservation of cervical architecture in younger women reflects active hormonal stimulation and reproductive function. These findings support previous reports that aging significantly influences cervical morphology and histological integrity.

The study found a progressive and significant thinning of the cervical mucosa as age increased. The mean thickness was recorded at 2.920 mm in the reproductive age group, which decreased to 1.820 mm in the postmenopausal group. These findings are supported by regional research in Assam that documented marked atrophy of the squamous epithelium and reduced stromal vascularity in older women [5,6].

The reduction in oestrogen levels post-menopause leads to a depletion of epithelial layers and protective glycogen content [7]. Furthermore, the upward migration of the transformation zone into the endocervical canal complicates clinical screenings in the elderly [3]. Similar morphological trends have been reported in South Asian and international postmortem studies, highlighting the involution of uterine and cervical dimensions [8, 9]. Understanding cellular shifts, such as squamous metaplasia, remains fundamental to differentiating physiological aging from early pathological changes [10]. Additional morphometric studies in the region have also noted that cervical length varies significantly between reproductive and postmenopausal periods [11]. They are particularly relevant in North Eastern India, where cervical cancer remains an important clinical concern [1,2].

Generalizability

The findings of this study may be generalizable to women from similar ethnic and geographical populations in northeastern India. However, variations in genetic, environmental, nutritional, and hormonal factors across populations may influence cervical histology. Therefore, caution should be exercised when extrapolating the results to broader populations, and multicenter studies are recommended for wider applicability.

Conclusions

Progressive thinning of cervical mucosa and glandular atrophy occur with advancing age, especially after 50 years. In Assam, as in other regions, diseases of the cervix, including carcinoma, remain common. In this context, normal histological benchmarks are important for anatomical teaching, diagnostic interpretation, and future studies on cervical pathology in North Eastern India.

Limitations of the study

The study had several limitations. First, the sample size was relatively small, consisting of only 30 specimens. Second, specimens were obtained from a single institution, which may limit external validity. Third, information regarding hormonal status, parity, reproductive history, and menopausal duration was unavailable. Finally, only routine H&E staining was employed, and no immunohistochemical analyses were performed.

Recommendations

Larger multicenter studies should be conducted to establish comprehensive reference values for cervical histology.

Future studies should incorporate hormonal profiles and reproductive histories.

Advanced histochemical and immunohistochemical techniques may provide additional insight into age-related cervical changes.

The present findings may serve as baseline data for future research on cervical pathology and cervical cancer screening programs.

Acknowledgement

The authors express their sincere gratitude to the Department of Anatomy, Gauhati Medical College and Hospital, Guwahati, Assam, for providing laboratory facilities and institutional support. The authors also acknowledge the contribution of all technical staff involved in specimen preparation and histological processing.

List of abbreviations

H&E	Hematoxylin and Eosin
GMCH	Gauhati Medical College and Hospital
SD	Standard Deviation
IEC	Institutional Ethics Committee

Conflicts of interest

In compliance with the ICMJE uniform disclosure form, all authors declare no conflicts of interest.

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Financial relationships

All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Author contributions

Santosh Kumar Sahu: Conceptualization, data collection, histological analysis, manuscript preparation.
Joydev Sarma: Study design, supervision, manuscript review.
Rup Sekhar Deka: Data interpretation and literature review.
Pradipta Ray Choudhury: Statistical analysis and manuscript editing.
Kunja Lal Talukdar: Study supervision, critical review, and final approval of the manuscript.
All authors read and approved the final manuscript.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author biographies

Dr. Santosh Kumar Sahu is an academician in the Department of Anatomy with research interests in gross anatomy, histology, and anatomical education.
Dr. Joydev Sarma is a faculty member in Anatomy with experience in histomorphological and cadaveric research.

Dr. Rup Sekhar Deka is an anatomist involved in teaching and research related to human morphology and medical education.
Dr. Pradipta Ray Choudhury is a faculty member specializing in anatomical sciences and histological studies.
Dr. Kunja Lal Talukdar is a former Professor of Anatomy with extensive experience in anatomical teaching and research.

Disclosures

Human subjects

Consent was obtained or waived by all participants in this study. The study was approved by the Institutional Ethics Committee of Gauhati Medical College and Hospital, Guwahati. The specimens were collected from unclaimed human cadavers after completion of medico-legal formalities.

Animal subjects

All authors have confirmed that this study did not involve animal subjects or tissue.

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