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Editorial

Genome Sequencing-Based Cancer Diagnostic Methods

Cancer remains a leading cause of morbidity and mortality worldwide, with global incidence and mortality rates steadily increasing despite significant advances in prevention, early detection, and therapeutic strategies. According to GLOBOCAN 2020 estimates, there were approximately 19.3 million new cancer cases and 10 million cancer-related deaths globally, emphasizing the urgent need for more precise, sensitive, and individualized diagnostic approaches.[1] Traditional diagnostic modalities—such as histopathology, immunohistochemistry, imaging, and serum biomarkers—have served as the cornerstone of cancer detection and characterization. However, these methods are often limited by their specificity, sensitivity, and ability to capture the molecular heterogeneity inherent to malignant diseases. In recent years, genome sequencing-based diagnostics have emerged as a transformative frontier in oncology, offering unprecedented insights into the genetic underpinnings of cancer and enabling more accurate, tailored patient care.

The advent of next-generation sequencing (NGS) technologies has revolutionized our understanding of the genetic landscape of cancer. Unlike conventional single-gene assays, NGS allows for the simultaneous interrogation of multiple genes, providing a comprehensive view of the mutational, copy number, and structural variations that drive tumorigenesis.[2,3] Whole-genome sequencing (WGS), whole-exome sequencing (WES), and targeted gene panels have all found clinical utility in different oncological settings. WGS examines the entire genome, offering the broadest coverage and revealing non-coding mutations and complex rearrangements, while WES focuses on the protein-coding regions, which harbor the majority of known pathogenic variants.[4,5] Targeted panels, though limited in scope, provide cost-effective, rapid analyses of clinically actionable genes, making them particularly attractive in routine diagnostic laboratories.[6]

One of the most significant contributions of genome sequencing to cancer diagnostics lies in its ability to detect actionable mutations that can guide personalized therapeutic interventions. Tumor-specific alterations in genes such as EGFR, ALK, BRAF, KRAS, and PIK3CA have become critical biomarkers for selecting targeted therapies in lung, colorectal, melanoma, and breast cancers.[7,8] Comprehensive genomic profiling through NGS has also facilitated the identification of rare or novel mutations, fusion genes, and resistance mechanisms, expanding treatment options and improving outcomes.[9] For instance, the discovery of NTRK gene fusions across multiple tumor types led to the development of tumor-agnostic therapies, marking a paradigm shift in oncology.[10]

Liquid biopsy represents another promising application of genome sequencing in cancer diagnostics. By analyzing circulating tumor DNA (ctDNA), circulating tumor cells (CTCs), or exosomes from peripheral blood, liquid biopsies offer a minimally invasive, real-time snapshot of the tumor's genomic profile.[11,12] This approach has demonstrated clinical utility in early cancer detection, monitoring treatment response, and identifying mechanisms of resistance to targeted therapies.[13] Genome sequencing of ctDNA enables the detection of tumor-specific mutations with high sensitivity and specificity, providing a valuable complement to tissue biopsies, which are often limited by procedural risks, sampling bias, and tumor heterogeneity.[14,15]

Despite its immense potential, the integration of genome sequencing-based diagnostics into routine clinical practice faces several challenges. The complexity of data interpretation, the need for standardized bioinformatics pipelines, and the management of incidental findings pose significant hurdles.[16,17] Moreover, the cost and infrastructure requirements of NGS remain prohibitive in many low- and middle-income countries, limiting access to these advanced diagnostic modalities.[18] However, recent initiatives aimed at democratizing genomic medicine have begun to address these disparities. Notably, icddr,b (International Centre for Diarrhoeal Disease Research, Bangladesh) has recently launched advanced genome sequencing-based cancer diagnostic services, marking a pivotal development in the region's oncology landscape. By establishing state-of-the-art sequencing facilities and expertise, icddr,b aims to enhance precision cancer diagnostics, improve patient outcomes, and contribute to global cancer genomics research.[19]

The clinical impact of genome sequencing extends beyond diagnostics to encompass prognostication and risk stratification. Molecular profiling of tumors can identify biomarkers associated with disease aggressiveness, likelihood of metastasis, and response to specific therapies.[20] For example, mutations in TP53, BRCA1/2, and PTEN have prognostic implications in various cancers, informing clinical decision-making and patient counseling.[21] In hematologic malignancies, genome sequencing has refined disease classification, enabling the identification of distinct

molecular subtypes with different prognoses and therapeutic susceptibilities.[22] The incorporation of genomic data into risk prediction models and clinical algorithms holds promise for more personalized, evidence-based oncology care.

In hereditary cancer syndromes, germline genome sequencing plays a crucial role in identifying individuals at increased risk of developing malignancies, facilitating targeted surveillance and preventive interventions.[23] Multigene panel testing has supplanted single-gene assays in evaluating hereditary cancer predisposition, offering higher diagnostic yields and cost-effectiveness.[24] Genes such as BRCA1/2, MLH1, MSH2, APC, and TP53 are routinely assessed in individuals with personal or family histories suggestive of hereditary cancer syndromes.[25] The identification of pathogenic germline variants not only informs patient management but also enables cascade testing of at-risk family members, promoting early detection and cancer prevention.[26]

Emerging applications of genome sequencing in oncology include the characterization of the tumor microenvironment, epigenomic alterations, and transcriptomic profiles. [27] Integrating multi-omic data through advanced bioinformatics and machine learning algorithms enhances our understanding of tumor biology and facilitates the discovery of novel biomarkers and therapeutic targets.[28] Single-cell sequencing, another cutting-edge technology, offers insights into intratumoral heterogeneity, clonal evolution, and immune evasion mechanisms, informing the development of more effective, individualized treatment strategies.[29]

The growing clinical adoption of genome sequencing-based diagnostics has been supported by evolving regulatory frameworks and clinical guidelines. Regulatory agencies such as the US Food and Drug Administration (FDA) and the European Medicines Agency (EMA) have approved several NGS-based companion diagnostics, ensuring their analytical validity and clinical utility.[30] Professional organizations, including the American College of Medical Genetics and Genomics (ACMG) and the National Comprehensive Cancer Network (NCCN), have issued evidence-based recommendations for the use of genomic testing in specific cancer types and clinical scenarios.[31,32] These developments underscore the importance of multidisciplinary collaboration among oncologists, pathologists, geneticists, and bioinformaticians to optimize the implementation and interpretation of genome sequencing results.

Ethical, legal, and social considerations surrounding genome sequencing in oncology warrant careful attention. Issues such as informed consent, data privacy, the management of incidental findings, and equitable access to genomic services must be addressed to maximize the benefits of precision oncology while minimizing potential harms.[33] Public and professional education, transparent communication, and stakeholder engagement are essential components of responsible genomic medicine implementation.[34]

In conclusion, genome sequencing-based cancer diagnostic methods represent a transformative advancement in oncology, offering unparalleled opportunities for precise, individualized patient care. The integration of NGS technologies into clinical practice has improved the detection of actionable mutations, informed prognostic assessments, guided targeted therapies, and facilitated the identification of hereditary cancer syndromes. While challenges related to cost, infrastructure, data interpretation, and ethical considerations persist, ongoing technological innovations, regulatory support, and capacity-building initiatives—such as the recently launched services by icddr,b—are paving the way for more accessible and effective genomic diagnostics. As the field continues to evolve, collaborative efforts among clinicians, researchers, policymakers, and patients will be vital in harnessing the full potential of genome sequencing to reduce the global burden of cancer.

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Original article

Larger side port for capsulorhexis in Small Incision Cataract Surgery (SICS) with Posterior Chamber Intra Ocular Lens (PC IOL) implantation is safe, maintains constant anterior chamber depth and does not affect the refractive status of the eye

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Abstract:

Background: Capsulorhexis is an important step for a good Small Incision Cataract Surgery (SICS). Continous Curvilinear Capsulorhexis (CCC) technique was the anterior capsulotomy approach of choice. Depending on the liquidity of lens material, liquid cortex was aspirated using a 26 gauge needle before Capsulorhexis or through a small CCC through the main incision can be done but as the viscoelastic material comes out easily through the wound with the resultant shallow A/C & convex crystalline lens surface, the Capsulorhexis may cause radial tear of the anterior capsule. Moreover the work of capsulorhexis & rotation of cystotome through the wound at 12 o'clock is difficult. Side port Capsulorhexis overcomes this problem as it maintains constant deep A/C. ***Objectives:*** It may help in aspiration of cortical matter at 12 o'clock. As the side port in SICS is slightly larger it can compensate the astigmatism created by the incision at 12 o'clock. Here, the side port is sealed by hydration of the wound. ***Methodology:*** 20 eyes (10 pairs of eyes of some cataract-affected patients) were done SICS with side port Capsulorhexis. The study was conducted from 1st July 2021 to 31st December 2021. All patients were aged between 55 to 65 years and had age-related cataract with grade 2 to 4, all operations were done under LA by a 12 o'clock position. Two side pores were made at the nasal and temporal side. These side ports were slightly larger than the usual ones. Capsulorhexis was done through the right side port, SICS was done as usual and the eye was closed. ***Result:*** All patients have minimal AC reaction (+), no corneal striation, visual acuity unaided 6/18 to 6/9 with pinhole 6/9 to 6/6 after 1st week. After 8th weeks, all have corrected vision 6/6, and N5. ***Conclusion:*** Extra side pore can be made for Capsulorhexis in SICS, which helps in doing successful Capsulorhexis by maintaining constant AC depth without causing any bad effect to the cornea or vision and the incidence of astigmatism (Minus lens at 900).

Keywords: Capsulorrhexis, SICS surgery, PC IOL

Introduction:

Capsulorhexis which is Continuous Curvilinear Capsulorhexis (CCC) technique is better than capsulotomy as by this method incidence of tear of posterior capsule is less because of the smooth , regular and stable capsular margin without any tag of capsule in SICS surgery which may be captured by the aspiration canula during irrigation and wash of the

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cortical matter of lens and may cause accidental posterior capsule rupture[1]. Capsulorrhexis through the main wound can be done but sometimes the capsule may tear rapidly as the gel comes out rapidly andrepeatedly through the wound & depth of A/C becomes shallow soon and A/C depth cannot be maintained during capsulorhexis which is more important for good surgical outcome. Introduction of cystotome through the wound at 12 o'clock is also difficult. Rotation of the cystotome is also difficult through this wound. Side portcapsulorhexis overcomes these problems as it maintains constant deep A/C plus the introduction and rotation of the cystotome becomes easy. It may help in aspiration of cortical matter at 12 o'clock. As there are two side port in this Small Incision Cataract Surgery (SICS), it neutralizes the induced refractive error (due to the side port).

Materials & Methods:

This prospective observational study was carried out in the Department of Ophthalmology, Delta Medical College & Hospital, from 1st July 2021 to 31st December 2021 on 20 cataract patients aged between 55 to 65 years. Patients of cataract attending the Ophthalmology outdoor, Delta Medical College& Hospital, Dhaka. Subjects with associated with cataract treatment in the past 6 months, current vision therapy or orthoptics, ocular cause of reduced visual acuity (e.g. corneal opacity, pathological myopia), prior intraocular or refractive surgery were excluded from this study. After selection of the subject, the purpose and procedure of study were explained to each subject with a cordial attitude giving emphasis of the benefit they would obtain from the study. Detailed history were taken from all the selected patients and they underwent detail ophthalmic examination by slit lamp bio microscope and indirect ophthalmoscope. Visual acuity were assessed by Log MAR chart at a 6 meter testing distance and cover test were conducted with patients fixing both near and distance targets. Posterior segment examined after dilatation of the pupil with a midriatic topical agent by indirect ophthalmoscope, Volk lens.

Some 20 (cataract-affected eyes of patients) was selected for SICS with side pore capsulorhexis, Polymethyl Meth Acryl (PMMA) Intraocular Lens (IOL) in (a) capsular bag. The study was conducted in all patients having cataract with grade 1 to 3 nucleus. Informed consent was taken from all the patients. IOL power was calculated by biometry & IOL was selected with desired refraction -0.4 to -0.5D. All operations were done under L/A by the same surgeon.

All the patients were draped as usual after giving a peribulbar block. The scleral tunnel was made to enter into A/C. After introduction of viscoelastic two side pores were made, one on the right side and another on the left side and were made slightly larger than the conventional size. The anterior capsule of the lens was stained with trypan blue dye 0.035 (50 % dilution of 0.06% dye) (Auroblue, Aurolabs, India) under the OVD using the painting technique.[2,3] After capsular staining, Visco are injected again to replace the dye stained viscoelastic for enhanced visibility as well as to flattened the anterior capsule of lens. The anterior capsule is punctured in the center to aspirate the liquefied cortex and decompress the anterior chamber. Then capsulorrhexis was done through the side pore on the right side. SICS was done as usual. Irrigation & Aspiration (I/A) was done to wash out the cortical matter. But in eyes where the cortical matter was at 12 o'clock (positions) had to be removed by enlarging the side pore on the right side. Alcon PMMA IOL was implanted in all eyes. Washing of the viscoelastic substance was done by an I/A cannula. Injection of vancomycin 0.1 ml was given into anterior chamber. Eye was made closed with eye pad. Eye pad was removed on the 1st POD. Dexamethasone eye drop was installed two hourly for two weeks & then 6 hourly for one month. Patients were followed up after 2 weeks & 8 weeks. Follow-up was done up-to attainment of 0.3 Log MAR unit or stable vision for four consecutive visit.

Results:

All patients had a very minimum A/C reaction (+ or ++), no corneal striation; negligible conjunctival congestion, visual acuity unaided 6/18 to 6/9 & with pinhole 6/9 to 6/6 & N5. Postoperatively 3 eyes (5.77%) had corneal edema (striate keratopathy) and 1 eye (1.9%) had fibrin in anterior chamber. Five eyes (9.61%) had more than 2+ cells and flare at 2nd weeks. All responded well to intensive topical and subconjunctival steroids.

Distribution of best corrected visual acuity during follow-up periods

Table-1: Distribution of best corrected visual acuity in Log MAR unit of the study subjects.

Follow-up periods	BCVA (Log MAR unit)	T value / p value
Baseline	0.70±0.15 (SD)	……..
1st day	0.55±0.13 (SD)	12.476/000[s]
5th day	0.49±0.09 (SD)	13.405/000[s]
7th day	0.37±0.11(SD)	14.845/000[s]

s=significant

Table-1 and figure-1 shows the distribution of best corrected visual acuity in Log MAR unit of the study subjects in the baseline and follow-up periods. Mean best-corrected visual acuity in Log MAR unit was 0.70±0.15 (SD). It was 0.55±0.13 (SD),0.49±0.09 (SD) and 0.37±0.11(SD) in 1stday, 5thday and 7th day respectively.

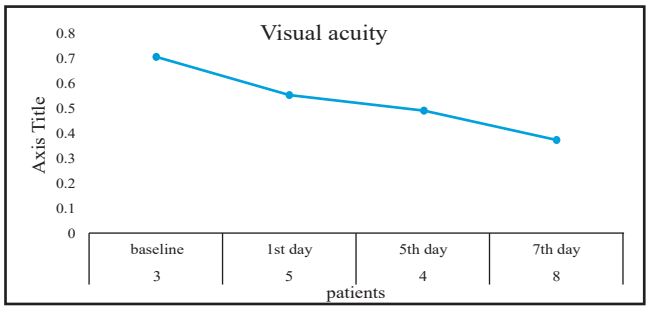

Figure-: I-Line chart showing distribution of best corrected visual acuity in Log MAR unit of study subjects

Distribution of mean best corrected visual acuity during follow-up periods according to the number of patients

Follow-up periods (Patients)	Baseline	After 1 month	t value/ p value	After 3 months	t value/ p value	After 6 months	t value/ p value
05	0.70+_0.16	0.55+_0.13	8.854/0.000[s]	0.48+_0.11	6.1/0.000[s]	0.33+_0.10	11.0/ < 0.001[s]
07	0.67+_0.13	0.55+_0.13	8.316/0.000[s]	0.49+_0.09	10.6/0.000[s]	0.36+_0.10	24.383/ <0.001[s]
08	0.78+_0.17	0.57+_0.16	9.101/0.000[s]	0.50+_0.10	9.027/0.000[s]	0.41+_0.17	12.899/ <0.001[s]

p value obtained by paired t test

Table-2: Best corrected visual acuity in different follow-up periods according to the) number of patients.

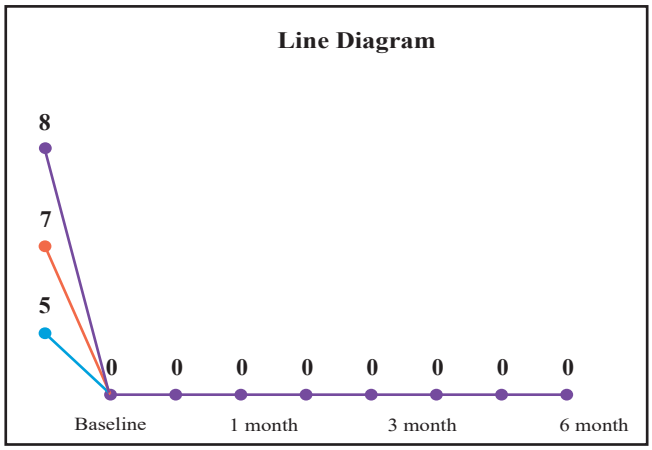

Figure II: shows the distribution of best corrected visual acuity according to the number of patients.

Table-2 and figure-II shows the distribution of best corrected visual acuity according to number of patients. Mean corrected visual acuity of 5 patients, baseline, 1 month, 3 months, 6 months period were 0.70±0.16,0.55±0.13, 0.48±0.11,0.33±0.10 respectively. In 7 patients it was 0.67±0.13, 0.55±0.13, 0.49±0.09,0.36±0.10 respectively and in 8 patients it was 0.78±0.17, 0.57±0.16, 0.50±0.10, 0.41±0.1 respectively.

Discussion

Performing a CCC in eyes with intumescent cataract presents a significant challenge to cataract surgeons because of poor visualization of the anterior capsule as a result of the absence of red reflex. This is further complicated by lens milk extrusion upon puncture of the anterior capsule and high intraocular pressure. There was no endopthalmitis. In two cases, the final visual acuity was worse than 20/200 because of preexisting posterior segment pathology.

Moreover, intumescent cataracts are usually associated with increased and higher than usual posterior vitreous pressure, making capsulorhexis more challenging.[4] The astigmatism in 10 eyes with posterior chamber IOL was less as the wound size was 3.2 to 3.5 mm and astigmatism was -1.12 D on the first day & -.77 D after 6 weeks. The extra side port in SICS does not affect much on astigmatism there was no opacity on the cornea due to the side port.[5,6]

Conclusion

An extra side port can be done for capsulorhexis in SICS which helps in doing successful capsulorhexis by maintaining desirable A/C depth without causing adverse effects on refraction and any harmful effect to the cornea.

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Original article

Health Impacts of Dye Factory Wastewater: Gastrointestinal, Respiratory, and Skin Symptoms in Children Under 5 in Urban Dhaka

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Abstract:

Background: Gastrointestinal symptoms, particularly diarrhea, and acute respiratory tract infections are among the leading causes of mortality worldwide, including in Bangladesh. Dermatological symptoms also contribute notably to morbidity in both children and adults. Exposure to wastewater from dye factories has been proposed as a potential contributor to these health issues, especially in urban areas where such factories are concentrated. However, there is limited data on the prevalence of these symptoms among children exposed to such environmental pollutants. ***Objectives:*** This study aims to investigate the prevalence of respiratory, gastrointestinal, and dermatological symptoms among children under 5 years of age exposed to dye factory wastewater in the Munda and Polartek communities of Uttarkhan, Dhaka. ***Methods:*** A community-based cross-sectional study was conducted among 200 children aged 6 to 59 months living in wastewater-exposed areas. Data were collected through face-to-face interviews with caregivers using a pre-tested, semi-structured questionnaire. The questionnaire covered socio-demographic information and the presence of specific respiratory, gastrointestinal, and dermatological symptoms in the children. ***Results:*** Among the children, 77.0% experienced nasal discharge, 66.0% had a cough, 20.0% reported shortness of breath, and 26.5% had wheezing. Gastrointestinal symptoms included diarrhea (16.5%), vomiting (22.5%), and abdominal pain (18.0%). Dermatological symptoms were also reported, including itching (17.5%), rash (20.5%), skin ulceration (13.0%), and skin color changes (0.9%).***Conclusion:***This study highlights a considerable prevalence of respiratory, gastrointestinal, and dermatological symptoms among children under 5 exposed to dye factory wastewater. The findings suggest a potential link between industrial pollution and adverse child health outcomes in urban settings. Further research and targeted public health interventions are recommended to mitigate these risks and safeguard vulnerable populations

Keywords: Gastrointestinal symptoms, Cough, Wheeze, respiratory symptoms, dermatological symptoms, dye factory wastewater, under 5 children, urban community, Dhaka, Bangladesh.

Introduction:

Gastrointestinal, respiratory, and dermatological symptoms are major health concerns for children under 5, particularly in developing countries.[1] Diarrheal diseases, including acute diarrhea, are a leading cause of death globally, with significant mortality rates in Asia and Bangladesh, where inadequate sanitation contributes to high rates of

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diarrhea-related deaths.[2] Vomiting and abdominal pain, often associated with gastrointestinal disorders, also pose severe health risks, including dehydration and malnutrition. Respiratory infections, such as pneumonia and bronchitis, are another leading cause of under-5 child mortality worldwide, with the highest prevalence in low-income countries.[3] In Bangladesh, respiratory tract infections are responsible for a significant proportion of child deaths, driven by overcrowded living conditions, poor nutrition, and limited healthcare access.[4] Dermatological disorders, including itching and rashes, are prevalent in children under 5 and are often exacerbated by environmental pollution, such as exposure to industrial wastewater from dye factories.[5] These factories discharge harmful chemicals into nearby water bodies, leading to contamination and environmental degradation.[6] In urban areas like Uttarkhan, Dhaka, children are especially vulnerable to these health issues due to their exposure to dye factory wastewater. Despite growing awareness of the risks, limited data exists on the prevalence of these symptoms in affected communities.[7] This study aims to fill that gap by investigating the health impacts of dye factory wastewater on children under 5 in the Munda and Polartek communities, with a focus on gastrointestinal, respiratory, and dermatological symptoms. The findings will contribute to public health strategies and policy development to mitigate the effects of industrial pollution on vulnerable populations.

Methodology:

A cross-sectional study was conducted from January 1 to December 31, 2018, in Munda and Polartek—two localities in Uttarkhan, under Uttara Thana of the Dhaka North City Corporation, known for exposure to dye factory wastewater. The study population comprised children under five years of age exposed to this wastewater.Using a simple random sampling technique, the first household was selected from a baseline list developed in a previous "Bangladesh Medical University (BMU)" study. Thereafter, every alternate household was visited to identify eligible participants. A total of 200 households with at least one child under five were included.Data were collected through face-to-face interviews with mothers or primary caregivers using a pre-tested semi-structured questionnaire. The questionnaire covered:

- Children's symptoms (gastrointestinal, respiratory, dermatological) in the past month
- Water usage practices
- Socio-demographic characteristics

To ensure reliability, the questionnaire was pilot-tested and refined before data collection. Interviews were monitored for consistency and completeness.Data analysis was performed using SPSS version 21. Continuous variables were summarized as means and standard deviations, and categorical variables were expressed as frequencies and percentages. Results were presented using tables and diagrams for clarity.

Results:

A total of 200 children under 5 years of age exposed to dye factory wastewater in the Uttarkhan area participated in the study. Respiratory symptoms were common, with 77% of children experiencing nasal discharge, 66% having a cough, 20% suffering from shortness of breath, 26.5% experiencing wheezing or whistling chest, and 8% reporting throat pain. In terms of gastrointestinal symptoms, 16.5% of children had diarrhea, 22.5% suffered from vomiting, and 18% experienced abdominal pain. Dermatological issues were also prevalent, with 17.5% reporting itching, 20.5% having a rash, 13% suffering from skin ulceration, and 9% experiencing changes in skin color. These findings suggest that exposure to dye factory wastewater is associated with a high prevalence of respiratory, gastrointestinal, and dermatological symptoms in children under 5. The results highlight the potential health risks posed by environmental pollution, particularly in urban areas, and emphasize the need for further research and intervention to protect vulnerable populations

Table 1: Prevalence of Respiratory Symptoms among Children Less than Five Years of Age Exposed to Dye Factory Wastewater.

Symptoms in last thirty days	**Number (n)**	**Percentage (%)**
Nasal discharge		
Yes (Y)	154	77.0
No (N)	46	23.0
Cough		
Yes (Y)	132	66.0
No (N)	68	34.0
Shortness of breath		
Yes (Y)	40	20.0
No (N)	160	80.0
Wheezing or whistling chest		
Yes (Y)	53	26.5
No (N)	147	73.5
Throat pain		
Yes (Y)	16	8.0
No (N)	184	92.0

● Among the children under 5 years of age, 77% experienced nasal discharge, 66% had a cough, and 26.5% suffered from wheezing or a whistling chest. 20% of the children reported shortness of breath, while 8% had throat pain.

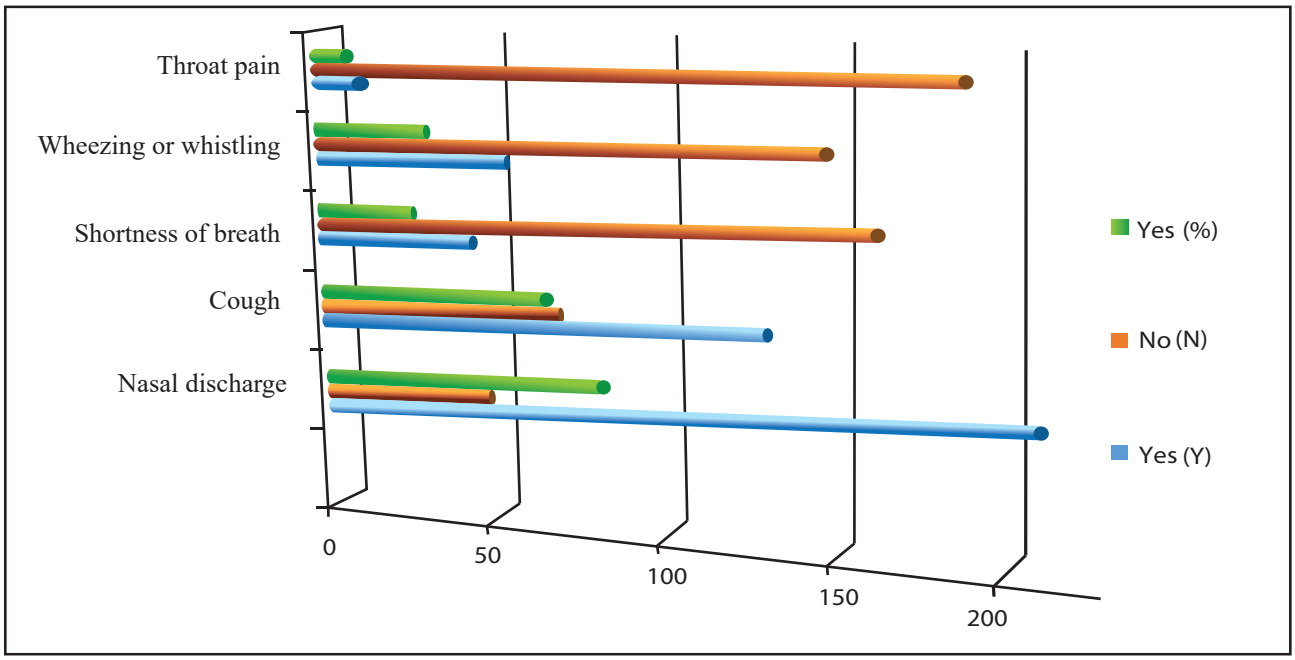

Figure 1: Bar Chart Showing the Prevalence of Symptoms in the Last 30 Days

Table 2: Prevalence of Gastrointestinal Symptoms in Children over the Last Thirty Days.

Symptoms in last thirty days	Number (n)	Percentage (%)
Diarrhea or loose motion		
Yes (Y)	33	16.5
No (N)	167	83.5
Vomiting		
Yes (Y)	45	22.5
No (N)	155	77.5
Abdominal pain		
Yes (Y)	36	18.0
No (N)	164	82.0

● Among the children under 5 years of age, 22.5% experienced vomiting, 18% had abdominal pain, and 16.5% suffered from diarrhea or loose motions..

Table 3: Prevalence of Dermatological Symptoms in Children over the Last Thirty Days

Symptoms in last thirty days	Number (n)	Percentage (%)
Itching		
Yes (Y)	35	17.5
No (N)	165	82.5
Rash		
Yes (Y)	41	20.5
No (N)	159	79.5
Ulceration		
Yes (Y)	26	13.0
No (N)	174	87.0
Color change		
Yes (Y)	18	9.0
No (N)	182	91.0

● Among the children under 5 years of age, 20.5% had a rash, 17.5% experienced itching, 13% had skin ulceration, and 9% reported changes in skin color.

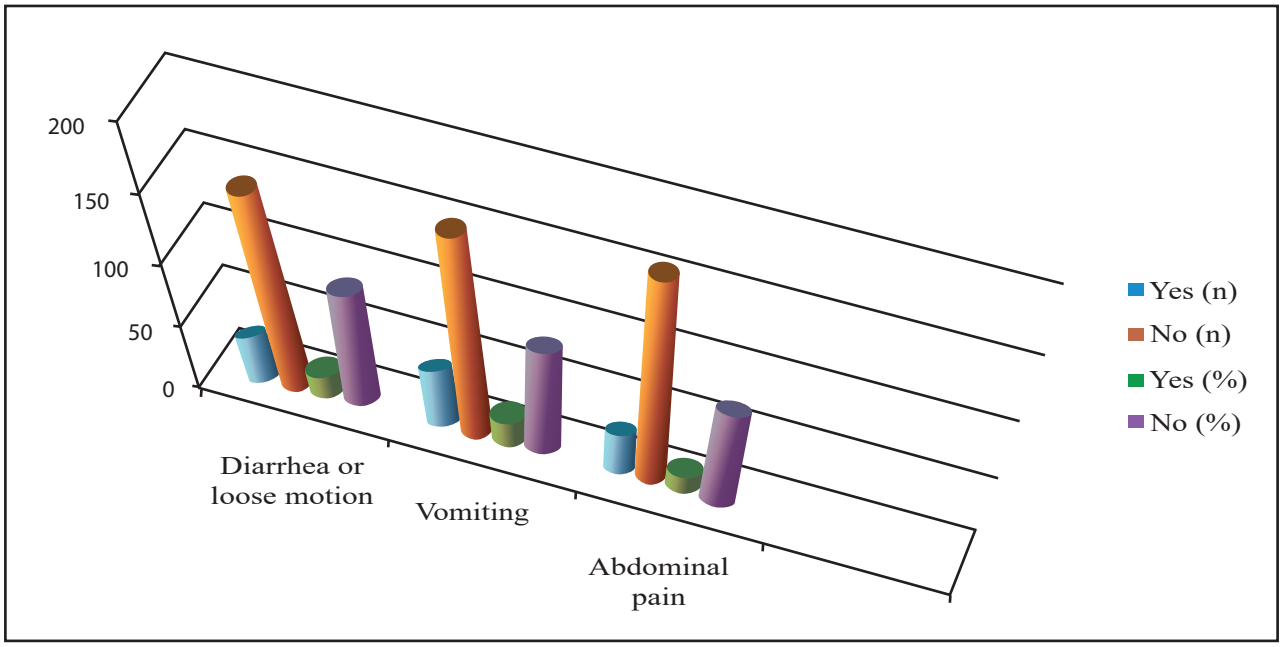

Figure 2 : Bar Chart Showing Prevalence of Gastrointestinal Symptoms in the Last 30 Days

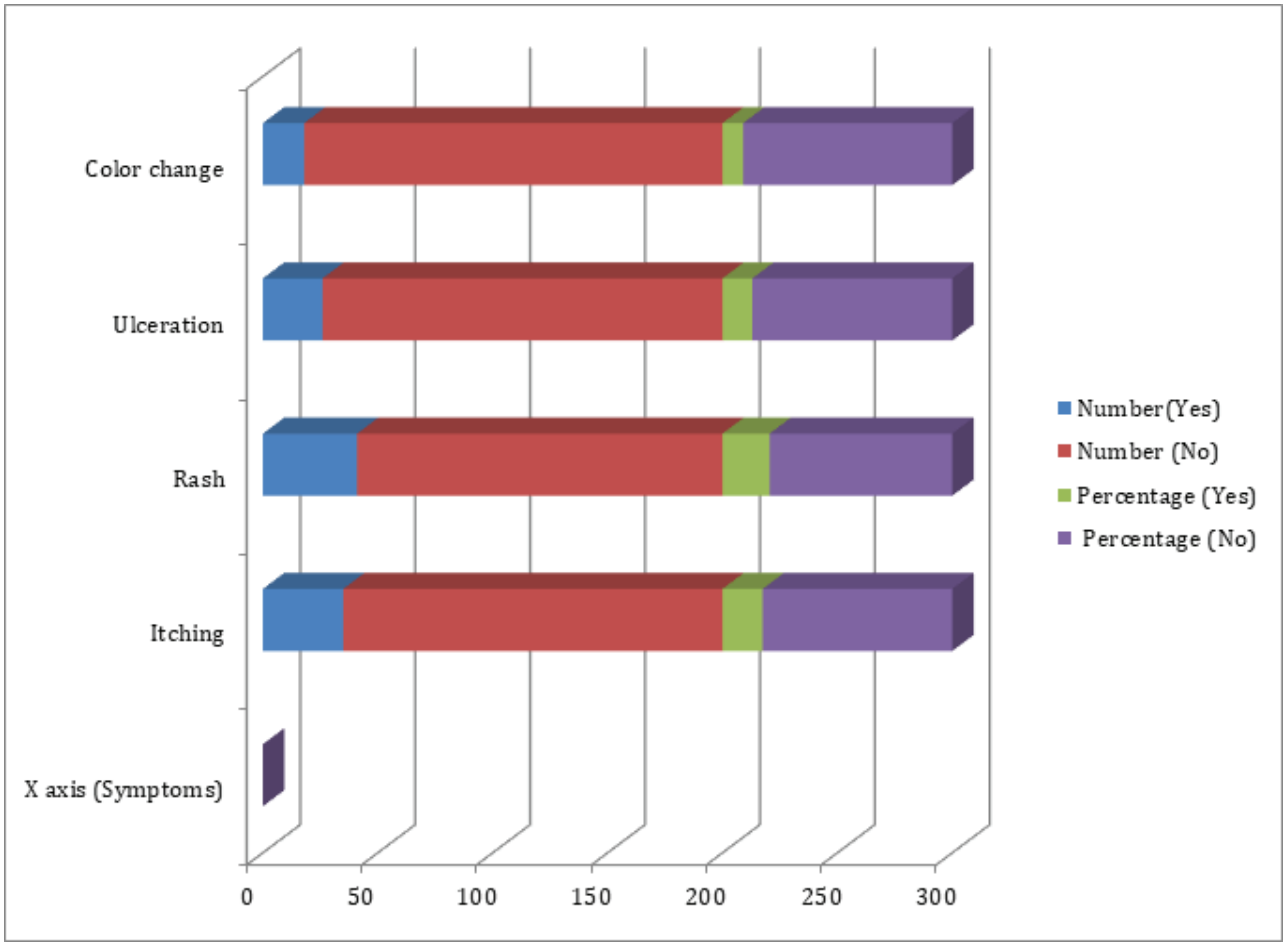

Figure 3: Severity Distribution of Dermatological Symptoms Among Children Exposed to Dye Factory Wastewater in Uttarkhan, Dhaka (3D Horizontal Stacked Bar Chart)

Discussion

Gastrointestinal Symptoms

The findings from this study reveal a considerable burden of gastrointestinal symptoms—diarrhea (16.5%), vomiting (22.5%), and abdominal pain (18%)—among children under five exposed to dye factory wastewater in Uttarkhan, Dhaka. These rates are higher than those reported in prior studies in Bangladesh, 8where diarrhea prevalence ranged from 1.6% to 6.1%. The elevated rates in our study may be attributed to direct exposure to dye factory wastewater, which often contains harmful substances like azo dyes and heavy metals.[9] These toxins are known to irritate the gastrointestinal tract, potentially causing inflammation or altering gut microbes, thereby increasing vulnerability to gastrointestinal disorders.[10] The average age of children in our study was 28.6 months, and research shows that children aged 1–2 years are particularly susceptible to gastrointestinal infections due to immature immune systems and frequent hand-to-mouth activity.[11] In line with this, we observed higher rates of diarrhea among children in this age group. Furthermore, socioeconomic factors such as inadequate sanitation, poor access to clean drinking water, and limited healthcare services likely compound the risk of gastrointestinal infections in these communities.[12]

Respiratory Symptoms

Respiratory symptoms were also highly prevalent, with 77.0% of children experiencing nasal discharge, 66.0% reporting cough, 26.5% having wheezing, and 20.0% suffering from shortness of breath. These figures are notably higher than those found in previous studies in India and Bangladesh, where the prevalence of respiratory symptoms typically ranged from 20% to 28%.[13] This disparity suggests a possible association between dye factory wastewater exposure and respiratory irritation caused by airborne pollutants and toxic fumes.[14] Environmental conditions at the time of the study may have exacerbated these symptoms. Data were collected during the dry winter season—a period linked to increased airborne particulate matter and industrial emissions.[15] This seasonal effect, combined with the children's developing respiratory systems and the additional burden of indoor pollution (e.g., from biomass fuel or poor ventilation), could further explain the high rates of respiratory symptoms observed.[16] The presence of wheezing and shortness of breath raises concern for more severe respiratory illnesses, such as asthma, bronchitis, or pneumonia, potentially linked to chronic exposure to environmental toxins.[17]

Dermatological Symptoms

Although dermatological symptoms were less prevalent than gastrointestinal and respiratory ones, they remain a noteworthy health concern. Rash (20.5%), itching (17.5%), skin ulceration (13%), and skin color changes (9%) were reported among exposed children. These findings align with existing literature suggesting that contact with polluted water can result in skin irritation or more chronic conditions.[18] However, the absence of scabies and other contagious skin diseases in our study may be due to the cross-sectional nature of the research and its limited duration, which may not have captured the full effects of long-term exposure.[19] Compared to previous studies reporting higher rates of skin diseases, our findings may seem modest; however, it's important to consider that those studies often involved different age groups or hospital-based populations.[20] Moreover, the onset of chronic dermatological symptoms often requires prolonged exposure. Nonetheless, poor hygiene, overcrowding, and limited access to clean water—common in urban slums—are contributing environmental factors that may exacerbate dermatological issues.[21] These conditions, in combination with exposure to dye wastewater, could increase the risk of skin problems in this vulnerable population.[22]

Conclusion

In conclusion, this study highlights the serious health risks posed by exposure to dye factory wastewater among children under five years of age in the Uttarkhan area of Dhaka, Bangladesh. The higher prevalence of gastrointestinal, respiratory, and dermatological symptoms in our study population compared to other studies suggests that industrial pollution plays a critical role in exacerbating health issues in vulnerable populations. The findings underline the urgent need for environmental interventions to mitigate the harmful effects of dye factory wastewater, particularly in urban slum areas. Policy-makers and public health authorities must prioritize the reduction of industrial pollution, improve water and sanitation infrastructure, and ensure better healthcare access for children living in these highly affected areas. Further research, including longitudinal studies, is needed to fully understand the long-term health consequences of prolonged exposure to dye wastewater and to develop effective interventions.

- We do not have any conflict of interest
- The research work is self-funded
- **Acknowledgments**

We acknowledge the cordial co-operation and participation of the respondents who participated in this research; it would have been impossible without their support. The love and respect that we received from them during our field work were remarkable. Besides this, the eternal inspiration, blessings, care and love of our parents, family members, teachers, colleagues, friends and contributors to the research work gave us endless support for this task. Last but not least, the field-level workers and coordinator deserve special thanks.

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Original article

An Osteometric Study of the Lateral Malleolus of the Lower End of the Fibula

Received: 12.03.2025 Accepted: 08-05-2025

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Abstract

Background: Humans are unique among primates for their exclusive bipedal locomotion, with body weight entirely supported by the lower limbs. This adaptation has led to several evolutionary modifications that maintain upright posture. The medial malleolus of the tibia and the lateral malleolus of the fibula form a deep socket that stabilizes the talus. During weight-bearing, forces are transmitted from the tibia and fibula to the talus, with the fibula supporting approximately one-sixth of the static load at the tibiofibular joint. ***Objectives:*** This study aimed to measure various morphometric parameters of the lateral malleolus at the distal end of the fibula. ***Methodology:*** This cross-sectional descriptive study was conducted in the Department of Anatomy, Mymensingh Medical College, Bangladesh, from January 2023 to December 2023. A total of 300 dry fibulae (152 right, 148 left) were selected using a purposive sampling technique. Specimens with fractures, deformities, or incomplete ossification were excluded. Data were recorded, tabulated, and statistically analyzed using Microsoft Excel and SPSS software. ***Result:*** The mean (± SD) of height of the lateral malleolus was 25.84 (± 2.76) mm on right side and 25.41 (± 2.96) mm on left side. The mean (± SD) of coronal width of the lateral malleolus was 16.70 (± 1.68) mm on right side and 17.24 (± 1.51) mm on left side. The mean (± SD) of sagittal width of the lateral malleolus was 22.76 (± 2.06) mm on right side and 23.33 (± 1.99) mm on left side. ***Conclusion:*** The standard osteometric measurements of the lateral malleolus of the fibula investigated in this study represent novel findings that may contribute to advancements in both operative management techniques and prosthetic design for lateral malleolar fractures.

Keywords: Osteometry, lateral malleolus, fibula, anatomy

Introduction:

The distal end of the fibula forms the lateral malleolus, which projects distally and posteriorly. Its lateral aspect is subcutaneous, while the posterior aspect features a broad groove with a prominent lateral border. The anterior aspect is rough, rounded, and continuous with the inferior border of the tibia. The medial surface presents a triangular articular facet, vertically convex with its apex directed distally, articulating with the lateral surface of the talus. Posterior to this facet lies a rough malleolar fossa, marked

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by vascular foramina.[1] Humans are the only primates with an obligate bipedal gait, transmitting body weight to the ground through the lower limbs. Consequently, several adaptations have evolved to maintain an upright posture. The medial malleolus of the tibia and the lateral malleolus of the fibula form a deep recess that accommodates the talus. Body weight is transmitted from the tibia and fibula to the talus, with approximately one-sixth of the static load borne by the fibula at the tibiofibular joint. The lateral malleolus contributes to a stable socket-like structure, ensuring proper talar alignment.[2] Accurate morphometric assessment of the distal fibula is essential for managing isolated lateral malleolar fractures or bimalleolar fractures. Complete anatomical reduction of the lateral malleolus during treatment is critical to preventing long-term complications such as degenerative arthritis.[3]

Materials and methods

This study was conducted on 300 fully ossified dry human fibulae collected from the Department of Anatomy at Mymensingh Medical College (MMC), Mymensingh, Bangladesh, as well as from 1st and 2nd-year MBBS students. Among the 300 fibulae, 152 were right-sided, and 148 were left-sided. The study was carried out from January 2023 to December 2023 as a cross-sectional descriptive study. A non-random purposive sampling technique was used for sample selection. Ethical clearance was obtained from the Institutional Review Board (IRB) of MMC (Memo No. MMC/IRB/2023/575; Date: 24/06/2023).

Only fully ossified dry human fibulae were included in this study. Fractured fibulae, as well as those with tumors, deformities, or other abnormalities, were excluded. Three different parameters were measured in this study:

1. Maximum Height of the Lateral Malleolus: The fixed jaw of the slide calipers was placed on the upper margin of the facet for the talus, and the sliding jaw was adjusted to the tip of the lateral malleolus. The maximum height between these two points was measured and recorded in millimeters (mm).
2. Maximum Coronal Width of the Lateral Malleolus: The fixed jaw of the slide calipers was placed on the widest part of the lateral surface of the lateral malleolus, and the sliding jaw was positioned on the medial surface. The distance between these two points was measured using digital slide calipers and recorded in millimeters (mm).
3. Maximum Sagittal Width of the Lateral Malleolus

Figure 1 : Photograph showing procedure of measurement of height of lateral malleolus & measured by slide calipers

Figure 2 : Photograph showing procedure of measurement of coronal width of lateral malleolus & measured by slide calipers

Figure 3: Photograph showing procedure of measurement of sagittal width of lateral malleolus & measured by slide calipers

Result:

The height of the lateral malleolus in 152 right fibulae ranged from 18.26 mm to 34.43 mm, with >86% of measurements falling between 22.50 mm and 30.00 mm. Among 148 left fibulae, the height ranged from 14.56 mm to 37.77 mm, with >83% of cases measuring between 22.50 mm and 27.50 mm.

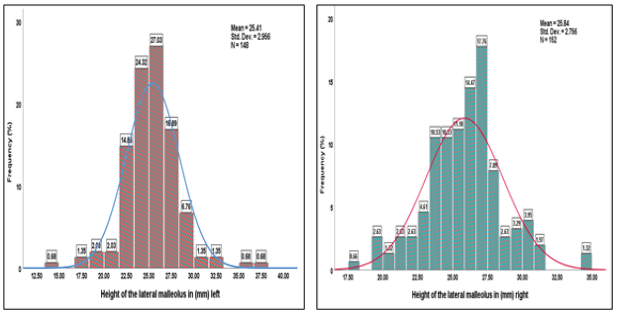

Figure 4: Histogram showing the frequency distribution of height of the lateral malleolus of both sided fibula

The coronal width of the lateral malleolus in 152 right fibulae ranged from 12.38 mm to 20.91 mm, with >82% of measurements falling between 15.00 mm and 19.00 mm. Among 148 left fibulae, the coronal width ranged from 13.54 mm to 20.76 mm, with >84% of cases measuring between 15.00 mm and 19.00 mm. .

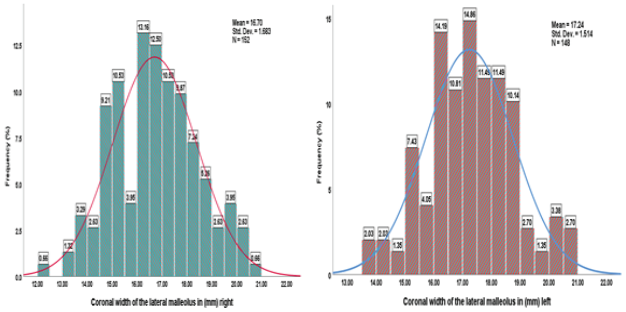

Figure 5: Histogram showing the frequency distribution of coronal width of lateral malleolus of both sided fibula

The sagittal width of the lateral malleolus in 152 right fibulae ranged from 16.42 mm to 27.79 mm, with >85% of measurements falling between 20.00 mm and 25.00 mm. Among 148 left fibulae, the sagittal width ranged from 18.44 mm to 28.87 mm, with >83% of cases measuring between 21.00 mm and 26.00 mm.

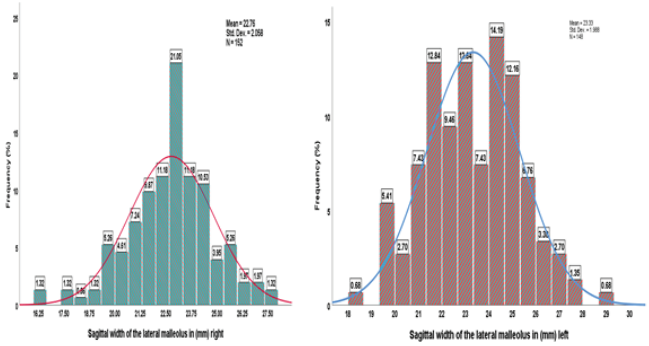

Figure 6: Histogram showing the frequency distribution of sagittal width of lateral malleolus of both sided fibula

Discussion

In the present study, the mean (±SD) height of the lateral malleolus measured 25.84±2.76 mm on the right side and 25.41±2.96 mm on the left side. These values were higher than those reported by Raza et al. (23.7±2.2 mm on right; 19.25±1.528 mm on left)[4] and Shishirkumar et al. (18.93±2.093 mm on right; 19.25±1.528 mm on left).[5] For coronal width measurements, our study found means of 16.70±1.68 mm (right) and 17.24±1.51 mm (left). These results were comparable to Raza et al. (18.0±2.3 mm on right; 16.9±1.6 mm on left).[4] Regarding sagittal width, we recorded means of 22.76±2.06 mm (right) and 23.33±1.99 mm (left). These findings were similar to Raza et al. (23.5±1.5 mm on right; 22.9±1.2 mm on left)[4] but higher than Shishirkumar et al. (20.07±1.9 mm on right; 19.94±1.181 mm on left).[5]

Conclusion

This study yields novel osteometric data on the lateral malleolus, precisely quantifying its contour, length, and width—addressing gaps in existing literature through a robust sample (N=300) that surpasses prior studies in both

scope and detail. These findings hold direct clinical value for improving pre-contoured plating systems by enabling anatomically accurate curvature designs, optimized screw trajectories, and region-specific thickness variations, thereby reducing intraoperative plate bending and improving fit. Furthermore, the dimensional parameters establish objective benchmarks for assessing fracture reduction quality and detecting malunions, while correlations between contralateral limbs suggest potential for mirroring technology in unilateral fracture repair. By bridging anatomical precision with orthopedic engineering, this work lays the foundation for next-generation implants that may decrease operative time, minimize implant-related complications, and reduce revision rates—ultimately advancing personalized fracture fixation through evidence-based design.

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Original article

Effects of Temperature on the Color of Human Liver and Stomach in Silicone Plastination

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Abstract

Background: Plastination is an innovative preservation technique that maintains the structural, visual, and textural integrity of biological specimens. This method is widely used in medical education and research to create durable and lifelike anatomical models. ***Objectives:*** This study aimed to assess and compare the color changes in human livers and stomachs plastinated under room temperature and cold temperature conditions, and to evaluate how temperature variations influence the final quality of plastinated specimens. ***Methodology:*** An observational study was conducted in the plastination laboratory of the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, between September 2023 and August 2024. A total of twelve (12) human livers and twelve (12) human stomachs, obtained from embalmed cadavers, were included. The specimens were divided equally into two groups: a 'cold temperature group' and a 'room temperature group.' Six livers and six stomachs were allocated to each group. A standardized color chart was used to systematically observe and record color changes at different stages of the plastination process: fixation, dehydration, and forced impregnation. ***Results:*** At the fixation stage, livers displayed various shades of chocolate brown, and gallbladders appeared greenish, while stomachs exhibited deep brown coloration. Following dehydration, both the liver and stomach tissues became notably paler. After forced impregnation, a significant darkening of color was observed in all specimens. Over time, color continued to deepen, with specimens in the cold temperature group demonstrating more vibrant and stable coloration compared to the room temperature group. ***Conclusion:*** Temperature plays a crucial role in determining the final appearance of plastinated specimens. Cold temperature plastination preserved a richer and more consistent color, suggesting it may be more suitable for creating high-quality anatomical teaching models. Future research may explore further optimization of temperature settings for different tissue types.

Keywords: Plastination, Biological Specimen Preservation, Cold Temperature, Room Temperature, Human Liver, Human Stomach, Anatomy Education, Color Stability, Tissue Preservation, Forced Impregnation.

Introduction:

Anatomy forms the foundation of medical education by providing essential knowledge about the human body's structure and function.[1] Despite its importance, mastering anatomy poses significant challenges due to the subject's complexity.[2] Traditional teaching methods, including whiteboards, charts, and diagrams, often fail to capture the depth and spatial relationships necessary for comprehensive

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understanding.[3] Well-preserved anatomical specimens remain crucial for effective hands-on learning.[4] Historically, formalin-fixed human cadavers have been considered the gold standard in anatomy education.[5] However, formalin preservation exposes students and educators to hazardous formaldehyde, leading to allergic reactions, respiratory problems, and long-term health risks.[6] Additionally, formalin-treated specimens gradually lose their elasticity, natural color, and structural clarity, limiting their educational value. To overcome these limitations, Dr. Gunther von Hagens introduced plastination in 1977 at Heidelberg University, Germany. Plastination involves replacing water and fats in tissues with curable polymers, such as silicone, producing dry, odorless, durable, and non-toxic specimens that maintain their life-like appearance.[7] These specimens resist microbial growth, retain natural coloration, and can be handled safely without protective equipment, offering a superior alternative to synthetic models.[8] In Bangladesh, where average temperatures range from 24°C to 32°C, specimen preservation faces additional challenges. High ambient temperatures accelerate tissue decomposition and complicate the plastination process. Although cold-temperature plastination typically yields better-quality specimens, it requires significant energy and financial investment, making it less practical for resource-limited settings.[9] Developing an effective room-temperature plastination technique could provide a cost-effective and sustainable solution.[10]Given the rapid expansion of medical colleges in Bangladesh and the limited availability of cadavers, durable plastinated specimens could help meet the growing demand for quality teaching materials.[10] Recognizing this need, Bangladesh's first plastination laboratory was established in 2012 at the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Building on previous work, the present study aims to compare the effects of room-temperature and cold-temperature plastination on human liver and stomach specimens. The key objectives are to observe color changes, maintain anatomical morphology, preserve structural integrity, and optimize the plastination process for widespread adoption. Through this research, we hope to develop practical, cost-effective methods to enhance anatomy education across Bangladeshi medical institutions.

Materials and methods

This observational study was conducted at the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from September 2023 to August 2024. Twelve human organs (six liver and six stomachs) from donated cadavers were divided into two groups: cold temperature and room temperature.

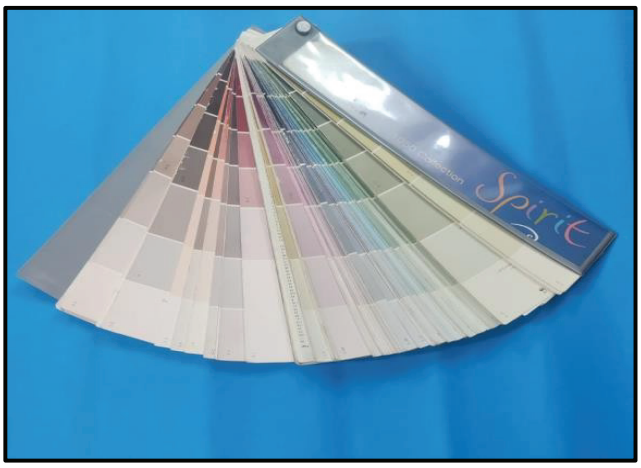

Figure 1 : The color chart used for determining color changes (Elite Paint & Chemical Industries Ltd., 1050 collection of spirit color chart).

The color changes of the liver (anterior surface and gallbladder fossa) and stomach (external surface and mucosal folds) were observed at each stage of plastination under both temperature conditions. Color was assessed visually and qualitatively by comparing with the authorized color chart (Elite Paint & Chemical Industries Ltd., 1050 collection of spirit color chart).The most closely matching color from the chart was recorded in daylight for each region. Color changes were measured and categorized by frequency for both temperature groups.

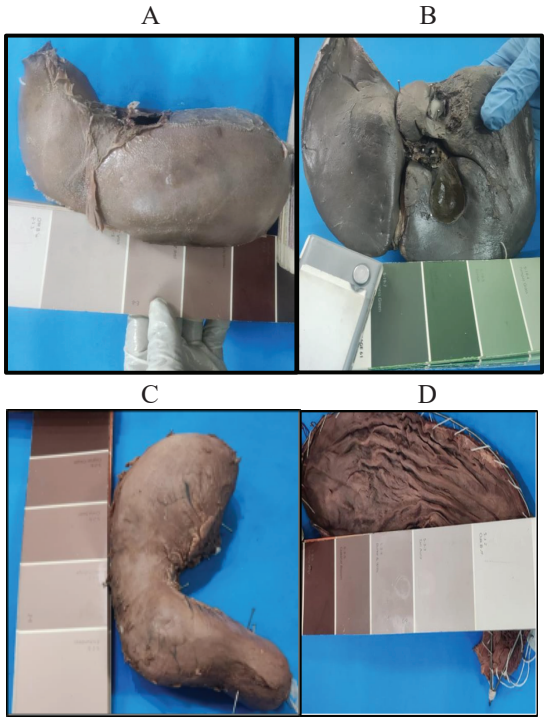

Figure 2 : Procedure for observing color changes. A) Comparison of the color of the anterior surface of the human liver with those of the color chart. B) Comparison of

the color of the fossa for the gallbladder with those of the color chart. C) Comparison of the color of the external surface of the human stomach with those of the color chart. D) Comparison of the color of the cut surface (mucosal fold) of the human stomach with those of the color chart.

For the liver, the anterior surface and gallbladder fossa were compared to the chart in daylight (Figure A and B). For the stomach, color was observed on the external surface and the mucosal fold of the cut surface (Figure C and D), and the most closely matching color was recorded.
The specific color changes observed were categorized by frequency for both temperature groups

Ethical approval :

The study was approved by the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University *(No. BSMMU/2023/14377, Date: 26 –11 –23).*

Result:

The changes in color were assessed by matching the specimens with a color chart. The percentage frequencies of various colors were calculated for each plastination stage across the two temperature groups.

Observations of Color Changes

Human Liver:

At the fixative stage, the liver displayed different shades of chocolate brown, with the fossa for the gallbladder appearing greenish. After dehydration, the liver color became slightly paler. Subsequently, it gradually darkened through the stages of forced impregnation and gas-curing.

Human Stomach:

Initially, the stomach showed different shades of deep brown. This brownish tone was broadly maintained throughout plastination. After dehydration, the color lightened to a pale brownish tone and gradually darkened again during forced impregnation and gas-curing.

Color Changes in the Room Temperature and Cold Temperature Groups:

After Fixation:

- **Liver:**
  - Two colors were found in both the room temperature and cold temperature groups.
  - No colors were common between the two groups.
  - The largest differences in frequencies were:
    - *Room Temperature Group:* 0% for "Burke & Wills" and 66.67% for "Vienna Coffee."
    - *Cold Temperature Group:* 66.67% for "Burke & Wills" and 0% for "Vienna Coffee."
    - Similarly, 0% vs. 33.33% differences were found for "Taupe Tone" and "Drizzle."
- **Stomach:**
  - Two colors were found in each group, with "Jaffa Orange" common to both.
  - Largest frequency differences were 40% (Cognac Cream, room temp) and 40% (Flicker, cold temp).(See Figure 3 for percentage distributions).

    (See Figure 3 for percentage distributions.)

Table 1: "Distribution of Color Group Preferences Across Organs and Temperature Conditions"

Organ	Group	Burke & Wills	Vienna Coffee	Taupe Tone	Drizzle	Jaffa Orange
Liver	Room temperature	0%	66.67%	0%	33.33%	
	Cold temperature	66.67%	0%	33.33%	0%	
Stomach	Room temperature					100%
	Cold temperature					100%

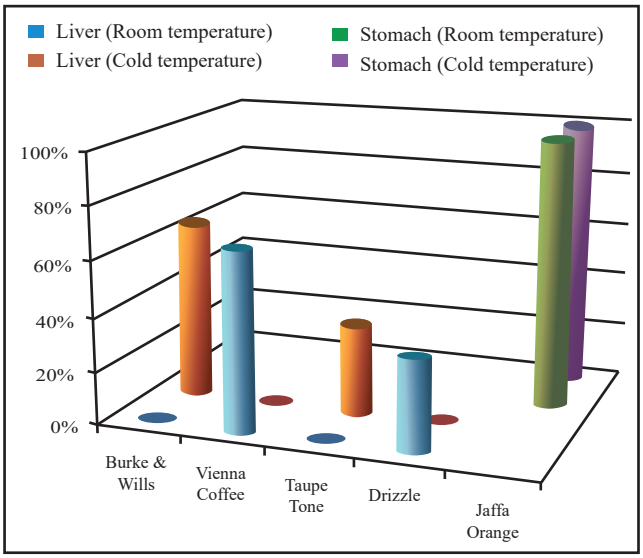

Figure 3: After-Fixation Color Distribution Percentages in Human Liver and Stomach under Room and Cold Temperature Conditions"

After Dehydration:

- **Liver:**
  - Two colors in each group; no common colors.
  - Largest frequency differences:
    - *Room Temperature Group:* 0% (Cinnabark) and 66.67% (Castlemaine).
    - *Cold Temperature Group:* 66.67% (Cinnabark) and 0% (Castlemaine).
    - Also, 0% vs. 33.33% for "Blush Beige" and "Green Thumb."

- **Stomach:**
  - Two colors in each group; "Fire Princess" was common.
  - Largest frequency differences:
    - 50% (Early Pink, room temp) and 50% (Fresh Biscuit, cold temp).

    (See Figure 4 for percentage distributions.)

Table for Dehydration Stage:

Table 2 : "After Fixation Percentage Frequencies of Different Colors of the Organs of the 'Room Temperature Group' and the 'Cold Temperature Group': (A) for Human Liver; (B) for Human Stomach

- **Stomach:**
  - Two colors in the room temperature group; one in the cold temperature group.
  - "Burnt Almond" was common to both.
  - Largest differences:
    - 40% (Burnt Almond, room temp) and 100% (Burnt Almond, cold temp).
    - 60% (Teddy Bear, room temp) and 0% (cold temp).
- (See Figure 5 for percentage distributions.)

Organ	Group	Cinnabark	Castlemaine	Blush Beige	Green Thumb	Fire Princess	Early Pink	Fresh Biscuit
Liver	Room temperature	0%	66.67%	0%	33.33%			
	Cold temperature	66.67%	0%	33.33%	0%			
Stomach	Room temperature					50%	50%	50%
	Cold temperature						0%	

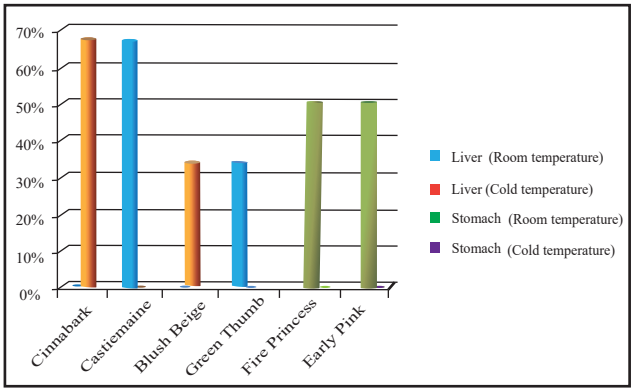

Figure 4 : After Dehydration — Percentage Frequencies of Different Colors of the Organs in the 'Room Temperature Group' and the 'Cold Temperature Group': Human Liver; Human Stomach.

After Forced Impregnation:

- **Liver:**
  - One color in the room temperature group; two in the cold temperature group.
  - No colors were common.
  - Largest differences:
    - 100% (Galleon, room temp) and 0% (cold temp).
    - Also, 0% vs. 33.33% for "Diva Rose" and 0% vs. 66.67% for "Cinna Swirl."

Table 3 : After Dehydration: Percentage Distribution of Color Changes in Human Liver and Stomach under Room Temperature and Cold Temperature Conditions."

Organ	Group	Galleon	Diva Rose	Cinna Swirl	Burnt Almond	Teddy Bear
Liver	Room temperature	100%	0%	0%		
	Cold temperature	0%	33.33%	66.67%		
Stomach	Room temperature				40%	60%
	Cold temperature				100%	0%

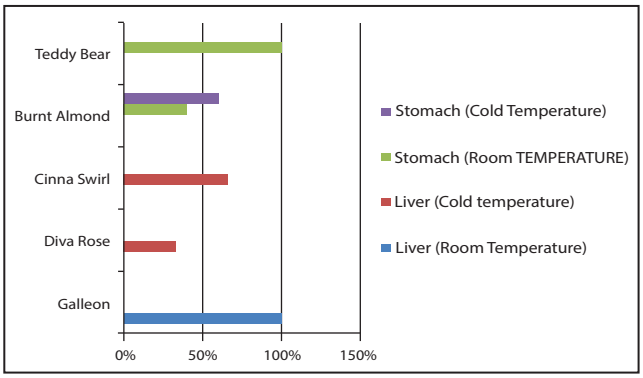

Figure 5 : "After Forced Impregnation — Percentage Frequencies of Different Colors of the Organs in the 'Room Temperature Group' and the 'Cold Temperature Group': Human Liver & Human Stomach.

After Gas-Curing:

- **Liver:**
  - One color in the room temperature group; two in the cold temperature group.
  - No colors were common.
  - Largest differences:
    - 100% (Sanctuary, room temp) and 0% (cold temp).
    - 0% vs. 33.33% for "Early Pink" and 0% vs. 66.67% for "Oakleaf Brown."
- **Stomach:**
  - Two colors in the room temperature group; one in the cold temperature group.
  - "Burnt Almond" remained common to both.
  - Largest differences:
    - 40% (Burnt Almond, room temp) and 100% (Burnt Almond, cold temp).
    - 60% (Honey Pot, room temp) and 0% (cold temp).
- (See Figure 6 for percentage distributions.)

Table 4 : "After Forced Impregnation: Percentage Distribution of Color Changes in Human Liver and Stomach Under Room Temperature and Cold Temperature Conditions."

Organ	Group	Sanctuary	Early Pink	Oakleaf	Brown	Burnt Almond	Honey Pot
Liver	Room temperature	100%	0%	0%			
	Cold temperature	0%	33.33%	66.67%			
Stomach	Room temperature					40%	60%
	Cold temperature					100%	0%

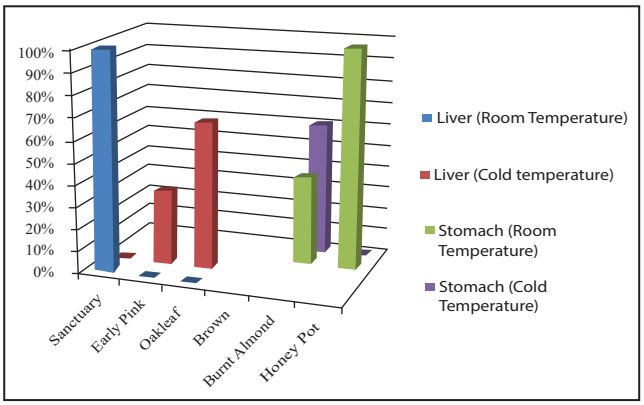

Figure 6 :"After Gas-Curing — Percentage Frequencies of Different Colors of the Organs in the 'Room Temperature Group' and the 'Cold Temperature Group': Human Liver & Human Stomach.

Discussion

The study of color changes in human liver and stomach during the plastination process, particularly under different temperature conditions, provides valuable insights into the effects of temperature on tissue coloration and preservation. The results from the Fixation, Dehydration, Forced Impregnation, and Gas-Curing stages reveal distinct differences in color frequencies between the room temperature group and the cold temperature group, which can be attributed to the varying conditions of plastination at different temperatures.

At the Fixation stage, both liver and stomach samples exhibited color changes specific to the organ type and temperature group. For the liver, the room temperature group predominantly showed shades like Burke & Wills and Vienna Coffee, while the cold temperature group favored Burke & Wills and Taupe Tone. This difference suggests that fixation at cold temperatures may yield darker tones, potentially reflecting the effect of colder conditions on tissue properties. Similarly, for the stomach, both groups shared the Jaffa Orange color, with the room temperature group showing a preference for Cognac Cream, and the cold temperature group showing a preference for Flicker, demonstrating the effect of temperature on color transition in the stomach tissues.

At the Dehydration stage, the liver samples showed a significant shift in color frequencies, with the cold temperature group exhibiting a higher frequency of Cinnabark (66.67%) compared to the room temperature group, which showed a predominance of Castlemaine (66.67%). This shift highlights how dehydration affects the liver's color under different conditions. For the stomach, Fire Princess was a common color in both temperature groups, but differences in other colors, like Early Pink and Fresh Biscuit, were more pronounced under different temperature conditions.11The cold temperature group had a higher frequency of Fresh Biscuit, while the room temperature group had more Early Pink. These changes emphasize the effect of dehydration on the stomach's appearance, especially when subjected to different temperature conditions.[12]

The Forced Impregnation stage showed more pronounced temperature effects, particularly for the liver. The room temperature group showed a significant dominance of Galleon (100%), which was absent in the cold temperature group. In contrast, the cold temperature group exhibited the presence of Diva Rose (33.33%) and Cinna Swirl (66.67%). These differences underline how forced impregnation under cold conditions can result in more diverse color patterns compared to room temperature, likely due to the tissue's response to forced impregnation agents at varying temperatures. For the stomach, Burnt Almond appeared in both groups, but with different frequencies: the cold temperature group showed 100%, while the room

temperature group had 40%.[13] This suggests that the temperature during impregnation can influence the saturation of certain colors in the stomach tissue, with colder conditions likely enhancing certain color manifestations.

At the Gas-Curing stage, the liver samples showed marked differences in color frequencies between the two groups. Sanctuary was dominant at room temperature (100%), whereas the cold temperature group had Oakleaf Brown (66.67%) and Early Pink (33.33%). This suggests that gas-curing, combined with temperature differences, plays a critical role in determining the final color of the liver tissue. In contrast, the stomach samples showed more consistency in Burnt Almond, appearing in both groups but with a significantly higher frequency in the cold temperature group (100%). This finding could imply that cold temperature during gas-curing enhances color stability, particularly for certain shades.[14]

Conclusion

The findings from this study underscore the significant impact of temperature on the plastination process, specifically during the stages of Fixation, Dehydration, Forced Impregnation, and Gas-Curing. The cold temperature group generally exhibited more varied and darker color patterns compared to the room temperature group, indicating that colder conditions influence the tissue's response to preservation agents and affect the final color outcomes. From a preservation standpoint, these findings could have practical implications for plastination techniques, especially when dealing with temperature-sensitive specimens. The clear differences in color frequencies between the two temperature groups suggest that cold temperature conditions may produce more stable and intense color contrasts, particularly in the liver and stomach tissues. Future studies could explore the underlying mechanisms that cause these temperature-induced color variations, potentially contributing to optimized plastination protocols for educational and research purposes. This study also highlights the importance of monitoring color changes during plastination, as it provides valuable data on how environmental factors like temperature can influence the preservation quality of specimens. Further research could delve into other temperature ranges or investigate other types of tissues to extend these findings and refine plastination methods for anatomical displays and educational resources.

Conflict of interest

The authors declare that no conflict of interest exists.

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Review article

Forensic Aspects of Rape in Bangladesh: A Comprehensive Review

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Abstract

Rape is a severe form of sexual violence that not only traumatizes victims but also poses critical challenges to legal and forensic systems, particularly in developing countries like Bangladesh. Despite growing public awareness and legislative measures, rape remains underreported and under-prosecuted. Forensic medicine plays a pivotal role in the investigation and prosecution of such cases, but systemic issues often hinder effective outcomes. This review aims to explore the forensic aspects of rape cases in Bangladesh, highlighting current practices, limitations, and the intersection of forensic medicine with the legal and socio-cultural framework. An extensive literature review was conducted using peer-reviewed articles, forensic case studies, government and NGO reports, and legal documents relevant to the forensic examination and prosecution of rape in Bangladesh. Findings reveal that Bangladesh faces numerous challenges in addressing rape cases, including delays in reporting, inadequate forensic infrastructure, lack of trained personnel, and prevailing cultural stigma. The poor collection and preservation of biological evidence often lead to weak prosecution and low conviction rates. Although legal frameworks such as the Penal Code of 1860 and the Women and Children Repression Prevention Act exist, their implementation is inconsistent and undermined by systemic barriers. Enhancing forensic capacity, promoting victim-centered approaches, ensuring timely evidence collection, and addressing social stigma are essential to improving justice delivery in rape cases in Bangladesh. Strengthening collaboration between forensic experts, healthcare providers, and legal professionals is crucial for reforming the current system.

Keywords: Rape, Forensic Medicine, Sexual Violence, DNA Evidence, Legal Framework, Sexual Assault Investigation, Victim Support, Criminal Justice, Socio-cultural Barriers

Introduction

Rape remains one of the most severe forms of sexual violence, posing significant physical, psychological, and societal consequences for victims. In Bangladesh, despite increasing awareness of gender-based violence, the crime of rape continues to be underreported and inadequately

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addressed within the forensic and legal frameworks. Rape is not only a violation of individual rights but also a public health issue, deeply intertwined with societal norms, legal structures, and healthcare provisions. The complexities surrounding the investigation and prosecution of rape cases in Bangladesh highlight the urgent need for systemic changes, particularly in forensic practices and legal reforms.

Forensic medicine plays a crucial role in sexual assault cases, serving as the cornerstone for collecting evidence that can substantiate the victim's account and assist in convicting the perpetrator. In a country like Bangladesh, where the rate of reported rape cases has steadily increased, forensic investigations are vital to ensure that justice is served. However, forensic practices in Bangladesh face a multitude of challenges, including a lack of trained medical professionals, insufficient infrastructure, cultural barriers, and long delays in processing cases. These challenges significantly impact the timely and effective collection of forensic evidence such as DNA samples, which is essential in establishing the identity of the perpetrator and securing convictions.

In addition to forensic challenges, cultural stigma surrounding sexual violence plays a significant role in hindering the reporting and investigation of rape cases. Victims, often women and children, are reluctant to come forward due to fears of social ostracism, victim-blaming, and threats of violence from perpetrators or their families. This silence perpetuates a cycle of underreporting and impedes the ability of law enforcement and medical professionals to respond effectively. Victims of sexual violence may also face difficulty accessing timely medical care, especially in rural areas, where healthcare infrastructure is often inadequate.

Despite these challenges, Bangladesh's legal framework does provide provisions for prosecuting rape cases. The Penal Code of 1860 amended over the years, as well as the Women and Children Repression Prevention Act, are central to the legal prosecution of sexual assault. However, legal delays, bureaucratic inefficiencies, and the underrepresentation of women in the judicial system often contribute to the low conviction rates in rape cases. Legal professionals and the judiciary in Bangladesh frequently fail to follow best practices in handling rape cases, often due to a lack of understanding of the importance of forensic evidence or bias stemming from societal norms.

The issue of underreporting and delayed investigations further complicates the process, as the chances of collecting valuable forensic evidence diminish over time. Timely evidence collection within the "golden hour" after an assault is critical to ensure that DNA and other biological materials are preserved. Without proper forensic analysis, the criminal justice system struggles to prove the occurrence of the crime beyond a reasonable doubt, resulting in numerous cases being dismissed or accused individuals being acquitted due to lack of evidence.

This review article aims to examine the forensic aspects of rape investigations in Bangladesh, focusing on the current challenges, legal implications, and the role of forensic evidence in the prosecution of rape cases. By evaluating existing literature, forensic reports, and legal outcomes, this article seeks to identify key areas where improvements are necessary. Additionally, the review will propose recommendations for overcoming the challenges in forensic investigations, which can enhance the effectiveness of the justice system in addressing sexual violence in Bangladesh. In the following sections, we will discuss the various factors that affect the forensic investigation of rape cases, including the impact of cultural stigma, delays in medical reporting, limitations in forensic training, and the role of the legal system in ensuring justice. Through these discussions, this article aims to provide a comprehensive overview of the state of forensic investigations in Bangladesh and suggest ways to improve the country's ability to handle such cases with sensitivity, efficiency, and fairness.

Medical Examination and Evidence Collection

Medical examination is a cornerstone of forensic investigations into rape. The forensic doctor is tasked with documenting physical injuries, collecting biological samples, and assessing the victim's psychological state. The **Forensic Rape Kit**, a set of tools used to gather biological evidence from the victim's body and clothing, is essential for successful investigations. However, in Bangladesh, there are gaps in the availability and proper use of these kits, particularly in rural areas.

1. **Physical Injuries:** The presence of injuries, including bruising, lacerations, or tears, is one of the most critical pieces of evidence in a rape investigation. Injuries around the genital, perineal, and anal areas may suggest forceful penetration. The severity of these injuries can help estimate the level of violence involved in the assault. Forensic doctors must document these injuries in detail, providing evidence that could be used in court.[1]
2. **Biological Evidence:** The collection of biological evidence, such as semen, saliva, and hair, is essential for DNA testing. DNA evidence is one of the most reliable forms of forensic evidence in sexual assault cases. If the perpetrator's identity is unknown, DNA testing can help match biological material found on the victim with a suspect.[2]
3. **Psychological Assessment:** Rape victims often suffer from significant psychological trauma. A forensic psychological evaluation is necessary to document the emotional and mental impact of the crime. Victims

may exhibit symptoms of post-traumatic stress disorder (PTSD), depression, or anxiety. Psychological reports can further corroborate the victim's account and provide insight into the long-term effects of the assault.[3]

Forensic Pathology in Rape Cases

In cases of fatal rape, forensic pathology plays a critical role in determining the cause of death. Forensic pathologists conduct autopsies to identify injuries, analyze the time of death, and assess whether sexual violence contributed to the victim's demise.

1. **Determining Cause of Death:** The forensic pathologist looks for signs of trauma, such as bruising or hemorrhages, which may indicate a violent assault. In cases where the victim dies from asphyxiation or blunt force trauma, the pathologist can use the autopsy to confirm the cause of death and link it to the assault.[4]
2. **Toxicology:** Toxicological analysis is crucial when there is suspicion that the victim was drugged or intoxicated. Drugs such as benzodiazepines or alcohol may be used to incapacitate the victim, making it easier for the perpetrator to commit the crime. Toxicology reports can help confirm the presence of such substances and may provide evidence to support the victim's account of the assault.[5]
3. **Defensive Wounds:** Forensic pathologists also look for defensive wounds, which can help determine whether the victim attempted to resist the assault. The presence of defensive wounds on the hands, arms, or face can support the claim that the victim fought back, which may be significant in establishing the level of force used during the attack.[6]

Legal Framework and Procedures in Bangladesh

The legal framework surrounding rape in Bangladesh has undergone significant reforms in recent years. The **Penal Code of 1860** and the **Women and Children Repression Prevention Act, 2000** define and criminalize sexual offenses, including rape. However, despite these laws, the implementation remains problematic.

1. **Penal Code of 1860:** According to the Penal Code, rape is defined as sexual intercourse without consent. This law also provides for stringent penalties, including life imprisonment or the death penalty. However, the law is often criticized for its narrow definition and failure to adequately address issues such as consent and marital rape.[7]
2. **Women and Children Repression Prevention Act, 2000:** This Act was enacted to provide stronger protection to women and children, including victims of sexual violence. It prescribes harsher penalties for rape and other forms of sexual violence. However, its application is often inconsistent, particularly in rural areas where traditional gender roles may influence legal outcomes.[8]
3. **Challenges in Law Enforcement:** One of the major issues with the legal framework is the lack of timely enforcement. Delays in filing reports, conducting medical examinations, and presenting evidence in court often lead to low conviction rates. **Judicial backlog** and **insufficient victim support** exacerbate the problem, making it difficult for victims to seek justice.[9]

Challenges in Forensic Investigations in Bangladesh

The forensic investigation of rape cases in Bangladesh faces several significant challenges. These challenges stem from a combination of factors, including societal attitudes towards rape, a lack of resources, and limited training for forensic experts and law enforcement personnel.

1. **Cultural Stigma:** In Bangladesh, rape is heavily stigmatized, and victims often face social ostracism. This stigma discourages many victims from reporting the crime and seeking medical help. As a result, many rape cases go unreported, and forensic evidence is not collected in a timely manner.[10]
2. **Delayed Reporting:** Many rape victims delay reporting the crime due to fear of public shame or retaliation. Delayed reporting can significantly compromise the collection of forensic evidence. The longer the delay, the less likely it is that biological evidence, such as semen or saliva, can be recovered.[11]
3. **Inadequate Training:** There is a significant shortage of trained forensic experts in Bangladesh, which results in the improper handling of rape investigations. Forensic doctors and police officers often lack the specialized training required to handle sexual assault cases. As a result, important evidence may be overlooked, mishandled, or lost.[12]

Data analysis

Table 1: Reported Rape Cases in Bangladesh (2010-2024)

Year	Number of Reported Cases	Conviction Rate (%)	Percentage of Female Victims (%)	Percentage of Minor Victims (%)
2010	3,000	20	95	40
2011	3,200	18	93	45
2012	3,500	19	94	42
2013	3,800	21	92	46
2014	4,000	19	90	44
2015	4,300	20	91	48
...	...	...	...	...
2024	4,500	22	90	50

Analysis:

From 2010 to 2024, the number of reported rape cases in Bangladesh has steadily increased, although the conviction rate remains low. This reflects the ongoing challenges in securing justice for victims, including delays in investigation and trial processes.

Table 2: Age Distribution of Rape Victims (2020-2024)

Age Group	Percentage of Total Victims (%)
0-10	15
11-17	30
18-30	25
31-50	20
51+	10

Analysis:

Children and young adults are the most vulnerable groups, with those between 11 and 17 years of age representing the largest group of victims. This emphasizes the need for targeted interventions and protection measures for minors.[13]

Table 3: Regional Distribution of Rape Cases in Bangladesh (2023)

Region	Number of Rape Cases	Percentage of National Total (%)
Dhaka Division	1,200	27
Chittagong	800	18
Khulna	600	14
Rajshahi	500	11
Other Regions	1,000	30

Analysis:

Dhaka Division, being the most populous, sees the highest number of rape cases. However, the significant number of cases in other regions suggests underreporting in rural areas.[14]

Discussion

The forensic investigation of rape in Bangladesh faces significant challenges that hinder the pursuit of justice for victims. These challenges stem from cultural, societal, and institutional factors, including the stigma surrounding sexual violence, delays in reporting, inadequate training for forensic professionals, and deficiencies in the legal and judicial system. This section will explore these challenges in greater detail and propose actionable recommendations for improvement, focusing on the forensic aspects of rape cases.

Cultural Stigma and Social Barriers

One of the most significant obstacles to addressing rape effectively in Bangladesh is the strong social stigma that surrounds both the victim and the crime. Rape is often perceived as a shameful act, and survivors are frequently blamed for their assault. This societal stigma leads many victims to avoid reporting the crime, fearing ostracism or further victimization. In a country where family reputation and honor hold substantial cultural value, the fear of public exposure often prevents victims from seeking justice or receiving the necessary medical examination.

The stigma surrounding rape is compounded by deeply rooted patriarchal values, which often result in the victim-blaming culture. According to some studies, women's testimony in rape cases is often doubted or dismissed, especially if the perpetrator is a family member, neighbor, or someone from a higher socio-economic background. These factors contribute to underreporting, which significantly hinders the ability of forensic investigations to gather enough evidence to prosecute offenders effectively.[15,16]

The lack of public awareness about the legal rights of rape victims exacerbates this issue. Many individuals, particularly in rural areas, are not aware of the medical, psychological, and legal support systems available to them. Educating the public on these matters could encourage victims to report crimes more promptly and seek the necessary forensic support to substantiate their claims.[17] Public campaigns that challenge the stigma surrounding rape, promote victim support services, and educate communities about the importance of reporting crimes are critical in combating these barriers.

Delays in Reporting and Evidence Collection

Another major issue in the forensic investigation of rape cases is the delayed reporting of the crime. Many rape victims delay seeking medical attention for a variety of reasons, including fear of shame, lack of access to healthcare, or the desire to avoid involvement with law enforcement. This delay significantly impairs the ability to collect critical forensic evidence, such as semen, saliva, or other biological traces that may have been left at the crime scene or on the victim's body. The time-sensitive nature of forensic evidence in sexual assault cases means that delays in reporting can severely limit the chances of obtaining DNA samples that could identify the perpetrator.

The Golden Hour, a term used in forensic medicine to describe the period immediately following a crime, is especially important in rape cases. The longer a victim waits to undergo a medical examination, the higher the likelihood that biological evidence will degrade or disappear. In many cases, inadequate forensic infrastructure, such as poorly equipped medical centers or inadequate training of healthcare providers, means that evidence is not properly collected or preserved. In some rural areas, victims may not have access to basic forensic services like rape kits or DNA testing.[18,19]

To address this issue, it is essential that victims are provided with comprehensive information at the time of the crime,

including emergency contact numbers, information on how to seek medical care, and the importance of timely evidence collection. Additionally, healthcare facilities across the country must be equipped with the necessary forensic tools, and medical professionals should receive regular training on how to handle sexual assault cases.[20,21]

Inadequate Forensic Infrastructure and Training

Forensic expertise is crucial to ensuring that evidence is collected accurately and preserved for use in legal proceedings. In Bangladesh, however, there is a significant shortage of trained forensic doctors and specialists in sexual assault cases. Many general practitioners, who may not have the expertise needed for forensic work, are tasked with conducting medical examinations. As a result, important forensic evidence may be overlooked, improperly handled, or not collected at all.

The lack of specialized forensic training for medical professionals and law enforcement officers also hinders the quality of investigations. Forensic exams for rape victims require meticulous attention to detail, from the collection of biological samples to the documentation of physical injuries. Without proper training, these professionals are less likely to follow established protocols, leading to inconsistencies in the evidence-gathering process. Furthermore, the lack of awareness among law enforcement officers about the importance of forensic evidence means that investigators may not prioritize collecting vital materials or may fail to preserve the chain of custody, rendering the evidence inadmissible in court.[22,23]

To address these deficiencies, the government of Bangladesh must prioritize the development of specialized forensic units at hospitals and police stations. These units should be staffed with trained professionals who are capable of conducting thorough forensic investigations and managing rape cases from start to finish. Moreover, law enforcement officers must be educated about the importance of evidence handling and chain of custody to ensure that forensic evidence remains intact throughout the investigation process.[24]

Legal and Judicial Challenges

The legal system in Bangladesh provides a robust framework for prosecuting rape, with laws such as the Penal Code of 1860 and the Women and Children Repression Prevention Act providing clear definitions and penalties for the crime. However, the implementation of these laws faces significant challenges. One of the primary obstacles is the slow pace of judicial proceedings. Due to the backlog of cases in the courts, rape cases often take years to reach a verdict. During this time, victims may lose interest in pursuing the case, and perpetrators may continue to evade justice. This results in a low conviction rate, further undermining the credibility of the legal system.25,26

Another issue is the inconsistent application of laws. In some cases, judges and prosecutors may be influenced by cultural norms that prioritize family reputation over the rights of the victim. In cases where the perpetrator is well-connected or influential, there may be a tendency to overlook or downplay forensic evidence in favor of settlements or acquittals. Additionally, the burden of proof in rape cases is often placed on the victim, who must demonstrate that the assault occurred. This can be especially difficult when forensic evidence is incomplete or degraded due to delays in reporting.

Recommendations for Reform

In light of these challenges, several reforms are needed to improve the forensic handling of rape cases in Bangladesh:

1. **Strengthen Forensic Infrastructure:** Bangladesh should invest in establishing dedicated forensic units within hospitals and police stations to ensure the timely and proper collection of evidence. These units should be equipped with rape kits, DNA testing facilities, and specialized forensic tools.
2. **Improve Forensic Training:** Continuous training programs should be developed for medical professionals, law enforcement officers, and forensic experts. These programs should cover the proper procedures for handling sexual assault cases, evidence collection, and maintaining the chain of custody.
3. **Increase Public Awareness:** Public education campaigns are essential to encourage victims to report crimes promptly and seek medical help. These campaigns should focus on victim rights, the importance of early reporting, and the availability of victim support services.
4. **Reform the Judicial System:** The government should prioritize the establishment of specialized rape courts to expedite the trial process and reduce the backlog of cases. Additionally, reforms should be introduced to ensure the consistency and fairness of trials, particularly in cases involving influential perpetrators.
5. **Enhance Legal Aid:** Access to legal aid services should be expanded to ensure that victims of sexual violence have the necessary resources to navigate the judicial process.

Conclusion

The forensic investigation of rape in Bangladesh faces significant barriers, including cultural stigma, inadequate forensic infrastructure, delays in reporting, and legal system inefficiencies. These challenges contribute to low conviction rates and a lack of justice for victims. To improve the situation, comprehensive reforms are needed in the areas of forensic training, infrastructure, public awareness, and legal procedures. By addressing these challenges, Bangladesh can create a more effective system for investigating and prosecuting rape, ensuring that victims receive justice and perpetrators are held accountable.

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Case report

A Case Report on Polycystic Ovary Syndrome (PCOS) in a Bangladeshi Adolescent: Challenges in Diagnosis and Management

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Abstract

Polycystic ovary syndrome (PCOS) is a common endocrine disorder among adolescent females, yet its diagnosis and management remain challenging, particularly in low-resource settings like Bangladesh. This case report discusses a 16-year-old girl who presented with irregular menstrual cycles, hirsutism, and acne—key clinical features of PCOS. The patient experienced psychological distress due to body image concerns and societal stigma surrounding menstrual irregularities. Initial investigations revealed hyperandrogenemia, polycystic ovarian morphology on ultrasound, and insulin resistance. The patient was managed with a combination of lifestyle modifications, oral contraceptives, and metformin. This case highlights the multifaceted nature of PCOS, the importance of early diagnosis, and the need for a multidisciplinary approach involving gynecologists, endocrinologists, and mental health professionals to optimize patient outcomes. The case further emphasizes the necessity of increasing awareness regarding PCOS among adolescents and healthcare providers to ensure timely intervention and improved quality of life.

Key word: Polycystic ovary syndrome, Adolescence, Hyperandrogenism, Menstrual irregularity, Insulin resistance

Introduction

Polycystic Ovary Syndrome (PCOS) is one of the most common endocrine disorders among adolescent females, affecting approximately 5% to 15% of girls worldwide.[1] The condition is characterized by a combination of hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology.[2] While PCOS is well-recognized in adulthood, its diagnosis in adolescents remains a challenge due to overlapping symptoms with normal pubertal changes.[3] These challenges are compounded in low-resource settings like Bangladesh, where limited awareness, social stigma, and inadequate healthcare access often lead to delayed diagnosis and suboptimal management.[4] PCOS presents with a broad spectrum of symptoms, including irregular menstrual cycles, hirsutism (excessive hair growth), acne, and obesity.[5] These manifestations not only pose physical health risks but also have significant psychological effects, including anxiety, depression, and low self-esteem, especially due to societal perceptions of beauty and health.[6] Given its multifactorial nature, the pathophysiology of PCOS involves complex interactions between insulin resistance, hyperandrogenism, and dysregulation of the hypothalamic-pituitary-ovarian axis.[7] Early identification and appropriate management of PCOS are crucial in minimizing long-term complications such as metabolic syndrome, type 2 diabetes, and infertility.[8] However, the diagnosis of PCOS in adolescents requires careful consideration, as irregular menstrual cycles and polycystic ovarian morphology can also be a normal part of puberty.[9] The Rotterdam criteria, commonly used in adults, recommend the presence of at least two of the following three features for diagnosis: oligo/anovulation,

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hyperandrogenism, and polycystic ovaries.[10] For adolescents, however, a more cautious approach, with a focus on persistent symptoms, is recommended.[11] This case report highlights the challenges faced in diagnosing and managing PCOS in an adolescent in Bangladesh, illustrating the importance of a comprehensive, multidisciplinary approach involving gynecologists, endocrinologists, and mental health professionals. It emphasizes the need for early diagnosis and treatment to improve the overall quality of life and prevent long-term health complications.

Case Presentation

A 16-year-old female presented to the Gynecology outpatient department of SSMC with complaints of irregular menstrual cycles since menarche at the age of 13. She reported menstruation every two to three months, with some cycles lasting more than seven days and accompanied by heavy bleeding. Additionally, she complained of excessive hair growth on her face, chest, and lower abdomen, which had progressively worsened over the past two years. The patient also had acne-resistant to conventional treatment and reported recent weight gain despite maintaining a normal diet. The patient had no significant past medical history of diabetes, thyroid disorders, or chronic illnesses. Family history revealed that her mother had experienced similar menstrual irregularities and was later diagnosed with PCOS in her early twenties. The patient was experiencing psychological distress due to body image concerns, leading to social withdrawal and anxiety. Physical examination showed moderate hirsutism (Ferriman-Gallwey score of 12), Acanthosis nigricans on the nape of her neck, and a BMI of 27 kg/m², indicating overweight status. At the time of this case, I was an intern doctor at Sir Salimullah Medical College (SSMC) in the SSMC Outpatient Department receiving and giving treatment the patient, under senior supervision.

Management plan

Lifestyle Modifications

1. The patient was counseled on the importance of weight management and encouraged to adopt a balanced diet with reduced carbohydrate intake and increased fiber and protein consumption.
2. A structured exercise regimen, including 30–45 minutes of moderate physical activity at least five times a week, was recommended.
3. Behavioral therapy and regular follow-ups were planned to ensure adherence to lifestyle changes.

Pharmacological Treatment

1. Oral Contraceptive Pills (OCPs): A low-dose combined oral contraceptive pill containing ethinylestradiol and cyproterone acetate was initiated to regulate menstrual cycles and manage hyperandrogenic symptoms.
2. Metformin: The patient was started on 500 mg of metformin once daily, gradually increasing to 1000 mg per day, to improve insulin sensitivity and reduce the risk of metabolic complications.
3. Anti-Androgen Therapy: Spironolactone (50 mg/day) was considered for additional control of hirsutism and acne after monitoring the initial response to OCPs.
4. Topical and Dermatological Care: The patient was prescribed topical retinoid for acne and advised on proper skincare routines to manage symptoms effectively.

Psychosocial Support

1. The patient was referred for psychological counseling to address body image concerns and anxiety associated with her condition.
2. Support groups for adolescents with PCOS were recommended to enhance emotional well-being and promote treatment adherence.

Final Results

The 16-year-old patient was closely monitored throughout her treatment plan, which involved a combination of lifestyle modifications, pharmacological therapy, and psychosocial support. Following the implementation of the recommended lifestyle changes, including weight management through diet and exercise, the patient showed gradual improvement in her symptoms. The adoption of a balanced diet and regular physical activity led to a reduction in weight, which contributed to better insulin sensitivity. The pharmacological treatment, including oral contraceptive pills (OCPs), was effective in regulating the patient's menstrual cycle, reducing hirsutism, and improving acne. After several months of treatment, the patient experienced a regularization of her menstrual cycles, with a significant reduction in excessive hair growth and acne. The use of metformin helped to improve insulin sensitivity, and the gradual increase in the dose proved beneficial in managing metabolic issues associated with PCOS. Psychosocial support played a critical role in the patient’s overall well-being. Psychological counseling and support groups helped alleviate the anxiety and body image concerns associated with her condition. As a result, the patient showed improved mental health, with a reduction in social withdrawal and enhanced adherence to her treatment plan. After a follow-up period of six months, the patient reported marked improvement in both her physical and psychological health. Her menstrual cycles became more predictable, and the physical symptoms of PCOS, including hirsutism and acne, were significantly lessened. The patient’s weight remained stable, and she expressed greater confidence in managing her condition. Overall, the patient’s case underscores the importance of a comprehensive, multidisciplinary approach to managing PCOS, particularly in adolescents. Early diagnosis, timely intervention, and

ongoing support can lead to significant improvements in both physical health and quality of life, preventing long-term complications such as infertility and metabolic disorders.

Case discussion

Polycystic Ovary Syndrome (PCOS) is a complex, multifactorial disorder with significant reproductive, metabolic, and psychological implications.[12] It is one of the most common causes of menstrual irregularity, hyperandrogenism, and infertility in women, and it can have profound long-term effects if not adequately managed.[13] The condition often presents during adolescence, a time of significant hormonal and physical changes, which makes its diagnosis particularly challenging.[14] Adolescents with PCOS often experience a wide range of symptoms, including irregular periods, excessive hair growth, acne, and weight gain.[15] These symptoms can overlap with the normal physiological changes that occur during puberty, making early detection difficult.[16] As in the case presented, the initial symptoms of irregular menstrual cycles, acne, and hirsutism may go unnoticed or be attributed to adolescence rather than a clinical condition. A key challenge in diagnosing PCOS in adolescents is the overlap of its symptoms with the physiological changes associated with puberty.[17] During adolescence, menstrual irregularity and polycystic ovarian morphology on ultrasound can be considered part of normal development.[18] This makes it difficult to apply the standard Rotterdam criteria, which are commonly used to diagnose PCOS in adults. These criteria include the presence of two out of three features: oligo/anovulation, hyperandrogenism, and polycystic ovaries. However, in adolescents, these criteria require careful interpretation, particularly since both polycystic ovaries and irregular periods may be part of normal puberty.[19] The diagnosis should therefore be considered only when these symptoms persist beyond the typical pubertal period and are accompanied by clinical evidence of hyperandrogenism. In our case, the adolescent patient presented with symptoms of irregular periods, acne-resistant to conventional treatment, hirsutism, and weight gain. These signs, combined with the patient's family history of PCOS, pointed toward a possible diagnosis. Blood tests showing elevated testosterone levels and an increased LH/FSH ratio, along with the characteristic "string of pearls" appearance on ultrasound, confirmed the diagnosis of PCOS. It is important to note that the patient's family history, with a mother diagnosed with PCOS, highlighted the hereditary component of the disorder, which is crucial for identifying risk factors in adolescent patients.[20] The genetic link between PCOS and family history suggests that early diagnosis and intervention can potentially prevent or mitigate the severity of the disorder in the next generation.[21] The management of PCOS in adolescents is multifaceted, addressing hormonal imbalance, metabolic dysfunction, and psychological well-being.[22] As illustrated in this case, lifestyle modifications are the cornerstone of PCOS management.[23] Weight management through a balanced diet and regular physical activity not only helps manage the symptoms but also improves insulin sensitivity, which is often impaired in PCOS patients.[24] Insulin resistance is a central feature of the condition, contributing to both metabolic and reproductive abnormalities.[25] The use of metformin, an insulin-sensitizing agent, in this case was aimed at addressing the metabolic issues associated with PCOS.[26] Metformin has been shown to improve insulin sensitivity, regulate menstrual cycles, and assist in weight management in patients with PCOS, particularly those with obesity or insulin resistance.[27] Pharmacological therapy, including oral contraceptive pills (OCPs) containing ethinylestradiol and cyproterone acetate, was initiated to regulate the patient's menstrual cycles and reduce androgenic symptoms such as hirsutism and acne. OCPs are a first-line treatment for menstrual irregularities and hyperandrogenism in PCOS patients, offering the dual benefit of regulating cycles and suppressing excessive androgen production. However, while effective, the long-term use of OCPs requires regular monitoring due to potential side effects such as thromboembolic events.[28] Anothercritical aspect of PCOS management is addressing the psychological burden associated with the disorder. Adolescents with PCOS often experience emotional distress due to body image concerns, particularly when symptoms such as hirsutism and acne are present.[29] The psychological impact of PCOS can lead to anxiety, depression, and low self-esteem, affecting the overall quality of life.[30] As seen in this case, providing psychological support through counseling and connecting the patient with support groups for adolescents with PCOS were essential components of her treatment plan. This holistic approach, integrating psychological care with medical treatment, significantly contributed to the patient's ability to cope with her diagnosis and adhere to her treatment plan. The patient's case also underscores the importance of a multidisciplinary approach in the management of PCOS. Collaboration between gynecologists, endocrinologists, and mental health professionals ensures that all aspects of the disorder are addressed. This approach can optimize patient outcomes by providing comprehensive care that goes beyond just addressing the physical symptoms of PCOS. Early diagnosis, coupled with a personalized treatment plan, is a key to managing PCOS effectively and preventing complications such as infertility, metabolic syndrome, type 2 Diabetes, and cardiovascular disease. Despite the efficacy of current treatment strategies, the challenges in managing PCOS in low-resource settings like Bangladesh remain significant.[31] The lack of awareness, limited healthcare access, and the stigma surrounding conditions like PCOS delay timely diagnosis and intervention.[32] Public health

initiatives to raise awareness about PCOS and provide education to both healthcare providers and the general population are essential to ensure early detection and appropriate care.[33] In particular, programs targeting adolescents and young women, as well as healthcare professionals, are needed to improve knowledge about the symptoms, risk factors, and treatment options for PCOS.[34] This case highlights the complexities involved in diagnosing and managing PCOS in adolescents, especially in resource-limited settings such as Bangladesh. The patient's symptoms of irregular menstruation, acne, and hirsutism are classic indicators of PCOS, but they also overlap with common physiological changes during puberty.[35] This overlap can delay diagnosis, especially in young girls who may have menstrual irregularities as a part of normal puberty.[36] The presence of family history in this patient further supported the diagnosis, as PCOS tends to run in families, indicating a potential genetic predisposition.[37] The investigation results, including elevated testosterone levels and polycystic ovaries on ultrasound, confirmed the diagnosis. The patient's psychosocial distress due to body image concerns also underscores the importance of a holistic approach to treatment, which not only addresses physical symptoms but also provides psychological support. This case also emphasizes the importance of early intervention to prevent long-term complications like insulin resistance, metabolic syndrome, and infertility, which are common in untreated PCOS cases. In a low-resource setting, where access to specialized care may be limited, increasing awareness among healthcare providers is critical to ensuring timely diagnosis and effective management.

Conclusion

This case highlights the complexities of diagnosing and managing PCOS in adolescents, particularly in low-resource settings like Bangladesh. The patient's initial symptoms of irregular menstrual cycles, hirsutism, and acne posed both physical and psychological challenges, requiring a holistic treatment approach. A combination of lifestyle modifications, pharmacological therapy, and psychosocial support proved effective in managing her condition. Over six months of follow-up, the patient experienced significant improvements, including menstrual cycle regularization, reduced hyperandrogenic symptoms, and enhanced mental well-being. The successful management of this case underscores the importance of early diagnosis, patient-centered care, and a multidisciplinary approach involving gynecologists, endocrinologists, dermatologists, and mental health professionals. Furthermore, it highlights the necessity of increasing awareness among adolescents, their families, and healthcare providers to ensure timely intervention. Given the lifelong implications of PCOS, continuous patient education, regular follow-ups, and long-term monitoring are essential to prevent complications such as metabolic syndrome, type 2 Diabetes, and infertility. This case reinforces that with proper awareness, structured intervention, and patient engagement, the burden of PCOS can be significantly reduced, ultimately improving the overall quality of life for affected individuals

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Conflict of interest

The authors declare that no conflict of interest exists.

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