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Editorial
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Intestinal Obstruction Following Inappropriate Anthelmintic Use

***Tajkia T**

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Introduction

Ascariasis is one of the most cosmopolitan intestinal parasite infections and can be found in inhospitable regions inhabited by human beings, but its highest prevalence is observed in the tropical and subtropical areas.[8]

Excessive or poorly timed administration of anthelmintic medications in patients with a heavy burden of *Ascaris lumbricoides* may precipitate or aggravate acute mechanical intestinal obstruction by immobilizing a large number of worms, which can subsequently aggregate into an obstructing intraluminal bolus. Anthelmintic treatment has been reported as a potential risk factor for intestinal obstruction in children with heavy *Ascaris* infestation.[1]

When individuals—predominantly young children in endemic, low-resource settings—harbor a high parasite load, administration of anthelmintic drugs such as mebendazole may result in immobilization of the worms. Rather than being eliminated smoothly, the immobilized worms may aggregate and form an obstructing mass within the intestinal lumen, particularly in the distal ileum or near the ileocecal region.[1,2] Therefore, anthelmintic treatment should be used cautiously in children presenting with abdominal pain, vomiting, abdominal distension, or features suggestive of subacute intestinal obstruction.

Clinical Presentation and Diagnosis

Patients with *Ascaris*-related intestinal obstruction typically present with acute colicky abdominal pain, persistent vomiting, abdominal distension, and constipation or obstipation. In some cases, patients may vomit or pass live worms.[2,3] Plain abdominal radiography may demonstrate dilated small-bowel loops and multiple air-fluid levels. Ultrasonography can provide additional diagnostic information and may demonstrate characteristic intraluminal echogenic structures corresponding to coiled *Ascaris* worms.[3,4]

The clinical diagnosis should therefore be based on a combination of symptoms, physical examination, epidemiological history, and appropriate imaging. Particular attention should be given to children from endemic areas who have a history of recent deworming and subsequently develop symptoms suggestive of intestinal obstruction.[1,4]

Management and Prevention

Initial management of intestinal obstruction due to *Ascaris* should focus on stabilization, including bowel rest with nil per os (NPO), nasogastric decompression when indicated, intravenous fluid and electrolyte replacement, and close clinical monitoring.[2,5] Conservative management may be successful in selected patients without evidence of complete obstruction, bowel ischemia, perforation, or peritonitis.

However, patients who develop complete mechanical obstruction, persistent obstruction despite conservative treatment, bowel ischemia, gangrene, perforation, or peritonitis require prompt surgical intervention. Surgical options may include manipulation or milking of the worm bolus into the colon, enterotomy with removal of the worms, and intestinal resection when nonviable or perforated bowel is present.[5,6]

Prevention remains an essential component of reducing morbidity associated with *Ascaris* infection. Deworming programs should be accompanied by appropriate clinical assessment, particularly in symptomatic children who may already have a heavy parasite burden or features suggestive of intestinal obstruction. Long-term prevention

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depends on regular access to safe water, adequate sanitation, appropriate disposal of human feces,hand hygiene, and sustained community-based control of soil-transmitted helminth infections.[7]

Conclusion

Clinicians should exercise caution when prescribing anthelmintic therapy to children with heavy *Ascaris lumbricoides* infestation who present with abdominal symptoms suggestive of subacute or evolving intestinal obstruction. A careful clinical assessment before treatment is important to identify patients who may require urgent observation, imaging, or surgical evaluation. [1,2]

Early recognition and appropriate management of *Ascaris*-related intestinal obstruction, together with effective deworming strategies and sustained improvements in sanitation and hygiene, are essential for reducing morbidity and mortality in endemic regions.[4,7]

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Original Article
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Occupational Health Conditions, Healthcare Utilization and Access Barriers among Bangladeshi Migrant Workers in Malaysia: A Cross-sectional Study

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Abstract

Background: *Bangladeshi migrant workers in Malaysia often work in labor-intensive sectors where occupational exposure, crowded accommodation, and restricted healthcare access may affect health. This study assessed reported occupational health conditions, healthcare utilization, treatment responses, and access barriers among Bangladeshi migrant workers in Kuala Lumpur and Selangor.*

Materials and Methods: *A community-based cross-sectional study was conducted among 400 Bangladeshi migrant workers aged 18 years or above and employed in Malaysia for at least six months. Data were collected by face-to-face interview using a structured questionnaire. Variables included demographic profile, occupation, living condition, PPE, safety training, reported health problems, treatment pathway, treatment outcome, satisfaction, language, and cost barriers. Data were analyzed using SPSS version 27.0. Chi-square test and binary logistic regression were applied, and $p<0.05$ was considered significant.*

Results: *Mean age was 30.60±8.18 years. Construction workers constituted 45.0% of respondents. 250 (62.5%) respondents reported at least one strict occupational disease. Infection was the commonest occupational condition [145 (36.3%)], followed by spinal/musculoskeletal pain [110 (27.5%)], skin disorders [80 (20.0%)], and traumatic injuries [65 (16.3%)]. Overall, 320 (80.0%) respondents sought treatment for any health problem. Language and cost barriers were reported by 196 (49.0%) and 120 (30.0%) respondents. Infection was significantly associated with dormitory/shared accommodation ($p<0.001$). Language barrier, high medication costs, duration >3 years, and no PPE significantly predicted an unsatisfactory outcome.*

Conclusion: *Bangladeshi migrant workers experienced a substantial burden of occupational morbidity and healthcare access barriers. Improved PPE provision, safety training, improved living conditions, and migrant-friendly health communication may reduce morbidity and improve outcomes.*

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Keywords: *Bangladeshi migrant workers; occupational health; healthcare utilization; Malaysia; personal protective equipment; language barrier.*

Introduction

Migrant workers are central to Malaysia's labor-intensive economy, particularly in construction, manufacturing, and services. These sectors commonly involve physically demanding work, long working hours, and exposure to occupational hazards. Globally, migrant workers have been shown to experience higher occupational exposure, injury, and illness than many host populations, partly because of precarious employment, limited protection and language or legal vulnerability [1,2]. Bangladesh is a major labour- sending country, and Bangladeshi workers in Southeast Asia often occupy low-skilled jobs where health and safety protection may be inconsistent [3]. Health problems

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among migrant workers are not limited to workplace injury. Reviews from Malaysia and comparable destination settings have identified occupational hazards, musculoskeletal disorders, infectious diseases, mental health concerns and healthcare access barriers as recurrent problems [4,5]. In Malaysia, infectious diseases among migrants and non-citizens have also been linked to crowded settlements and poor sanitation [6]. These findings are important for Bangladeshi workers, who often live in shared accommodation and work in environments where infections, skin disease, musculoskeletal pain and injury may overlap.

Healthcare utilization among migrant workers is influenced by affordability, insurance coverage, legal documentation, language and employer-related barriers. Studies in Malaysia have shown that migrant workers may delay seeking care because of high fees, uncertainty about entitlements, language barriers and lack of culturally appropriate communication [7–9]. The present study therefore assessed common occupational health conditions, healthcare utilization, communication barriers and predictors of poor outcomes among Bangladeshi migrant workers in Kuala Lumpur and Selangor, Malaysia.

Materials and Methods

Study design and setting: This community-based cross-sectional study was conducted among Bangladeshi migrant workers residing or working in Kuala Lumpur and Selangor, Malaysia. Data collection was carried out at workplaces, worker accommodations and nearby community locations.

Study population and sampling:

Bangladeshi migrant workers aged 18 years or above, employed in Malaysia for at least six months and willing to provide informed consent were eligible. Workers who were hospitalised or unable to provide consent were excluded. A total of 400 respondents were included using a snowball and convenience sampling approach initiated through worker hubs, company dormitories and community contacts.

Data collection tool and variables:

Data were collected by trained interviewers using a structured questionnaire. Information was obtained on age, education, job category, duration in Malaysia, working hours, living condition, PPE provision, safety training, reported health problems, treatment seeking, treatment pathway, treatment outcome, health service satisfaction, language barrier and cost barrier. Strict occupational disease was defined as the presence of at least one of infection, spinal/musculoskeletal pain, skin disorder or traumatic injury. Dental problem was recorded as a general health complaint and was not included in strict occupational disease classification.

Ethical considerations: Ethical approval was obtained from the appropriate institutional ethics committee Approval No. : **PAHMC/IERB/2023/08/08**. Written informed consent was obtained from all respondents. Data were collected anonymously and kept confidential.

Statistical analysis: Data were checked, coded and analyzed using SPSS version 27.0. Quantitative variables were summarized as mean±SD and categorical variables as frequency and percentage. Chi-square test was used to assess associations between categorical variables. Binary logistic regression was performed to identify predictors of unsatisfactory outcomes. Odds ratio (OR) with 95% confidence interval (CI) was reported. A p-value <0.05 was considered statistically significant.

Results

A total of 400 Bangladeshi migrant workers were included. Mean age was 30.60±8.18 years. Most respondents were aged 26-35 years (45.0%), followed by 18-25 years (30.0%). Construction workers formed the largest occupational group (45.0%), followed by factory workers (35.0%) and services/cleaning workers (20.0%). Mean duration in Malaysia was 3.13±1.69 years and mean working hour was 10.10±1.44 hours per day (Table I).

Table I. Socio-demographic and occupational characteristics of respondents (N=400)

Characteristic	Category	n	%
Age (years)	18-25	120	30.0
	26-35	180	45.0
	36-45	80	20.0
	>45	20	5.0
	Mean±SD	30.60±8.18	
Education	No formal	40	10.0
	Primary	160	40.0
	Secondary	140	35.0
	Higher	60	15.0
Job category	Construction	180	45.0
	Factory	140	35.0
	Services/Cleaning	80	20.0
Duration in Malaysia	6 months-1 yr	60	15.0
	1-3 yrs	160	40.0
	>3 yrs	180	45.0
	Mean±SD	3.13±1.69	
Working hours/day	8	80	20.0
	>8-10	140	35.0
	>10-12	180	45.0
	Mean±SD	10.10±1.44	
Living condition	Company	140	35.0
	Shared	130	32.5
	Dormitory	130	32.5

Values are expressed as frequency (%) unless otherwise stated.

Dental problem was the commonest general health complaint [191 (47.8%)] but was not classified as a strict occupational disease. Among strict occupational conditions, infection was reported by 145 (36.3%), spinal/musculoskeletal pain by 110 (27.5%), skin disorder by 80 (20.0%) and traumatic injury by 65 (16.3%) respondents. Overall, 250 (62.5%) respondents had at least one strict occupational condition (Table II).

Table II. Distribution of reported health conditions among respondents

Reported condition	n	%
Dental problem (general health complaint)	191	47.8
Infection (respiratory/diarrhoeal/fever/skin infection)	145	36.3
Spinal/musculoskeletal pain	110	27.5
Skin disorders (dermatitis, fungal, contact dermatitis)	80	20.0
Traumatic injuries (cuts, fractures, burns)	65	16.3
Total with >=1 strict occupational condition	250*	62.5

***Multiple responses were allowed; therefore, percentages do not add up to 100%. Dental problem was not included in strict occupational disease classification.**

Overall, 320 (80.0%) respondents sought treatment for any health problem. Clinic/hospital care was reported by 170 (42.5%) and pharmacy/self-medication by 150 (37.5%) respondents. Satisfactory improvement was reported by 232 (58.0%), while relapse/no improvement/no treatment was reported by 168 (42.0%). Language and cost barriers were reported by 196 (49.0%) and 120 (30.0%) respondents, respectively (Table III).

Table III. Healthcare utilization, treatment response and access barriers among respondents

Item	Category	n	%
Sought any treatment	Yes	320	80.0
	No	80	20.0
Treatment type recorded	Clinic/Hospital	170	42.5
	Pharmacy/self-medicated	150	37.5
	None	80	20.0
Overall reported treatment outcome	Satisfactory improvement	232	58.0
	Relapse/no improvement/no treatment	168	42.0
Overall reported language barrier	Yes	196	49.0
Overall reported cost barrier	Yes	120	30.0
Overall health service satisfaction	Excellent	53	13.3
	Good	125	31.3
	Fair	131	32.8
	Poor	91	22.8
Self-reported health change	Improved	232	58.0
	Same	80	20.0
	Worsened	88	22.0

Percentages were calculated among total respondents (N=400). Treatment seeking refers to any reported health problem and was not restricted to strict occupational diseases.

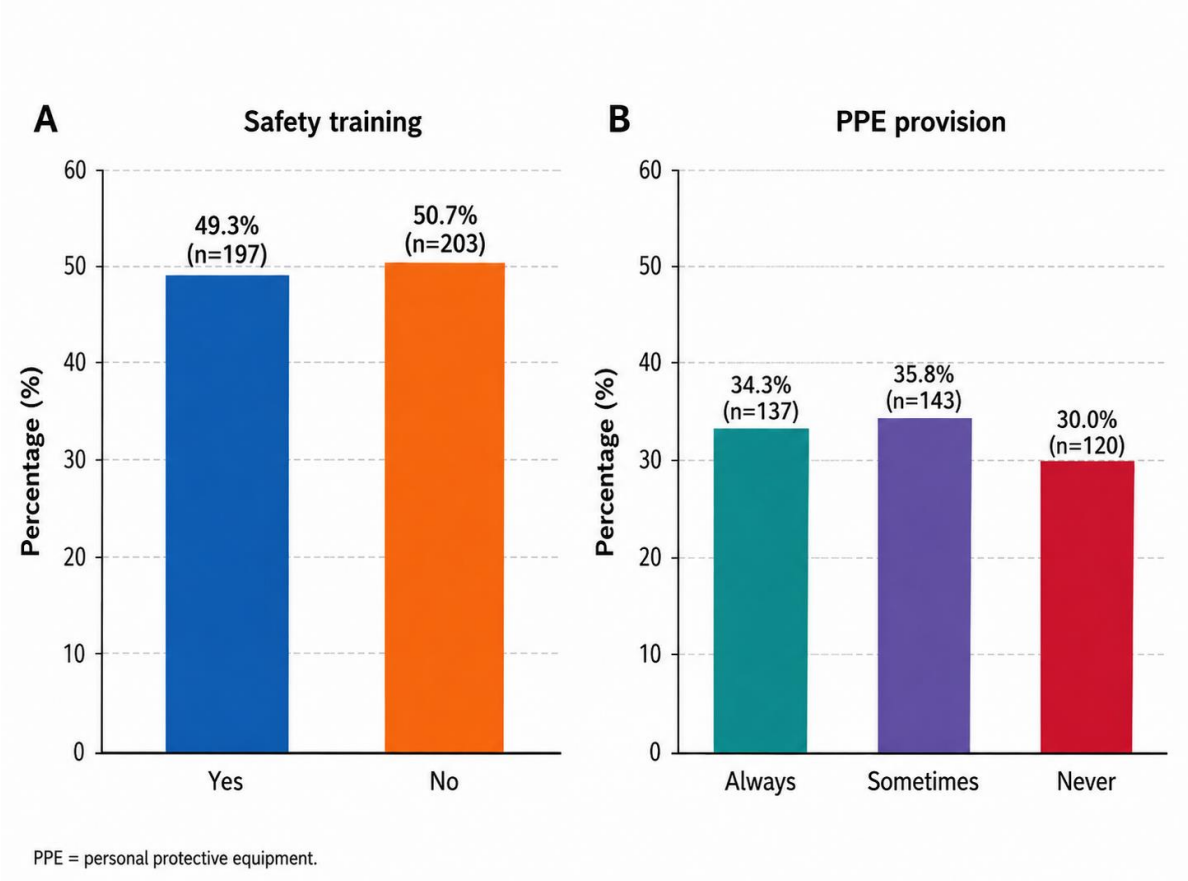

Figure 1. Distribution of workplace safety indicators among respondents (N=400).

Figure 1 indicates suboptimal workplace safety practice, with nearly half of respondents lacking safety training and only one-third reporting consistent PPE provision.

Living condition was significantly associated with infection. Infection was more frequent among respondents living in dormitories [60 (46.2%)] and shared housing [55 (42.3%)] compared with company housing [30 (21.4%); p<0.001]. Language and cost barriers were also significantly associated with unsatisfactory outcome (Table IV).

Table IV. Key bivariate associations with infection and unsatisfactory outcome

Variable	Category	Outcome present n (%)	Outcome absent n (%)	Total	p value
Living condition vs infection	Company	30 (21.4)	110 (78.6)	140	<0.001
	Dormitory	60 (46.2)	70 (53.8)	130	
	Shared	55 (42.3)	75 (57.7)	130	
Language barrier vs unsatisfactory outcome	Yes	100 (51.0)	96 (49.0)	196	<0.001
	No	68 (33.3)	136 (66.7)	204	
Cost barrier vs unsatisfactory outcome	Yes	65 (54.2)	55 (45.8)	120	0.001
	No	103 (36.8)	177 (63.2)	280	

For living condition, outcome present means infection present. For language and cost barriers, outcome present means relapse/no improvement/no treatment.

Strict occupational disease was significantly associated with job category, PPE provision and working hours. Disease was more frequent among construction workers, respondents who never received PPE and those working more than 10 hours per day (Table V).

Table V. Association of selected factors with strict occupational disease occurrence

Variable	Category	Disease present n (%)	Disease absent n (%)	Total	p value
Job type	Construction	125 (69.4)	55 (30.6)	180	**0.010**
	Factory	85 (60.7)	55 (39.3)	140	
	Services/Cleaning	40 (50.0)	40 (50.0)	80	
Duration in Malaysia	<=3 years	129 (58.6)	91 (41.4)	220	0.078
	>3 years	121 (67.2)	59 (32.8)	180	
PPE provided	Always	73 (53.3)	64 (46.7)	137	**0.004**
	Sometimes	89 (62.2)	54 (37.8)	143	
	Never	88 (73.3)	32 (26.7)	120	
Working hour	8 hours	47 (58.8)	33 (41.3)	80	**0.031**
	>8-10 hours	78 (55.7)	62 (44.3)	140	
	>10 hours	125 (69.4)	55 (30.6)	180	
Safety training	Yes	115 (58.4)	82 (41.6)	197	0.093
	No	135 (66.5)	68 (33.5)	203	

Strict occupational disease included infection, spinal/musculoskeletal pain, skin disorder and traumatic injury

In logistic regression, duration in Malaysia >3 years, communication barrier, cost barrier and no PPE were significant predictors of unsatisfactory outcome (Table VI).

Table VI. Logistic regression predicting unsatisfactory outcome

Predictor	OR	95% CI	p value
Age, per year increase	1.012	0.987-1.038	0.353
Construction job	1.193	0.795-1.789	0.408
Duration >3 years	1.144	1.012-1.294	**0.034**
Communication barrier	2.080	1.373-3.152	**0.001**
Cost barrier	1.575	1.007-2.462	**0.046**
No PPE	1.929	1.234-3.014	**0.004**

Reference categories: non-construction job, duration <=3 years, no communication barrier, no cost barrier and PPE provided always/sometimes. Outcome variable: relapse/no improvement/no treatment.

Discussion

This study found a substantial burden of reported occupational morbidity among Bangladeshi migrant workers in Malaysia. Nearly two-thirds of respondents had at least one strict occupational condition. Infection was the most frequent occupational condition, followed by spinal/musculoskeletal pain, skin disorders and traumatic injuries. This pattern is consistent with global evidence that migrant workers are commonly exposed to adverse working environments and experience work-related morbidity and injury [1,2]. Similar health domains, including occupational hazards and infectious diseases, were highlighted in a systematic review of Nepalese migrant workers in Malaysia and the Gulf countries [5].

The predominance of infection in this study is important because living conditions were significantly associated with infection. Respondents living in dormitories and shared accommodation reported higher infection rates than those living in company housing. Poor ventilation, overcrowding, and limited sanitation can increase transmission of communicable illnesses. Putera et al. [6] similarly reported that migrants and non-citizens in Malaysia were vulnerable to infectious diseases, partly related to cramped living conditions and sanitation problems. Recent evidence on Bangladeshi migrants in Southeast Asia also describes overcrowded and unhealthy accommodation as a recurring structural vulnerability [3].

Healthcare utilization was high, but access barriers remained common. Four-fifths of respondents reported seeking treatment for any health problem, yet almost half reported language barriers and nearly one-third reported cost barriers. These findings align with Karim and Diah[9], who described limited medical support and reliance on self-treatment among Bangladeshi workers in Malaysia. Loganathan et al. identified affordability, legal documentation, language barriers and employer-related restrictions as important barriers to healthcare access among migrant workers in Malaysia[7]. Similarly, Loganathan, Chan and Pocock showed that insurance and financing arrangements may remain inadequate for migrant workers despite mandatory schemes[8].

The regression findings further support the importance of communication and workplace protection. Communication barrier, cost barrier, and lack of PPE significantly predicted unsatisfactory outcomes. These findings are consistent with evidence that language difficulties may reduce the quality of care, informed consent, and adherence [7,10]. The association between no PPE and poor outcomes also supports the need for employer-supported occupational safety. Although this cross-sectional study cannot prove causality, the findings indicate that clinical services for migrant workers should be linked with workplace prevention, interpreter support, affordable access and improvement of living conditions.

Limitations

This study had limitations. The cross-sectional design prevents causal inference. Some health conditions and outcomes were self-reported and may be affected by recall bias. Snowball and convenience sampling may limit generalizability. The study was limited to Bangladeshi migrant workers in Kuala Lumpur and Selangor, and findings may not represent all migrant workers in Malaysia.

Conclusion:

Bangladeshi migrant workers in Malaysia experienced a considerable burden of occupational and general health problems, with infection, musculoskeletal pain, skin disorders, and injury representing important occupational conditions. Healthcare utilization was common, but language and cost barriers were frequent and were associated with poorer outcomes. Improved living conditions, consistent PPE provision, workplace safety training, affordable care, and migrant-friendly communication services may improve health outcomes in this vulnerable population.

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Conflict of interest

The authors declare no conflict of interest.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Disclosure

No artificial intelligence (AI) tools were used in the preparation of this manuscript.

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Morphometric Study of Occipital Condyles in Fully Ossified Dry Human Occipital Bone in a Bangladeshi Population

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Abstract

Background*: The occipital condyle is a bony structure lying anterolateral to the foramen magnum that connects the cranium to the vertebral column.*

Objective*: To determine the morphometric dimensions (length, width and height) of the occipital condyles in fully ossified dry human occipital bones in a Bangladeshi population.*

Methods*: A cross-sectional descriptive study was conducted on 100 fully ossified dry human occipital bones in the Department of Anatomy, Mymensingh Medical College, Mymensingh, between July 2021 and June 2022. A non-random purposive sampling technique was adopted. The length, width and height of the occipital condyles were measured using a sliding caliper (in mm).*

Results*: The mean±SD length of the occipital condyle was 22.29±2.83 mm on the right side and 22.21±2.87 mm on the left side. The mean width of the occipital condyle was 12.23±1.67 mm on the left side and 11.85±1.42 mm on the right side. The mean height was 8.92±1.3 mm for the left occipital condyle and 8.97±1.3 mm for the right occipital condyle.*

Conclusion*: As condylar drilling is an important step in the transcondylar approach, knowledge of the morphometry of the occipital condyle is of great surgical importance.*

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Keywords: *occipital condyle, condylectomy, morphometry, dry, fully ossified, Bangladeshi people.*

Introduction

The human occipital bone is a single bone occupying the back of the skull. It has four parts — the squamous part, the right and left condylar parts, and the basilar part.[1,2] The condylar part is situated on each side of the foramen magnum.[3]

The occipital condyles are important elements in maintaining the head vertically, as they articulate with the superior articular facets on the lateral mass of the atlas, forming the atlanto-occipital joint. The stability of this joint is important, and it is maintained by congruency of the articular surfaces together with capsulo-ligamentous factors. Deep to each condyle traverses the hypoglossal canal, which transmits the hypoglossal nerve and a meningeal branch of the ascending pharyngeal artery.[1] Morphometry of the occipital condyle is important in craniovertebral surgeries, particularly in accessing lesions ventral to the brainstem.[4,5] The transcondylar approach, which involves partial condylectomy by drilling the posterior aspect of the occipital condyle, is increasingly being used to access such lesions because it increases the surgical field of view and minimizes nerve tissue retraction.[6,7] Knowledge of the morphometry of the occipital condyle, as well as the position of the hypoglossal canal, may therefore be useful in

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decisions regarding the extent and direction of condylar drilling, to avoid occipito-cervical destabilization and injury to the hypoglossal nerve.[8]

Materials and Methods

This was a descriptive cross-sectional study. One hundred occipital bones were collected from the Department of Anatomy of Mymensingh Medical College, Bangladesh; Community Based Medical College, Bangladesh; and Netrokona Medical College, Bangladesh. Only fully ossified, intact bones were included; unossified, broken and abnormal bones were excluded. The length, width and height of the occipital condyles were measured using a digital Vernier sliding caliper. Two hundred condyles from the 100 occipital bones were measured on the left and right sides, and all data were compiled, sorted and analyzed statistically using Statistical Package for Social Science (SPSS) version 25. Regression analysis was also performed to test the association between findings. A P value of less than 0.05 was considered significant. This study was approved by the Ethical Review Committee of Mymensingh Medical College Hospital, Mymensingh, Bangladesh IRB No: **MMC/IRB2022/475.**

Figure 1: Procedure of measurement of length of occipital condyle

Figure 2: Procedure of measurement of width of occipital condyle

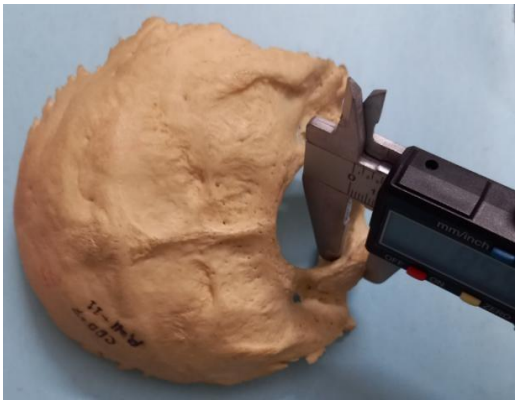

Figure 3: Procedure of measurement of height of occipital condyle

Results

The present study was performed on 100 occipital bones at the Department of Anatomy of Mymensingh Medical College, Mymensingh.

The length of the left occipital condyle ranged from 11.8 mm to 29 mm; more than 85% of samples were measured within the range of 20 mm to 30 mm. The length of the right occipital condyle ranged from 9.9 mm to 29.5 mm; more than 90% of samples were measured within the range of 20 mm to 30 mm.

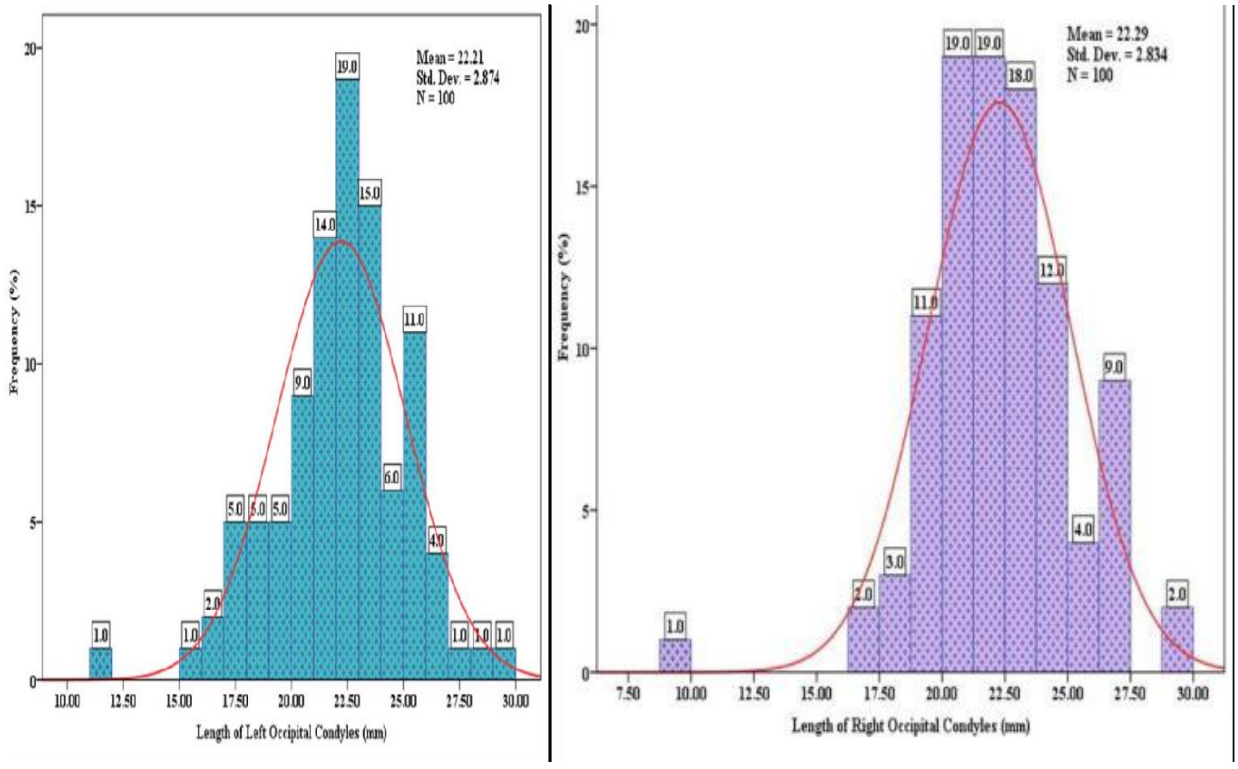

Figure 4: Frequency distribution of length of occipital condyles of both sides

The width of the left occipital condyle ranged from 8.8 mm to 19.4 mm; more than 85% of samples were measured within the range of 10 mm to 16 mm. The width of the right occipital condyle ranged from 8.8 mm to 16.5 mm; more than 80% of samples were measured within the range of 10 mm to 15 mm.

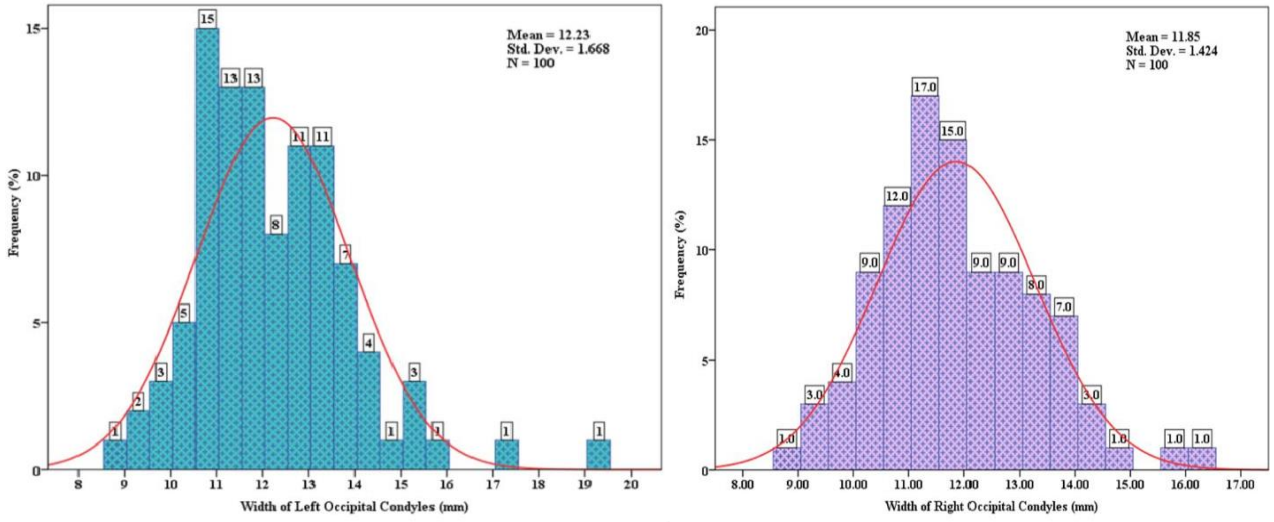

Figure 5: Frequency distribution of width of occipital condyles of both sides

The height of the left occipital condyle ranged from 6.7 mm to 15 mm; more than 90% of samples were measured within the range of 7 mm to 12 mm on the left side. The height of the right occipital condyle ranged from 6.8 mm to 15 mm; more than 90% of samples were measured within the range of 7 mm to 11 mm.

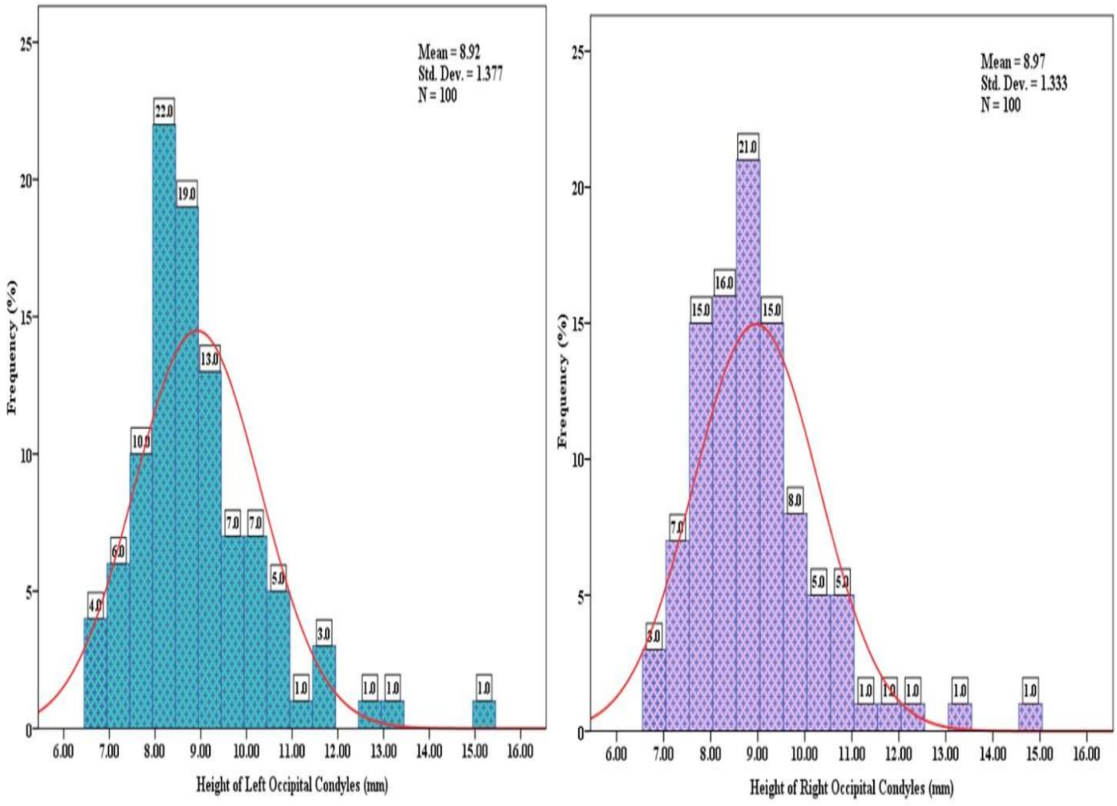

Figure 6: Frequency distribution of height of occipital condyles of both sides

Discussion

In the present study, the mean length of the occipital condyle was 22.21 ± 2.87 mm on the left side and 22.29 ± 2.83 mm on the right side. Similar findings were reported by Avci E et al.13, who observed the mean length of the occipital condyle to be 22.61 ± 2.3 mm on the right side and 22.36 ± 2.3 mm on the left side. S. Kavita, Shanta, Anand, and Shanthi9 reported a mean occipital condyle length of 22.34 ± 2.5 mm on the left side and 21.97 ± 2.5 mm on the right side, which is comparable to the findings of the present study. The findings of the present study are also consistent with those reported by Ajay, Dharati, and Shailesh.10

The mean width of the left occipital condyle was 12.23 ± 1.67 mm, whereas that of the right occipital condyle was 11.85 ± 1.42 mm. These measurements are comparable to the findings of Avci E et al.13, who reported mean widths of 12.3 ± 1.2 mm on the right side and 12.4 ± 1.5 mm on the left side. The findings of the present study are also in agreement with those reported by Anwesha et al.15 and Muthukumar et al.11.

The mean height of the occipital condyle was 8.92 ± 1.3 mm on the left side and 8.98 ± 1.3 mm on the right side. These measurements are comparable to those reported by Naderi S et al.12 and Fathi Z et al.14, who reported mean occipital condyle heights of 9.2 ± 1.4 mm on the right side and 9.2 ± 1.3 mm on the left side, respectively.

Conclusion

The occipital condyles are an integral part of the neck and the base of the skull. In the present study, an effort was made to measure various parameters related to the occipital condyle. These parameters should be taken into consideration during surgery of the craniovertebral junction by neurosurgeons and orthopaedic surgeons, to minimize mortality and morbidity. Preoperative radiological evaluation through plain radiography, CT and MRI is important for achieving surgical success, and this evaluation is required before surgery to prevent complications such as haemorrhage, atlanto-occipital instability, and injury to major structures passing through the foramen magnum. The findings are also useful for clinical anatomists and anthropologists for the purposes of teaching and further research.

Ethical Clearance

This study was approved by the Ethical Review Committee of Mymensingh Medical College Hospital, Mymensingh, Bangladesh. *[IRB reference number and date of approval to be provided]*

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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Author Contribution

Mili DA[1] conceived and designed the study, contributed to data collection and analysis, and drafted the manuscript. **Ara A**[2] contributed to the study design, data collection, interpretation of findings, and critical revision of the manuscript. **Begum T**[3] supervised the study and contributed to the interpretation of findings and critical review of the manuscript. **Islam ASMS**[4] contributed to the clinical interpretation of the findings and critical revision of the manuscript. **Jannat RA**[5] contributed to data collection, data organization, and manuscript preparation. **Shom T**[6] contributed to data collection, literature review, and manuscript revision. **Shanta MA**[7] contributed to data collection, data organization, and review of the manuscript. **Sharna T**[8] contributed to the literature review, interpretation of findings, and critical revision of the manuscript. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration on Use of Generative AI

No artificial intelligence (AI) tools were used in the preparation of this manuscript.

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Original Article
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Postoperative Analgesic Outcomes with Epidural Analgesia Following Major Abdominal Laparotomy: A Prospective Study

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Abstract

Background*: Uncontrolled postoperative pain after major abdominal laparotomy delays mobilization, impairs bowel recovery, and prolongs hospitalization, sustaining interest in regional analgesic strategies.*

Objective: *This study evaluated pain trajectory, analgesic supplementation, functional recovery, and complication frequency in patients receiving epidural analgesia after major abdominal laparotomy.*

Methods and Materials*: A prospective study of 106 adults aged 18–65 years undergoing major abdominal laparotomy at the Department of Anesthesia, Islami Bank Medical College Hospital, Rajshahi, between January 2024 and June 2025 received epidural analgesia via continuous infusion or patient-controlled delivery; pain, recovery, and safety outcomes were recorded serially.*

Results*: Mean age was 41.0 ± 13.0 years; 54 patients (50.9%) were male. Visual analog scale pain scores declined progressively from 3.72 ± 1.09 at 6 hours to 0.95 ± 0.88 at 72 hours postoperatively (Friedman $\chi^2 = 252.6$, $p < 0.001$). Rescue analgesia was required in 30 patients (28.3%), with no significant difference between continuous infusion and patient-controlled epidural regimens ($p = 0.78$). Mean time to ambulation was 27.97 ± 4.28 hours and mean time to first flatus was 35.71 ± 5.37 hours. Mean hospital stay was 6.37 ± 1.65 days. A total of 102 patients (96.2%) reported satisfaction rated "satisfied" or "very satisfied." Complications occurred in 4 patients (3.77%), consistent with the prespecified 2–4% benchmark, comprising hypotension, transient motor blockade, catheter-site erythema, and post-dural puncture headache, one case each.*

Conclusions*: Epidural analgesia produced a consistent, statistically significant decline in postoperative pain scores across 72 hours with a low complication burden in this cohort, supporting its continued role in major laparotomy analgesic protocols.*

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Keywords: *Epidural Analgesia, Laparotomy, Postoperative Pain, Visual Analog Scale, Patient-controlled Analgesia*

Introduction

The evidence base supporting epidural analgesia after major abdominal surgery is substantial but not uniform. Multicentre trial data spanning high-risk surgical populations have shown that epidural techniques reduce respiratory failure and deliver superior pain scores across the first three postoperative days, even where overall 30-day mortality does not differ from alternative analgesic strategies[1]. More recent comparative work has examined epidural analgesia against intravenous lidocaine infusion, regional blocks such as the transversus abdominis plane block and bilateral rectus sheath block, with mixed conclusions: some report non-inferiority of simpler systemic or fascial-plane alternatives, while others continue to demonstrate an epidural advantage, particularly in dynamic pain control during the first 24 hours[2-5]. This heterogeneity reflects genuine variation in surgical populations, catheter insertion technique, and infusion protocol, and it underscores the continued need for setting-specific outcome data rather than uncritical extrapolation from trial

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conducted in different healthcare systems. Within the epidural technique itself, clinicians must additionally choose between continuous background infusion and patient-controlled epidural analgesia (PCEA), a decision with implications for total local anesthetic consumption, breakthrough pain frequency, and nursing workload. Existing comparative data suggest broadly comparable analgesic efficacy between the two delivery modes[6]. Whether this equivalence holds in a South Asian tertiary hospital population undergoing a heterogeneous mix of major laparotomy procedures — exploratory laparotomy for perforated viscus, gastrectomy, colorectal resection, hepatobiliary and pancreatic surgery, and gynecological laparotomy — has not been well characterized. Beyond pain scores in isolation, the functional consequences of effective analgesia carry direct clinical weight. Early ambulation reduces venous thromboembolic risk and preserves respiratory mechanics; early return of bowel function shortens the interval to safe oral intake and, by extension, hospital discharge. Epidural analgesia has been linked in enhanced-recovery surgical pathways to accelerated return of gastrointestinal motility, although its effect on overall hospital stay is less consistent across surgical populations[7-10]. Complication frequency — hypotension from sympathetic blockade, transient motor weakness, catheter-site infection, and post-dural puncture headache — must be weighed against these functional gains; large-volume prospective series report severe neuraxial complications remain uncommon when catheter insertion and monitoring follow standardized protocols[8]. Bangladesh's tertiary surgical centers manage a substantial volume of major abdominal laparotomy, frequently in patients presenting with advanced or complicated intra-abdominal pathology under time and resource constraints that differ meaningfully from the settings in which much of the international epidural literature was generated. Locally derived, prospectively collected data on pain trajectory, analgesic supplementation requirements, functional recovery timelines, and complication frequency remain comparatively sparse, despite their direct relevance to protocol design in institutions such as the Department of Anesthesia at Islami Bank Medical College Hospital, Rajshahi. The present investigation was undertaken to characterize, in a prospectively assembled cohort of patients undergoing major abdominal laparotomy at this center, the trajectory of postoperative pain under epidural analgesia across the first 72 postoperative hours, the frequency and predictors of supplementary rescue analgesia, the timing of functional recovery milestones including ambulation and return of bowel function, overall length of hospital stay, patient-reported satisfaction, and the frequency and nature of analgesia-related complications. A secondary aim compared outcomes between continuous infusion and patient-controlled delivery modes within this cohort. This study does not include a non-epidural comparator arm; its purpose is descriptive and hypothesis-generating, intended to establish a locally grounded outcome benchmark against which future comparative trials in this population can be designed.

Methods

Study Design

This was a prospective observational cohort study conducted in the Department of Anesthesia, Islami Bank Medical College Hospital, Rajshahi, Bangladesh, between January 2024 and June 2025. All patients scheduled for major abdominal laparotomy who received epidural analgesia as their postoperative pain management modality during this period were considered for enrollment.

Participants

Adults aged 18 to 65 years undergoing major abdominal laparotomy — including exploratory laparotomy for perforated viscus or peritonitis, gastrectomy or gastroenterostomy, major colorectal resection, major hepatobiliary or pancreatic surgery, and abdominal hysterectomy or other gynecological laparotomy — were eligible. Exclusion criteria comprised contraindication to

neuraxial blockade (coagulopathy, local infection at the insertion site, or patient refusal), documented allergy to amide local anesthetics, preoperative chronic opioid dependence, American Society of Anesthesiologists (ASA) physical status IV or greater, and inability to comply with postoperative pain assessment. A total of 106 patients met eligibility criteria and were enrolled after providing written informed consent.

Anesthetic and Analgesic Protocol

Epidural catheters were sited preoperatively at the thoracic T8–T10, thoracic T10–T12, or lumbar L1–L2 interspace according to the planned surgical incision, under aseptic technique with loss-of-resistance confirmation. Postoperative analgesia was delivered either as a continuous epidural infusion of bupivacaine with fentanyl or via patient-controlled epidural analgesia (PCEA), at the discretion of the attending anesthesiologist based on patient factors and nursing supervision capacity. Catheters remained in situ for 48 or 72 hours depending on clinical course. Rescue analgesia (intravenous paracetamol or a supplementary opioid dose) was administered when the visual analog scale (VAS) score exceeded 4 despite epidural dosing, or on patient request.

Outcome Measures

The primary outcome was postoperative pain intensity, recorded on a 0–10 VAS at 6, 12, 24, 48, and 72 hours after surgery. Secondary outcomes included the requirement for and number of rescue analgesic doses, Ramsay sedation score, time to first unassisted ambulation, time to first passage of flatus, total epidural catheter duration, postoperative hospital length of stay, patient-reported satisfaction (very satisfied, satisfied, or unsatisfied), and the frequency and nature of analgesia-related complications, prespecified at an anticipated 2–4% incidence based on institutional experience.

Statistical Analysis

Data were analyzed using SPSS v26.0 (IBM Corp., Armonk, NY). Continuous variables are presented as mean ± standard deviation (SD) and categorical variables as frequency and percentage. The trajectory of VAS pain scores across the five postoperative time points was assessed using the Friedman test for repeated measures, followed by a paired t-test comparing the 6-hour and 72-hour scores as a sensitivity check. Between-group comparisons of continuous variables (continuous infusion versus PCEA) used the independent-samples t-test; categorical comparisons used the chi-square test. Pearson correlation assessed the relationship between age and hospital stay. A two-tailed p-value < 0.05 was considered statistically significant throughout.

Results

Baseline and Procedural Characteristics

A total of 106 patients were enrolled, with a mean age of 41.0 ± 13.0 years (range 20–65 years); 54 (50.9%) were male and 52 (49.1%) female. The majority resided in rural areas (61, 57.5%), and household income was distributed across lower-income (45, 42.5%), middle-income (48, 45.3%), and upper-middle-income (13, 12.3%) categories. Mean body mass index was 24.3 ± 3.1 kg/m². ASA physical status was predominantly Grade II (62, 58.5%), with 25 (23.6%) Grade I and 19 (17.9%) Grade III. Exploratory laparotomy for perforated viscus or peritonitis was the most frequent procedure (36, 34.0%), followed by gastrectomy or gastroenterostomy (22, 20.8%), major colorectal resection (20, 18.9%), hepatobiliary or pancreatic surgery (17, 16.0%), and gynecological laparotomy (11, 10.4%). Mean surgical duration was 140.4 ± 24.1 minutes, with mean intraoperative blood loss of 213.5 ± 50.3 mL [Table 1].

Table I: Baseline demographic and procedural characteristics of study participants (N = 106)

Variable	Category	n (%) / Mean ± SD
Age (years)	Mean ± SD	41.0 ± 13.0
Gender	Male	54 (50.9%)
	Female	52 (49.1%)
Residence	Rural	61 (57.5%)
	Semi-Urban	25 (23.6%)
	Urban	20 (18.9%)
Socioeconomic Status	Lower-Income	45 (42.5%)
	Middle-Income	48 (45.3%)
	Upper-Middle-Income	13 (12.3%)
BMI (kg/m²)	Mean ± SD	24.3 ± 3.1
ASA Grade	I	25 (23.6%)
	II	62 (58.5%)
	III	19 (17.9%)
Laparotomy Procedure	Exploratory (perforated viscus/peritonitis)	36 (34.0%)
	Gastrectomy/Gastroenterostomy	22 (20.8%)
	Major colorectal resection	20 (18.9%)
	Hepatobiliary/Pancreatic surgery	17 (16.0%)
	Gynecological laparotomy	11 (10.4%)
Surgery Duration (min)	Mean ± SD	140.4 ± 24.1
Intraoperative Blood Loss (mL)	Mean ± SD	213.5 ± 50.3

Epidural analgesia was delivered via continuous infusion in 57 patients (53.8%) and PCEA in 49 patients (46.2%). Thoracic T8–T10 catheter placement was most common (65, 61.3%), followed by T10–T12 (29, 27.4%) and lumbar L1–L2 (12, 11.3%). Catheters remained in situ for 48 hours in 67 patients (63.2%) and 72 hours in 39 patients (36.8%).

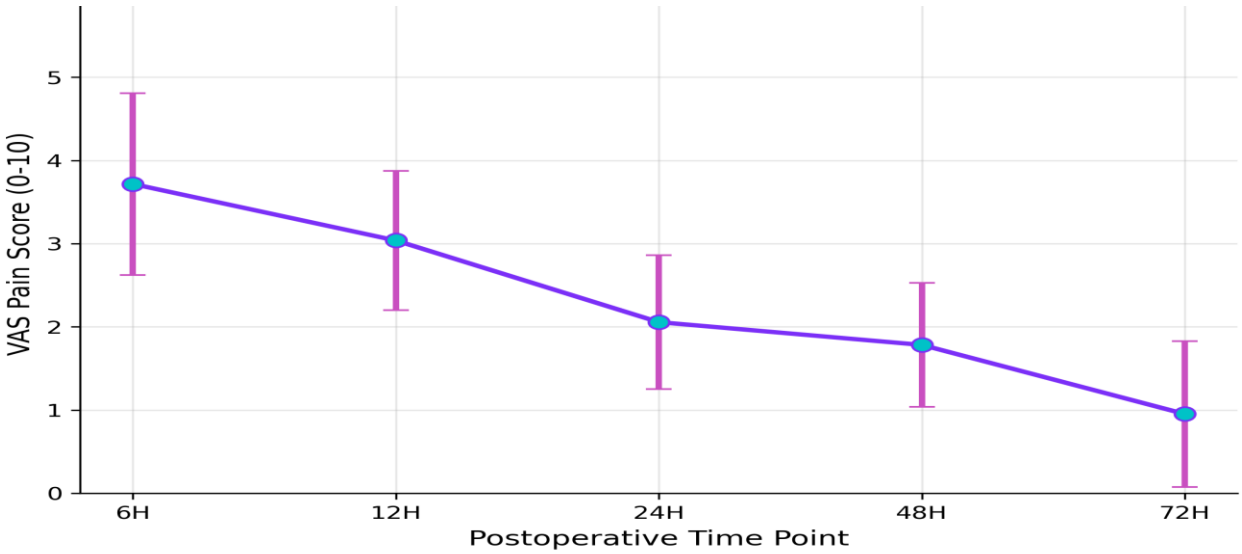

Figure 1: Trajectory of mean visual analog scale (VAS) pain scores across five postoperative time points (6, 12, 24, 48, and 72 hours) in the study cohort (N = 106)
Showing a progressive and statistically significant decline (Friedman test, $p < 0.001$)

Postoperative Pain Trajectory

Mean VAS pain scores declined progressively across the five assessment points: 3.72 ± 1.09 at 6 hours, 3.04 ± 0.84 at 12 hours, 2.06 ± 0.80 at 24 hours, 1.78 ± 0.74 at 48 hours, and 0.95 ± 0.88 at 72 hours [Table 2, Figure 1]. This decline was statistically significant across the five time points (Friedman $\chi^2 = 252.6$, $p < 0.001$), and the difference between the 6-hour and 72-hour scores was confirmed by paired t-test ($t = 20.67$, $p < 0.001$).

Table II: Visual analog scale pain scores at serial postoperative time points (N = 106)

Time Point	Mean VAS ± SD	Statistical Test
6 hours	3.72 ± 1.09	
12 hours	3.04 ± 0.84	
24 hours	2.06 ± 0.80	Friedman $\chi^2 = 252.6$, $p < 0.001$
48 hours	1.78 ± 0.74	
72 hours	0.95 ± 0.88	Paired t (6h vs 72h) = 20.67, $p < 0.001$

When VAS scores were compared between delivery modes, patients receiving PCEA reported numerically lower scores at 6 hours (3.53 ± 1.02 versus 3.88 ± 1.13 for continuous infusion) and 24 hours (1.98 ± 0.79 versus 2.12 ± 0.81), but neither difference reached statistical significance ($p = 0.10$ and $p = 0.36$, respectively), nor did the 72-hour comparison (0.91 ± 0.85 for continuous infusion versus 1.00 ± 0.92 for PCEA, $p = 0.61$) [Table 3, Figure 2].

Table III: Comparison of outcomes between continuous infusion and patient-controlled epidural analgesia (PCEA)

Outcome	Continuous Infusion (n=57)	PCEA (n=49)	p-value
VAS at 6 hours	3.88 ± 1.13	3.53 ± 1.02	0.104
VAS at 24 hours	2.12 ± 0.81	1.98 ± 0.79	0.362
VAS at 72 hours	0.91 ± 0.85	1.00 ± 0.92	0.610
Rescue analgesia required, n (%)	15 (26.3%)	15 (30.6%)	0.785

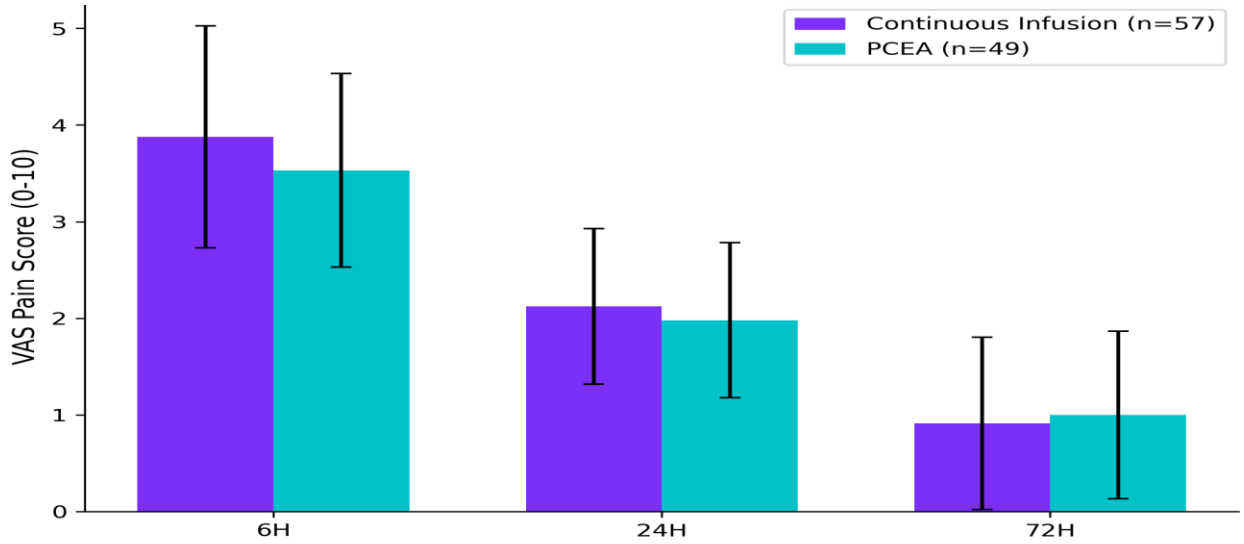

Figure 2: Comparison of mean VAS pain scores between continuous epidural infusion (n = 57) and patient-controlled epidural analgesia (n = 49) at 6, 24, and 72 hours postoperatively, generated directly from study data

No statistically significant between-group difference was observed at any time point

Rescue Analgesia and Sedation

Rescue analgesia was required in 30 patients (28.3%), with a mean of 0.48 ± 0.91 supplementary doses per patient across the cohort. The proportion requiring rescue analgesia did not differ significantly between continuous infusion (15/57, 26.3%) and PCEA (15/49, 30.6%) groups (χ^2 test, p = 0.78). Mean Ramsay sedation score was 2.43 ± 0.63, with the majority of patients (68, 64.2%) scoring 2 (cooperative, oriented, tranquil), 30 (28.3%) scoring 3, and 8 (7.5%) scoring 4.

Functional Recovery and Length of Stay

Mean time to first unassisted ambulation was 27.97 ± 4.28 hours, and mean time to first passage of flatus was 35.71 ± 5.37 hours. Time to ambulation did not differ significantly between patients with 48-hour versus 72-hour catheter duration (28.26 ± 4.32 versus 27.46 ± 4.19 hours, p = 0.35). Mean postoperative hospital stay was 6.37 ± 1.65 days (range 4–9 days) [Table 4]. No significant correlation was observed between patient age and length of hospital stay (Pearson r = −0.05, p = 0.59).

Patient Satisfaction and Complications

Overall satisfaction was high: 67 patients (63.2%) reported being "satisfied" and 39 (36.8%) "very satisfied" with postoperative analgesia, with no patient in this cohort reporting dissatisfaction. Complications attributable to epidural analgesia occurred in 4 of 106 patients (3.77%), consistent

with the prespecified institutional benchmark of 2–4%. These comprised one case each of hypotension attributable to epidural sympathetic blockade, transient lower-limb motor weakness, catheter-site erythema or local infection, and post-dural puncture headache. No case of epidural hematoma, abscess, or respiratory depression was recorded. Complication frequency did not differ meaningfully across ASA grade strata (Grade I: 1/25, 4.0%; Grade II: 3/62, 4.8%; Grade III: 0/19, 0%) [Table 4].

Table IV: Functional recovery, length of stay, satisfaction, and complications

Variable	Result
Time to ambulation (hours), mean ± SD	27.97 ± 4.28
Time to first flatus (hours), mean ± SD	35.71 ± 5.37
Rescue analgesia required, n (%)	30 (28.3%)
Ramsay sedation score, mean ± SD	2.43 ± 0.63
Hospital stay (days), mean ± SD (range)	6.37 ± 1.65 (4–9)
Patient satisfaction — Very Satisfied, n (%)	39 (36.8%)
Patient satisfaction — Satisfied, n (%)	67 (63.2%)
Complications, n (%)	4 (3.77%)
Hypotension (epidural sympathetic block)	1 (0.94%)
Transient lower-limb motor weakness	1 (0.94%)
Catheter-site erythema/local infection	1 (0.94%)
Post-dural puncture headache	1 (0.94%)

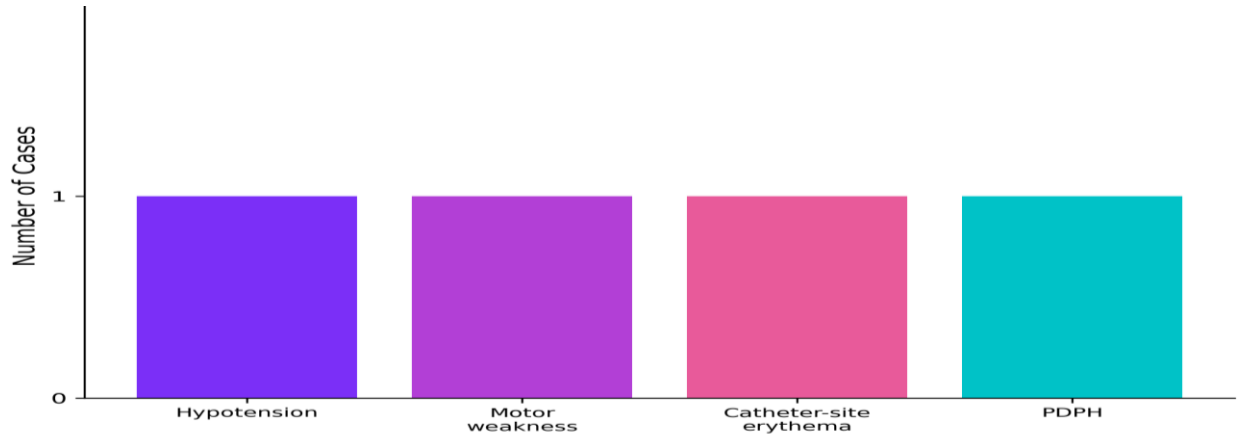

Figure 3: Distribution of postoperative complications (n = 4/106, 3.77%) by type, generated directly from study data: hypotension, transient motor blockade, catheter-site erythema, and post-dural puncture headache, one case each.

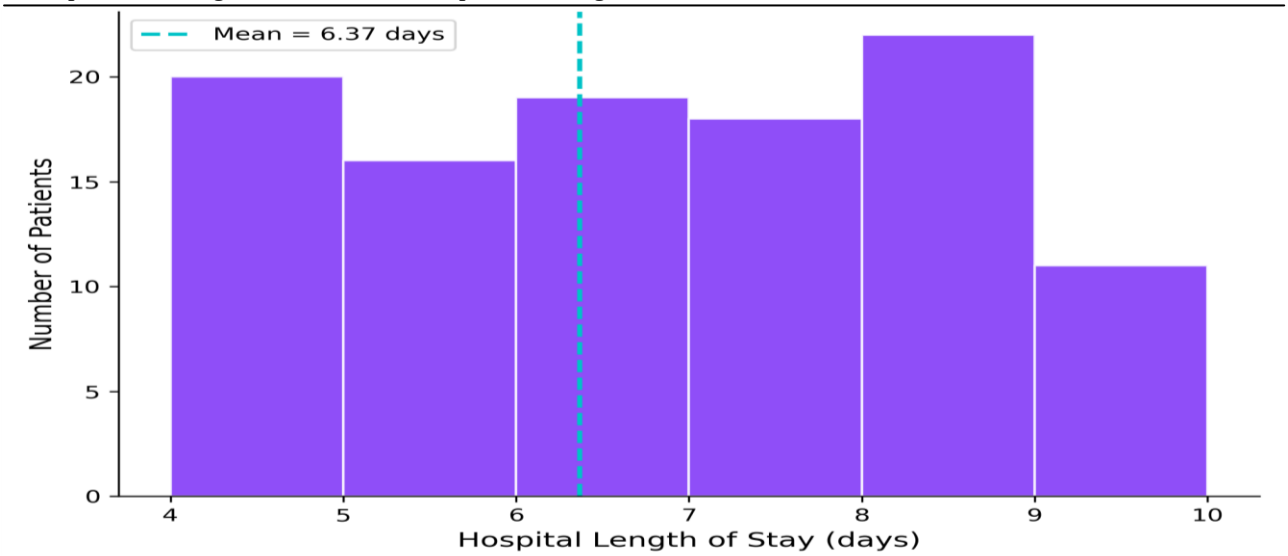

Figure 4: Distribution of postoperative hospital length of stay (days) across the study cohort, generated directly from study data, with mean 6.37 ± 1.65 days (range 4–9 days).

Discussion

In this prospective observational cohort of 106 patients undergoing major abdominal laparotomy, epidural analgesia was associated with a progressive and statistically significant decline in VAS pain scores across the first 72 postoperative hours, falling from a mean of 3.72 at 6 hours to 0.95 at 72 hours. Roughly one in four patients required supplementary rescue analgesia, functional recovery milestones — ambulation at approximately 28 hours and flatus at approximately 36 hours — occurred within a timeframe consistent with enhanced-recovery expectations, and complications were infrequent (3.77%), matching the institutional benchmark set a priori.

Comparison with Existing Literature

The pain trajectory observed here parallels findings from randomized and observational series evaluating epidural analgesia after major abdominal surgery. In the landmark MASTER trial, epidural analgesia was associated with lower pain scores during the first three postoperative days in a high-risk surgical population, even though overall 30-day mortality did not differ from control[1]. The present cohort's 6-hour to 72-hour VAS decline is consistent with that pattern, though direct numeric comparison is limited by differences in scoring instrument and patient case-mix. Comparative trials pitting epidural analgesia against alternative techniques offer a more nuanced picture than a simple efficacy verdict. A non-inferiority trial of intravenous lidocaine infusion against thoracic epidural analgesia in major abdominal surgery found lidocaine statistically non-inferior for dynamic pain up to 72 hours, with a signal toward improved safety[2]. A meta-analysis comparing epidural bupivacaine with intravenous lidocaine

similarly found a significant epidural advantage confined to the first 24 hours, with the difference attenuating by 48 and 72 hours a pattern that broadly echoes the present cohort's own steep early decline followed by a flatter late-phase trajectory[3]. Comparable convergence has been reported against fascial-plane techniques: a meta-analysis of transversus abdominis plane block versus epidural analgesia found epidural techniques modestly superior at 12 and 48 hours but equivalent at other time points and a randomized trial comparing bilateral rectus sheath block against thoracic epidural analgesia after open gastrectomy likewise reported comparable pain control between the two approaches[4, 5]. Collectively, this body of work situates epidural analgesia as an effective but not categorically superior option among a widening

menu of regional techniques, a positioning consistent with the present cohort's own strong within-group pain reduction absent a formal comparator arm.

The absence of a statistically significant difference between continuous infusion and PCEA delivery modes in this cohort (p = 0.10–0.61 across time points) aligns with earlier controlled comparisons. A retrospective analysis of programmed intermittent bolus versus continuous infusion in major upper abdominal surgery found no significant difference in rescue opioid consumption, pain scores, or adverse events between delivery strategies[6]. These convergent findings suggest that, once adequate catheter placement and dosing are achieved, the choice between continuous and patient-controlled delivery may matter less for analgesic outcome than for resource allocation and nursing burden an operationally relevant conclusion for institutions weighing PCEA pump availability against staffing for continuous-infusion titration.

The 3.77% complication rate recorded in this cohort sits within the range reported in comparable series. Retrospective work comparing epidural analgesia against continuous wound infusion after hepatobiliary and pancreatic surgery reported no significant difference in length of stay or opioid consumption between techniques, while noting the small but recognized risk of epidural-specific complications inherent to neuraxial catheterization[7]. A large prospective single-center series of 5,083 epidural cases reported major complications in 1.36% overall, including post-dural puncture headache in 0.14% and epidural hematoma in just 0.02% underscoring that severe neuraxial complications remain rare even at high procedural volume[8]. No hematoma, abscess, or respiratory depression occurred in the present cohort; the four recorded events — hypotension, transient motor weakness, catheter-site erythema, and post-dural puncture headache — represent the more common, self-limiting end of the epidural complication spectrum.

Functional recovery metrics in this cohort mean ambulation at 28.0 hours and flatus at 35.7 hours — sit consistent with enhanced-recovery literature describing epidural analgesia's association with accelerated gastrointestinal motility restoration; a meta-analysis of laparoscopic colorectal trials found thoracic epidural analgesia significantly improved time to first bowel motion and pain scores, though without a corresponding reduction in overall hospital stay[9]. This dissociation between improved bowel recovery and unchanged length of stay is corroborated by a large propensity-matched analysis of open colorectal surgery, which found epidural analgesia conferred no significant advantage in cardiopulmonary complications, length of stay, or 30-day mortality relative to non-epidural analgesia[10-12]. The mean hospital stay of 6.37 ± 1.65 days observed in the present cohort is broadly comparable to these reported ranges, reinforcing that hospital discharge in major laparotomy is governed by a composite of surgical, nutritional, and systemic recovery factors beyond analgesic technique alone, even when analgesia itself is effective.

Novelty and Contribution

Much of the comparative epidural literature originates from high-income, high-resource surgical settings with established enhanced-recovery infrastructure. This study contributes prospectively collected, granular outcome data — serial VAS trajectories, delivery-mode comparison, functional recovery timing, and complication profiling — from a Bangladeshi tertiary teaching hospital managing a heterogeneous major laparotomy caseload dominated by emergency exploratory procedures for perforated viscus and peritonitis, a case-mix that differs materially from the elective gastrectomy and colorectal cohorts that populate much of the existing trial literature. In doing so, it establishes a locally derived descriptive benchmark against which future comparative or interventional trials at this and similar institutions can be designed and powered, and it directly addresses a documented scarcity of setting-specific perioperative pain outcome data from this region.

Directions for Future Research

Several questions remain unresolved by the present descriptive design. First, and most fundamentally, this cohort lacks a non-epidural comparator arm; the pain reduction documented here reflects within-cohort trajectory rather than a causal effectiveness estimate relative to systemic analgesia or an alternative regional technique, and a randomized comparator trial remains necessary to establish comparative effectiveness in this specific population. Second, the modest but non-significant differences favoring PCEA at early time points may reflect a true small effect that this sample was underpowered to detect, warranting a larger, adequately powered trial with delivery mode as the primary randomized variable. Third, the drivers of the 28.3% rescue analgesia requirement were not formally modeled here; multivariable analysis incorporating procedure type, catheter level, and ASA grade could clarify which patients are most likely to need supplementary analgesia. Finally, longer-term outcomes — chronic post-surgical pain incidence, functional status at 30 and 90 days — were outside this study's observation window and merit dedicated follow-up.

Limitations

This study's principal strengths include its prospective design, a sample size adequate to detect within-cohort trajectory changes, standardized serial pain assessment across five defined postoperative time points, and complete complication ascertainment with case-level detail. Its principal limitation is the absence of a randomized or non-epidural comparator group, which restricts causal claims about epidural analgesia's effectiveness relative to alternative strategies and confines interpretation to descriptive, within-cohort change over time. The single-center design and predominance of emergency exploratory laparotomy in the case-mix may limit generalizability to elective surgical populations or other institutional settings. Delivery mode (continuous infusion versus PCEA) was assigned by clinician discretion rather than randomization, introducing potential selection bias into the subgroup comparison. Finally, patient satisfaction was captured as a categorical ordinal measure rather than a validated multidimensional instrument, which may understate variation in the patient experience of analgesic quality.

Conclusion

In this prospective cohort of patients undergoing major abdominal laparotomy, epidural analgesia was associated with a significant and sustained reduction in postoperative pain across 72 hours, functional recovery within an expected enhanced-recovery timeframe, high patient-reported satisfaction, and a low complication rate consistent with institutional expectations. These findings support the continued use of epidural analgesia within this center's major laparotomy analgesic protocol and provide a locally grounded benchmark for future comparative trials.

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Ethical Considerations

The study protocol was reviewed and approved by the Bangladesh Society of Clinical Research (BSCR) Institutional Review Board (Ethical Approval ID: BSCR/IRB/2024/ICU/0173). Written informed consent was obtained from each patient or their legal guardian prior to enrollment, consistent. Patient identifiers were anonymized prior to analysis, and all procedures conformed to the ethical standards of the Declaration of Helsinki.

Consent for Publication

Not applicable — no identifying individual patient data or images are presented.

Data Availability Statement

The dataset analyzed during the current study is available from the corresponding author on reasonable request.

Declaration of Conflicting Interests

The author declares no conflict of interest relevant to this study.

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Abbreviations

ASA, American Society of Anesthesiologists; BMI, body mass index; PCEA, patient-controlled epidural analgesia; SD, standard deviation; VAS, visual analog scale.

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Staged Bilateral Uncemented Total Hip Arthroplasty for Steroid-Induced Avascular Necrosis of the Femoral Head in a Young Woman

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Abstract

Background: *Avascular necrosis (AVN) of the femoral head is a progressive and disabling condition that predominantly affects young adults. Prolonged corticosteroid exposure is a well-established risk factor, while unsupervised steroid use remains a concern in resource-limited settings.*

Objective: *To report a case of advanced bilateral femoral head AVN in a young woman following prolonged unsupervised corticosteroid use and to describe the outcome of staged total hip arthroplasty.*

Case Summary: *A 19-year-old woman from a low-income rural background in Bangladesh presented with bilateral hip pain for three years and progressive difficulty walking for one year. She had taken oral corticosteroids for approximately four years on the advice of an unqualified practitioner. Examination revealed an antalgic gait, bilateral restriction of hip movements, more pronounced on the left, a positive Thomas test, and 1 cm supratrochanteric shortening of the left lower limb. Pelvic radiographs demonstrated bilateral joint-space narrowing, femoral head distortion, osteosclerosis, and marginal osteophyte formation, consistent with advanced AVN. Screening for tuberculosis and septic causes was negative. Staged uncemented modular total hip arthroplasty was performed through the direct lateral (Hardinge) approach, with the left hip replaced first and the right hip approximately ten months later following preoperative traction.*

Results: *At follow-up, the patient was walking comfortably with satisfactory function of both hip replacements.*

Conclusion: *Unregulated and prolonged corticosteroid use can lead to severe bilateral AVN even in very young patients. Early recognition and appropriate management are essential. Staged total hip arthroplasty can provide satisfactory functional recovery in young patients with end-stage bilateral AVN.*

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Keywords: *Avascular necrosis; femoral head; corticosteroids; total hip arthroplasty; young adult; case report.*

Introduction

Avascular necrosis, also called osteonecrosis, of the femoral head develops when the blood supply to that small, precariously vascularised piece of bone is interrupted for long enough that the bone itself dies. Once the supporting trabeculae give way, the joint surface collapses, arthritis sets in, and a young person who might have expected forty or fifty more years out of that hip is left in constant pain. Trauma is the most familiar cause, but among the non-traumatic causes, corticosteroid exposure is consistently the largest single contributor, whether the steroid was prescribed for a genuine medical indication or, as in the case described here, obtained informally. Estimates of how many steroid-treated patients go on to develop osteonecrosis vary widely across the literature, from roughly 3% to 40%, reflecting differences in the underlying illness, the steroid dose and duration, and probably genetic susceptibility that is still not fully worked out.[1] Higher cumulative dose and longer duration of exposure both raise the risk, though the relationship is not perfectly linear and disease has been reported even after comparatively brief high-dose courses.[1] In South Asia in particular

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weak regulation of over-the-counter and informally dispensed corticosteroids means that patients are sometimes exposed to substantial cumulative doses without any medical supervision or awareness of the risk, a pattern that has been documented repeatedly in Bangladesh and neighbouring countries.2

Bilateral involvement is common in steroid-induced disease, reflecting the systemic nature of the insult, and by the time symptoms bring a patient to hospital the disease has frequently progressed past the point where joint-preserving surgery is realistic. We present the case of a young woman whose hips were destroyed by four years of unsupervised oral steroid use, and who required staged bilateral total hip replacement in her late teens — a stark illustration of how much damage informal medicine can do, and of what can still be salvaged with careful surgical planning.

Case Presentation

A 19-year-old housewife from a rural, low-income household in Karimganj, Kishoreganj, Bangladesh, presented to the department of orthopaedics and traumatology with pain in both hips that had been building for three years and a year of increasing difficulty walking. The pain had begun insidiously on the left side as a mild, dull, intermittent ache that was worse with movement and eased with rest. Over the following two years it spread to involve the right hip as well, and began radiating down into both thighs and knees. By the time of admission, walking and ordinary daily activities had become genuinely difficult for her.

She denied any preceding trauma, fever, night sweats, cough, haemoptysis, or unexplained weight loss, which argued against an infective or tuberculous process. Her past medical history was otherwise unremarkable, but on direct questioning she gave a history of taking oral steroids for roughly four years, started on the advice of an unqualified local practitioner for vague "poor health," alongside intermittent non-steroidal anti-inflammatory drugs and anti-ulcer medication obtained through the same informal channel. She came from a low socio-economic background, and there was nothing of note in her personal, immunisation, or family history.

On general examination she looked anxious but was cooperative, mildly anaemic, and otherwise systemically well — normotensive with a pulse of 78 beats per minute, a temperature of 98.4°F, a respiratory rate of 16 breaths per minute, and no jaundice, cyanosis, clubbing, lymphadenopathy, or thyroid enlargement. Locally, she walked with an antalgic gait and could not squat. There was visible wasting of the left thigh compared with the right and an increased lumbar lordosis, but the overlying skin was normal with no sinuses or scars. On palpation, both hips were tender, local temperature was not raised, and the left leg measured one centimetre shorter than the right, with Bryant's triangle confirming this to be supratrochanteric shortening; the left thigh circumference was reduced by about a centimetre in keeping with the visible wasting. The Thomas test was positive, and distal neurovascular status was intact throughout. Movement was restricted in both hips, more severely on the left, as summarized in Table 1.

Movement	Left hip	Right hip	Normal range
Flexion	0°–50°	0°–80°	0°–140°
Abduction	0°–10°	0°–20°	0°–45°
Adduction	0°–10°	0°–10°	0°–35°

Internal rotation (in flexion)	0°–5°	0°–10°	0°–30°
External rotation (in flexion)	0°–5°	0°–10°	0°–45°

Table 1. Range of motion of both hip joints at presentation, compared with the accepted normal range.

Examination of the respiratory, cardiovascular, gastrointestinal, and nervous systems was unremarkable. Taken together, the clinical picture was of a young woman with three years of progressive bilateral hip pain, worse on the left, with mechanical signs of joint destruction, shortening, and a substantial history of unsupervised corticosteroid exposure — findings that pointed strongly towards bilateral avascular necrosis of the femoral heads, while tuberculous arthritis and the sequelae of septic arthritis remained reasonable alternatives to exclude given the sub-acute, indolent course.

Investigations

Baseline blood work showed mild anaemia with a haemoglobin of 9.5 g/dL; inflammatory markers were unremarkable, with a total leucocyte count of 8,000/mm³, an ESR of 30 mm in the first hour, and a C-reactive protein below 6 mg/L, none of which suggested an active infective or tuberculous process. The Mantoux test and rheumatoid factor were both negative, and a chest radiograph showed no active pulmonary disease, further weighing against tuberculosis. Renal function, fasting glucose, hepatitis B surface antigen, and serum calcium were all normal, and an abdominal ultrasound scan was unremarkable. These results are summarised in Table 2. Magnetic resonance imaging, which would have allowed formal Ficat–Arlet staging of the disease, was not available to us in this setting; staging was therefore based on the clinical picture and plain radiographs alone.[3]

Investigation	Result
Haemoglobin	9.5 g/dL
Total leucocyte count	8,000/mm³
ESR (1st hour)	30 mm
C-reactive protein	< 6 mg/L
Mantoux test	Negative
Rheumatoid factor	Negative
Random blood sugar	5.1 mmol/L
Serum creatinine	1.0 mg/dL
HBsAg	Negative
Serum calcium	9 mg/dL

Chest radiograph (PA view)	No active pulmonary lesion
Ultrasonography, whole abdomen	Normal study

Table 2. Summary of laboratory and baseline imaging investigations.

An antero-posterior radiograph of the pelvis including both hip joints was the key diagnostic study. It showed narrowing of the joint space, distortion of both femoral heads, shortening of both femoral necks, osteosclerosis, marginal osteophyte formation, and acetabular involvement bilaterally — a pattern of advanced, end-stage change in both hips rather than early, potentially salvageable disease.

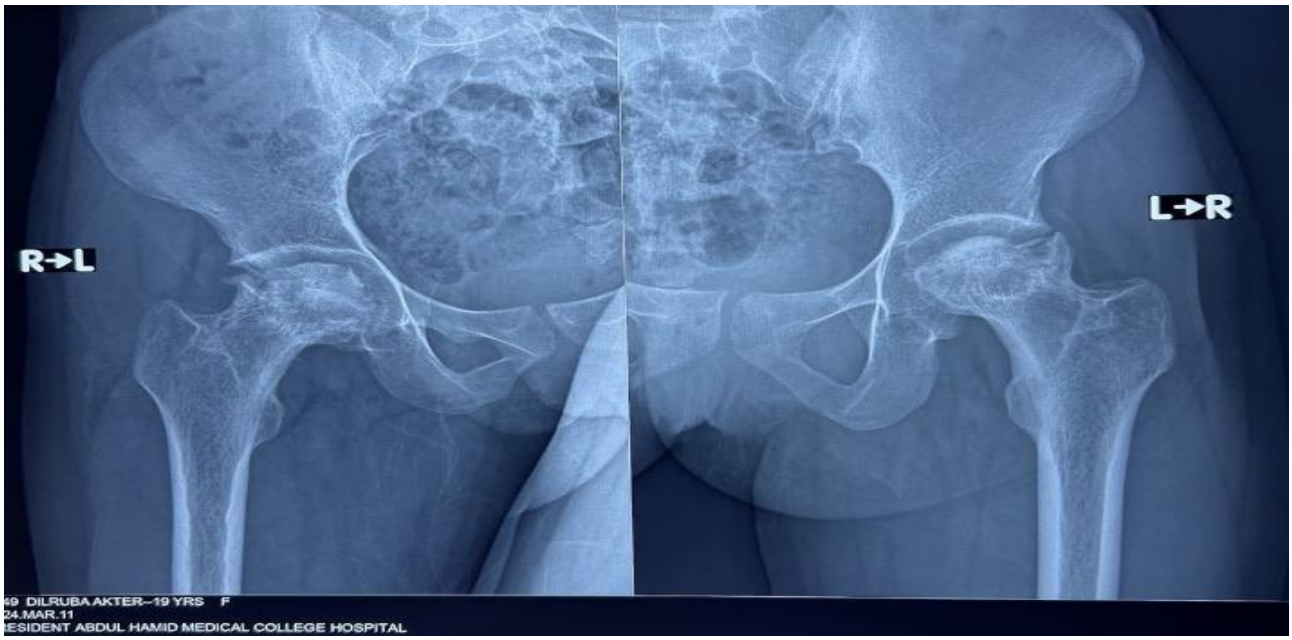

Figure 1. Pre-operative antero-posterior radiograph of the pelvis (11 March 2024) showing advanced bilateral avascular necrosis of the femoral heads, with joint-space narrowing, femoral head distortion, osteosclerosis, and marginal osteophyte formation on both sides.

Differential Diagnosis

Before the radiographic findings and the steroid history came together, we considered three possibilities: avascular necrosis of the femoral head, tubercular arthritis of the hip, and the sequelae of septic arthritis. The absence of fever, night sweats, weight loss, or a raised ESR and CRP argued against an active infective or tuberculous process, and the negative Mantoux test made tuberculosis still less likely. The bilateral, symmetrical pattern of joint destruction, together with the clear history of prolonged steroid exposure, was far more in keeping with steroid-induced avascular necrosis, which became the working and, ultimately, the confirmed diagnosis: steroid-induced bilateral avascular necrosis of the femoral head.

Treatment

Given the advanced radiographic changes in both hips, joint-preserving options such as core decompression were not realistic, and operative treatment was planned from the outset. She was first placed in bilateral surface traction for two weeks to settle the soft tissues and pain before surgery. She then underwent staged uncemented modular total hip replacement, the left hip first, on 14 March 2024, followed by the right hip on 22 January 2025,

roughly ten months later. Both procedures were carried out through a direct lateral (Hardinge) approach, which splits rather than detaches the anterior fibres of gluteus medius and vastus lateralis and gives reliable access to the acetabulum and proximal femur while keeping the dislocation risk low.4 The diseased femoral heads were excised, the acetabula and femoral canals were prepared, and modular uncemented components were implanted on each side in the standard fashion.

Outcome and Follow-up

Post-operative radiographs of both hips after each stage showed well-positioned, well-seated prostheses with no evidence of loosening or malalignment. Recovery from each procedure followed an unremarkable course, and staging the two operations roughly ten months apart allowed her to rehabilitate one hip before undertaking surgery on the other. At subsequent review she was mobilising independently and comfortably, without the antalgic gait or shortening that had brought her to hospital, and clinical and radiographic follow-up of both hips has been continued in the outpatient department.

Figure 2. Close-up post-operative radiograph of the left hip following uncemented modular total hip replacement, showing a well-fixed femoral stem and acetabular component secured with screws, with no radiographic evidence of loosening.

Figure 3. Antero-posterior pelvic radiograph (12 January 2025), obtained shortly before the second-stage procedure, showing the well-seated left total hip prosthesis in situ alongside persisting osteonecrotic change in the native right hip, which subsequently underwent total hip replacement.

Discussion

The single most striking feature of this case is not the surgery but the road that led to it: a healthy teenager given four years of unsupervised oral corticosteroids by an unqualified practitioner for nothing more specific than "poor health." It is a pattern that has been well documented in Bangladesh and across South Asia, where potent steroids can often be obtained without prescription from pharmacists, quacks, or other non-specialist providers who are frequently unaware of the systemic harm they can cause.2 The mechanisms linking corticosteroids to osteonecrosis are still incompletely understood, but the leading explanations converge on impaired perfusion of the femoral head — through fat embolism and marrow fat hypertrophy that raises intraosseous pressure, a hypercoagulable state that favours microvascular thrombosis, direct injury to the vascular endothelium, and increased apoptosis of osteoblasts and osteocytes — all of which ultimately choke off the blood supply that the femoral head depends on.1

What made this particular case severe was less the dose at any one time than the sheer duration of exposure and the complete absence of monitoring: nobody was tracking cumulative dose, watching for early hip pain, or thinking to order imaging before the disease had already progressed to joint-space narrowing and femoral head collapse on plain radiographs. This mirrors reports of adolescents and young adults elsewhere in the region who have developed osteonecrosis, growth disturbance, and other features of steroid excess after years of self-medication or informal prescribing, and it underlines why regulation of over-the-counter steroid access, and public and provider education about their risks, remain pressing public-health priorities rather than abstract policy concerns.5

Once the disease has reached the stage seen on this patient's radiographs — joint-space loss, femoral head distortion, and secondary acetabular change — head-preserving procedures such as core decompression or osteotomy no longer have much to offer, and total hip arthroplasty becomes the treatment of choice, exactly as it is in older patients with end-stage osteonecrosis.6 The concern with performing this operation in a patient still in her teens is longevity: implants in young, active patients with osteonecrosis have historically shown higher rates of loosening and revision than in older patients with straightforward osteoarthritis, which is why cementless fixation, chosen here, is generally favoured in this age group — modern uncemented components rely on bony ingrowth for long-term fixation and have performed well in mid- to long-term follow-up studies of young patients with avascular necrosis.6,7 A follow-up study of patients under 40 who underwent total hip arthroplasty for avascular necrosis reported good survivorship at five to nineteen years with modern implants and technique, and a mid-term series from a comparable South Asian setting using uncemented components for osteonecrosis of the femoral head showed marked functional improvement with a low complication rate — findings broadly in keeping with the good early outcome seen in our patient.6,7

The choice to stage the two hip replacements roughly ten months apart, rather than operate on both hips at once, reflected both the severity of her disease on each side individually and practical considerations around rehabilitation, blood loss, and recovery in a young patient who needed to be able to fully rehabilitate one hip before undergoing a second major operation. The direct lateral Hardinge approach was selected for its low reported dislocation rate and reliable exposure, both useful properties in a young patient for whom implant survival and stability over decades, rather than years, is the real measure of success.4

This report has the usual limitations of a single case: the absence of pre-operative magnetic resonance imaging meant that formal Ficat–Arlet staging could not be applied, and follow-up so far, while reassuring, is still relatively short in a patient whose implants will need to last for many decades. Longer follow-up will be needed to know how these particular components perform over the course of her life. Even so, the case illustrates two points

worth carrying into clinical practice: first, that unsupervised, prolonged corticosteroid use — however innocuous it might seem to the person prescribing or taking it — carries a real and sometimes devastating risk of avascular necrosis, even in patients without any other risk factor; and second, that with careful staging and modern implants, even very young patients with end-stage bilateral hip disease can be given back a functional, pain-free gait.

Conclusion

Steroid-induced avascular necrosis of the femoral head should be considered in any young patient presenting with progressive, bilateral hip pain, particularly where there is a history of prolonged or unsupervised corticosteroid use, and a careful drug history — including medicines obtained informally or without prescription — is essential to reaching the diagnosis. In this patient, staged uncemented total hip arthroplasty through the Hardinge approach restored pain-free mobility despite advanced bilateral disease at presentation, reinforcing that age alone should not deter surgeons from offering definitive arthroplasty when joint-preserving options are no longer viable. The case also serves as a caution about the orthopaedic cost of unregulated steroid dispensing in resource-limited settings, and argues for stronger public awareness and prescribing oversight.

Patient Consent

We are certifying that we have taken all appropriate patients' consent form. In the forms, the patient given her consent for use of her images (both photographic and radiological) and clinical information to be published both in electronic and print form. The patient understand that her name, and initials will not be published and due efforts will be made to hide her identity.

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Author Contribution

Dr. Avishek Bhadra: Conceptualization, case diagnosis and management, clinical supervision, data collection, and manuscript review. Dr. Ashikur Rahaman: Clinical management, data collection, literature review, and manuscript preparation. Dr. Md Abdur Rouf: Clinical assistance, data collection, literature review, and manuscript preparation. Dr. Md Ikbal Fahim: Clinical assistance, data collection, literature review, and critical revision of the manuscript. All authors: Participated in the preparation and review of the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

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Data Availability

Data Availability: The data that support the findings of this case report are available from the corresponding author upon reasonable request.

AI Disclosure

AI Disclosure: No artificial intelligence tools were used in the preparation of this manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Role of Color Doppler in Intrauterine Growth Restriction: A Comprehensive Review

*** Begum T**

Abstract

Background: *Fetal growth restriction (FGR), formerly termed intrauterine growth restriction (IUGR), is an important cause of perinatal morbidity and mortality. Although grey-scale ultrasound identifies abnormal fetal growth through biometric measurements, Doppler ultrasound provides additional information on fetal and placental haemodynamic adaptation.*

Objective: *To review the role of Color Doppler and Doppler velocimetry in the diagnosis, surveillance, and risk stratification of pregnancies complicated by FGR, focusing on the umbilical artery (UA), middle cerebral artery (MCA), cerebroplacental ratio (CPR), uterine arteries, and ductus venosus (DV).*

Methods: *This narrative review synthesises evidence from international guidelines, systematic reviews, meta-analyses, randomised trials, and major observational studies. Emphasis was placed on Doppler pathophysiology, technical principles, abnormal waveform interpretation, early- versus late-onset FGR, and implications for surveillance and delivery timing.*

Results: *UA Doppler is the most established fetal Doppler assessment and reflects placental vascular resistance. Progressive placental dysfunction is associated with increased pulsatility followed by reduced, absent, and reversed end-diastolic flow, indicating increasing perinatal risk. MCA Doppler may demonstrate cerebral redistribution or "brain sparing" during hypoxic stress. CPR integrates placental and cerebral haemodynamics and may improve risk stratification, particularly in late-onset FGR. DV Doppler reflects cardiovascular compromise and is particularly valuable in severe early-onset FGR. However, recommendations for routine MCA, CPR, and DV assessment vary among professional bodies.*

Conclusion: *Doppler assessment is integral to FGR surveillance. UA Doppler remains the cornerstone, while MCA, CPR, uterine artery, and DV Doppler provide complementary information in selected cases. Findings should be interpreted alongside fetal biometry, amniotic fluid, cardiotocography, gestational age, and maternal clinical status.*

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Introduction

How well a fetus grows depends on an interplay between its own genetic growth potential, the mother's health, placental performance, and the surrounding environment. When growth is pathologically curtailed, the fetus may face sustained hypoxia, cardiovascular adaptation, metabolic disturbance, and a higher chance of stillbirth or neonatal illness. "Small for gestational age" (SGA) and "fetal growth restriction" (FGR) are related but not interchangeable terms. A fetus can be SGA simply because it is constitutionally small and otherwise well, whereas FGR implies that the fetus has fallen short of its own growth potential — most often because the placenta is not supplying it adequately. Current international guidance stresses that biometry, growth trend, Doppler findings and the wider clinical picture together — not size alone — are what separate the two. Ultrasound sits at the centre of diagnosing suspected FGR. Measurements such as abdominal

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circumference, head circumference, biparietal diameter, femur length and estimated fetal weight give structural evidence that growth has deviated from expectation. Size alone, however, says little about how compromised the fetus actually is.

This is where Doppler ultrasound comes in — it looks at function rather than just structure, examining flow in the maternal, placental and fetal vessels. Color Doppler makes vessels visible and lets the operator position the spectral sample volume accurately; used together, color mapping and pulsed-wave Doppler give both an anatomical picture and a haemodynamic one.

The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) treats Doppler assessment of the fetoplacental circulation as a core part of the work-up and has published standardised techniques for examining the uterine arteries, umbilical arteries, middle cerebral artery (MCA) and ductus venosus.[1]

Pathophysiological Basis of Doppler Changes in FGR

Placental insufficiency is the mechanism most often responsible for placenta-mediated FGR.

In a normally progressing pregnancy, trophoblast cells invade the maternal spiral arteries and convert them into a wide, low-resistance vascular bed. When this invasion is incomplete, the resulting maternal vascular malperfusion leaves the uteroplacental circulation with abnormally high resistance.

This sets off a fairly predictable cascade:

Abnormal placentation → raised placental resistance → abnormal uterine/umbilical artery Doppler → redistribution of fetal blood flow → cardiac strain → venous Doppler changes → fetal decompensation

How severe this cascade becomes, and in what order the changes appear, differs between fetuses affected early versus late in pregnancy.

Early-onset FGR

Generally defined as onset before 32 weeks, early-onset FGR is usually the more severe phenotype, often accompanied by hypertensive disease of pregnancy and marked abnormalities on umbilical artery and ductus venosus Doppler. ISUOG describes a recognisable progression of abnormality across the umbilical artery, MCA and ductus venosus in these cases.[3]

Late-onset FGR

Arising at or beyond 32 weeks, late-onset FGR can be harder to spot because the fetus is often not dramatically small. Here, cerebral redistribution and changes in MCA/CPR tend to be more informative than gross umbilical artery abnormality.

Color Doppler and Spectral Doppler: Complementary Roles

Color Doppler paints flow onto the image according to direction and speed, which makes it excellent for finding vessels — but it is essentially a localisation tool rather than a measurement one.

It helps to keep the different modes distinct:

- Color-flow mapping — shows where vessels are and which way blood is moving.
- Power Doppler — more sensitive to slow flow, but gives no directional information.
- Pulsed-wave spectral Doppler — generates the velocity-time waveform from which quantitative indices are derived.
- Continuous-wave Doppler — rarely used in fetal work compared with pulsed-wave technique.

In short, Color Doppler's job is to help the operator find and confirm the vessel; the numbers that actually matter clinically in FGR — PI, RI, S/D ratio — come from the spectral trace.

Umbilical Artery Doppler

Why it matters

Of all the fetal Doppler vessels, the umbilical artery (UA) has by far the strongest evidence base in FGR, acting as an indirect gauge of placental vascular resistance.

ISUOG recommends UA Doppler as part of managing growth-restricted fetuses precisely because it helps separate genuine placental disease from the constitutionally small fetus.[3]

Once a diagnosis of FGR has been made, the Society for Maternal-Fetal Medicine (SMFM) advises repeating UA Doppler at intervals to watch for deterioration.[2]

Doppler indices

The three indices in routine use are:

Pulsatility Index (PI) = (Peak systolic velocity − End diastolic velocity) / Mean velocity

Resistance Index (RI) = (Peak systolic velocity − End diastolic velocity) / Peak systolic velocity

Systolic/Diastolic ratio (S/D) = Peak systolic velocity / End diastolic velocity

PI is the most widely used of the three because it is less sensitive to the absolute velocity recorded and is generally reported against gestational-age-specific charts.

Progressive abnormality

As placental resistance climbs, the UA waveform tends to move through a recognisable sequence:

Normal end-diastolic flow → reduced end-diastolic flow → absent end-diastolic velocity (AEDV) → reversed end-diastolic velocity (REDV)

AEDV and REDV both signal advanced placental vascular disease and a sharply higher risk to the fetus. A systematic review and meta-analysis found the odds of fetal death to be markedly higher in early-onset growth-restricted fetuses once UA or ductus venosus end-diastolic flow became abnormal.[6]

Middle Cerebral Artery Doppler

The middle cerebral artery (MCA) is the vessel of choice for assessing how the fetal brain is adapting haemodynamically.

Under chronic hypoxic stress, the fetal cardiovascular system can redirect output preferentially toward the brain — the well-known "brain-sparing" response.

Color Doppler is used first to identify the circle of Willis and the proximal MCA; pulsed-wave Doppler is then applied following a standardised technique. ISUOG recommends obtaining a suitable axial view of the fetal brain, locating the proximal MCA, and placing the sample volume in the proximal third of the vessel.[3]

Cerebral vasodilatation shows up as:

- falling MCA vascular resistance;
- a lower MCA PI;
- increased diastolic flow;
- a reduced cerebroplacental ratio.

An abnormal MCA trace can therefore be read as a sign that the fetus is actively adapting to hypoxaemia — but it should always be interpreted against gestational age and the broader clinical context, not on its own.

Cerebroplacental Ratio

The cerebroplacental ratio (CPR) merges the MCA and UA Doppler measurements into one figure:

CPR = MCA PI / UA PI

A low CPR can reflect raised placental resistance, reduced cerebral resistance, or both together — giving a combined snapshot of placental and cerebral status.

A number of studies link an abnormal CPR to poorer perinatal outcomes; one meta-analysis found it associated with higher rates of caesarean delivery for fetal distress, lower Apgar scores, NICU admission and neonatal complications.[4]

The evidence is not entirely consistent, however. An individual-participant-data meta-analysis concluded that CPR added little beyond what UA PI alone already predicted for a composite adverse perinatal outcome.[5]

Taken together, CPR is probably best used as a complementary risk-stratification tool rather than a stand-alone trigger for intervention.

Ductus Venosus Doppler

The ductus venosus (DV) links the umbilical vein to the inferior vena cava and is central to fetal circulatory physiology.

In severe early-onset FGR, worsening placental insufficiency can raise cardiac afterload to the point where cardiac function itself starts to suffer — a change that can be picked up on the DV waveform.

Key abnormal features include:

- raised DV PI;
- reduced forward flow during atrial contraction;
- an absent A-wave;
- a reversed A-wave.

These findings carry particular weight in severe early-onset disease.

The TRUFFLE trial, which compared different fetal-monitoring strategies in very preterm FGR, demonstrated the clinical value of combining ductus venosus Doppler with computerised cardiotocography when deciding on delivery timing.[7]

A separate systematic review confirmed a substantially raised risk of fetal death in early FGR once DV end-diastolic velocity became absent or reversed.[6]

Uterine Artery Doppler

Uterine artery Doppler looks mainly at the maternal side of the uteroplacental circulation. Abnormal patterns include:

- raised uterine artery PI;
- a persistent early diastolic notch;
- generally increased resistance.

An abnormal trace here points toward impaired placentation and a higher risk of both pre-eclampsia and FGR.

Its main value lies in risk assessment and evaluating placental function early on — it is not meant to substitute for UA Doppler once FGR has actually been diagnosed.

Doppler Patterns in Early- and Late-Onset FGR

The differences below underline why one fixed Doppler strategy cannot be applied uniformly to every FGR pregnancy.

Feature	Early-onset FGR	Late-onset FGR
Gestational age	< 32 weeks	≥ 32 weeks
Placental dysfunction	Usually severe	Often milder
UA Doppler	Frequently abnormal	May stay normal
MCA Doppler	Can become abnormal	Cerebral redistribution often prominent

CPR	May be abnormal	Potentially informative
DV Doppler	Important in severe cases	Usually less prominent
Maternal hypertension	Common	Less frequent
Perinatal risk	High	Raised, but generally lower than early-onset disease

Differentiating SGA from FGR with Doppler

Doppler's biggest practical contribution may be helping tell a constitutionally small fetus apart from one genuinely compromised by placental disease.

Constitutionally small fetus

Typically shows an estimated fetal weight below the 10th percentile but with a normal growth trajectory, normal UA Doppler, normal MCA/CPR, normal liquor volume, and no maternal or placental disease.

Pathological FGR

Typically shows a falling growth velocity, estimated weight or abdominal circumference below expectation, abnormal UA Doppler, abnormal MCA/CPR, abnormal uterine artery Doppler, oligohydramnios, maternal hypertensive disease, and other evidence of placental dysfunction.

Doppler, in other words, adds a functional layer on top of the purely structural information from biometry.

Doppler Surveillance and Timing of Delivery

The point of Doppler surveillance is not simply to confirm that the placenta is failing, but to catch deterioration early enough to choose the best moment for delivery.

SMFM guidance recommends serial UA Doppler once FGR has been diagnosed, with surveillance stepped up when diastolic flow falls, when the fetus is severely small, and especially once AEDV or REDV appears.[2]

Broadly, SMFM suggests:

- UA Doppler roughly every one to two weeks in established FGR;
- more frequent testing once UA flow becomes abnormal;
- two to three times weekly once AEDV develops;
- intensified surveillance, with delivery actively considered, once REDV appears.

Suggested delivery timing:

- 38–39 weeks for FGR with normal UA Doppler and an estimated weight between the 3rd and 10th percentile;
- 37 weeks for severe FGR, or reduced UA diastolic flow without AEDV/REDV;
- 33–34 weeks once AEDV is present;
- 30–32 weeks once REDV is present, depending on the overall clinical picture.

These figures are guideline defaults and need to be adjusted for gestational age, other fetal testing, maternal disease, neonatal facilities, and local protocol.

Comparing Major Guidelines

International bodies do not entirely agree on how much weight to give each Doppler vessel.

SMFM leans heavily on umbilical artery Doppler and does not recommend routine use of MCA, DV, or uterine artery Doppler for everyday clinical decisions in FGR.[2]

ISUOG takes a broader view, folding in MCA, CPR and DV Doppler where clinically appropriate — particularly useful for telling early- and late-onset FGR apart and gauging fetal adaptation.[1r]

The practical takeaway is that clinicians should work to a clearly agreed local protocol, recognising that international guidance is not fully harmonised on this point.

Technical Considerations in Doppler Examination

Getting reliable Doppler measurements depends on careful technique:

- Correct vessel identification using Color Doppler.
- An appropriate insonation angle and sampling approach.
- Correct placement of the sample volume.
- Suitable pulse-repetition frequency and velocity scale.
- Appropriate wall-filter setting.
- Avoiding excessive transducer pressure on the vessel.
- Capturing several consistent, consecutive waveforms.
- Using gestational-age-appropriate reference ranges.
- Keeping technique consistent across serial scans on the same patient.

ISUOG stresses standardised acquisition and interpretation because small differences in method can meaningfully shift the measured values.[3]

A systematic review of published reference ranges found considerable variation across standards for UA PI, MCA PI and CPR — a reminder of how much methodological standardisation is still needed.[9]

Advantages of Color Doppler in FGR

- Non-invasive — No ionising radiation, no instrumentation of the fetus.
- Real-time vascular visualisation — Fetal and placental vessels can be identified as the scan proceeds.
- Functional assessment — Adds information about vascular resistance and circulatory adaptation that biometry alone cannot give.
- Serial monitoring — Can be repeated through pregnancy to track how the picture is evolving.
- Risk stratification — Abnormal findings flag fetuses who need closer attention.
- Guides management — UA Doppler findings in particular shape how often to monitor and when to consider delivery.

Limitations

- Operator dependence — Poor vessel identification or incorrect sampling produces unreliable readings.
- Reference-range variation — Different charts and cut-offs can classify the same measurement differently.
- Gestational-age dependence — Normal values shift continually through pregnancy.
- Biological variability — Fetal movement, breathing, heart rate, maternal position and transient physiological changes can all move the numbers.

- Uneven evidence base — UA Doppler is well supported, but the added clinical value of MCA and CPR remains debated.
- Not a substitute for full assessment — Doppler cannot replace biometry, liquor assessment, fetal movement monitoring, cardiotocography or overall clinical judgement.

Evidence for the Cerebroplacental Ratio

CPR has drawn a lot of attention, particularly for late-onset FGR.

One systematic review and meta-analysis linked an abnormal CPR to several adverse perinatal outcomes.[4]

A later individual-participant-data meta-analysis, however, found that adding CPR on top of UA PI improved prediction of a composite adverse outcome only marginally.[5]

This gap is worth noting: an association between a test result and a poor outcome does not automatically mean that acting on that test result changes the outcome.

CPR therefore looks useful for risk stratification, but more prospective evidence is needed before it can be relied on to replace, or routinely supplement, UA Doppler in management protocols.

Recent Evidence on MCA Doppler

Evidence on MCA Doppler used in isolation is also still developing. A recent systematic review and meta-analysis found only moderate accuracy for MCA PI in predicting adverse outcomes among growth-restricted fetuses, with pooled sensitivity and specificity too modest to support its use as a stand-alone predictor.[14]

This supports the broader principle that MCA findings should be weighed within the overall clinical picture rather than acted on in isolation.

A Practical Clinical Algorithm

Suspected FGR

↓ Ultrasound biometry + EFW/AC + liquor assessment

↓ Assess gestational age and growth trajectory

↓ Color Doppler localisation

↓ Umbilical artery Doppler

- Normal UA Doppler → continue routine surveillance based on gestational age and risk; consider MCA/CPR where clinically useful.
- Raised UA PI / reduced diastolic flow → step up surveillance; repeat Doppler and fetal assessment.
- AEDV → intensive surveillance; reassess gestational age and fetal condition; consider hospital admission depending on circumstances.
- REDV → very high-risk finding; intensive surveillance; corticosteroids where appropriate; consider delivery based on gestational age and full fetal/maternal assessment.

For severe early-onset FGR, specialist fetal-medicine teams often combine UA Doppler, MCA/CPR, DV Doppler, CTG/short-term variation, and biophysical profile assessment into a single management plan.

Future Directions

Areas that would benefit from further work include: internationally standardised Doppler reference ranges; automated waveform analysis; AI-assisted detection of abnormal patterns; better

integration of Doppler with growth trajectory; combining Doppler with placental biomarkers; improved prediction of stillbirth and neonatal morbidity; long-term neurodevelopmental follow-up; individualised delivery timing; and prospective randomised trials testing whether Doppler-guided management genuinely improves neonatal outcomes.

Automated, AI-assisted quantitative ultrasound may, in time, reduce operator dependence and improve reproducibility across centres.

20. Conclusion

Color Doppler occupies an important place in evaluating pregnancies with suspected IUGR/FGR. Its strongest, best-proven use remains umbilical artery assessment, which indirectly gauges placental vascular resistance and helps identify fetuses at elevated risk of adverse perinatal outcome.

MCA Doppler adds information about cerebral adaptation, and the CPR brings placental and cerebral data together in one index. Ductus venosus Doppler offers further insight into cardiovascular strain, particularly in severe early-onset disease, while uterine artery Doppler speaks to the maternal side of the circulation and to impaired placentation.

None of these findings should be read alone. Sound management depends on combining fetal biometry, growth trend, UA Doppler, MCA/CPR where relevant, DV Doppler in selected severe cases, liquor volume, cardiotocography, maternal status and gestational age.

The evidence base is strongest for UA Doppler as the backbone of surveillance in confirmed FGR; the roles of MCA, CPR and DV vary with the FGR phenotype and the guideline being followed. Future work should aim to standardise thresholds and clarify whether Doppler-guided management truly improves not just short-term perinatal outcomes but long-term neurodevelopment as well.

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14. Recent evidence on MCA Doppler suggests moderate predictive accuracy when used alone in growth-restricted pregnancies, underscoring the need for standardised prospective studies before isolated MCA Doppler is used as a management trigger.

15. Recent diagnostic research continues to evaluate CPR as a predictor of adverse outcomes in IUGR pregnancies, supporting its potential as an adjunct to conventional Doppler assessment while highlighting the need for further validation.