Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 2 (2026): June 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i2.2814
Original Article

Clinicopathological profile and anaesthetic considerations in patients undergoing surgical management of orthopaedic bone tumours: a hospital-based descriptive cross-sectional study.

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Abstract

Background

Orthopaedic bone tumours comprise benign, primary malignant, and metastatic lesions whose surgical management requires integration of clinicopathological diagnosis with anaesthetic planning.

Objectives

To describe the clinicopathological profile, surgical procedures, anaesthetic techniques, intraoperative concerns, and early postoperative outcomes among patients undergoing surgery for orthopaedic bone tumours.

Methods

This hospital-based descriptive cross-sectional study was conducted at Government Medical College and Government General Hospital, Rajanna Sircilla, Telangana, India, from December 2025 to April 2026. One hundred consecutive eligible patients undergoing surgery for suspected or histopathologically confirmed bone tumours were included. Demographic, clinicopathological, operative, anaesthetic, blood-loss, transfusion, haemodynamic, and postoperative variables were analysed descriptively.

Results

The mean age was 34.8 ± 18.6 years; 58 (58.0%) patients were male. Pain was reported by 86 (86.0%), swelling by 62 (62.0%), and restricted movement by 38 (38.0%). The femur was involved in 34 (34.0%) cases. Benign tumours accounted for 46 (46.0%), primary malignant tumours for 34 (34.0%), and metastatic lesions for 20 (20.0%). General anaesthesia was used in 56 (56.0%), regional anaesthesia in 20 (20.0%), and combined techniques in 24 (24.0%). Blood loss exceeded 500 mL in 32 (32.0%), 30 (30.0%) required transfusion, and 18 (18.0%) developed intraoperative hypotension. Rescue analgesia was required in 28 (28.0%), postoperative nausea and vomiting occurred in 12 (12.0%), wound complications in 8 (8.0%), intensive care admission in 2 (2.0%), and re-exploration in 1 (1.0%). No perioperative deaths occurred.

Conclusion

Bone tumour surgery demonstrated substantial clinicopathological and procedural heterogeneity. Anticipated bleeding, transfusion preparedness, haemodynamic monitoring, multimodal analgesia, and selective critical-care surveillance were the principal anaesthetic considerations.

Recommendations

Multidisciplinary planning, preoperative optimisation, blood-conservation measures, and protocol-based analgesia should form institutional perioperative pathways.

***Keywords**: Orthopaedic bone tumours; Osteosarcoma; Giant cell tumour; Metastatic bone disease; Anaesthesia*
***Submitted:** May 13, 2026 **Accepted:** May 30, 2026 **Published:** June 30, 2026*

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Introduction

Bone tumours represent an uncommon but clinically important group of musculoskeletal disorders. They include benign lesions, locally aggressive tumours, primary malignant bone sarcomas, and metastatic deposits from extra-skeletal malignancies. Their relative rarity, wide age distribution, overlapping radiological features, and diverse biological behaviour make diagnosis and perioperative management challenging in routine orthopaedic practice. Indian clinicopathological series have reported that benign tumours are more frequent than malignant primary lesions, with male preponderance and long-bone involvement being recurring observations [1]. Large epidemiological datasets further indicate that osteosarcoma, chondrosarcoma, and Ewing sarcoma constitute the major primary malignant bone tumours, each showing distinct age, site, and survival patterns [2,3].

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Pain, swelling, restriction of movement, deformity, and pathological fracture are common reasons for presentation. In osteosarcoma and Ewing sarcoma, symptoms often evolve gradually and are sometimes mistaken for trauma-related or inflammatory conditions, leading to diagnostic delay [4,5]. Benign tumours such as giant cell tumour of bone frequently occur in young adults and can behave aggressively despite benign histology, causing cortical breach, periarticular destruction, and recurrence after curettage [6,7]. Metastatic bone disease, in contrast, is more common in older patients and often presents with pain, impending fracture, or established pathological fracture requiring urgent stabilisation [8,9].

Surgical treatment varies according to tumour biology, anatomical site, neurovascular involvement, skeletal stability, expected survival, and available reconstructive options. Procedures range from curettage with grafting to wide excision, endoprosthetic reconstruction, internal fixation, palliative stabilisation, and amputation. Modern orthopaedic oncology favours limb-sparing surgery where oncological clearance and functional preservation are feasible, while amputation is reserved for extensive disease, uncontrolled infection, major neurovascular encasement, or non-salvageable limbs [10]. These operations require coordinated input from orthopaedics, pathology, radiology, anaesthesia, transfusion medicine, oncology, and rehabilitation services.

Anaesthetic management in bone tumour surgery differs from routine orthopaedic surgery because the patient can present with anaemia, malnutrition, prior chemotherapy exposure, chronic pain, limited positioning options, extensive operative fields, and major anticipated blood loss. Major pelvic, femoral, and sacral tumour resections are particularly associated with haemodynamic instability and transfusion requirements [11,12]. Preoperative anaemia assessment, availability of blood products, patient-specific anaesthetic technique, regional analgesia when appropriate, and postoperative monitoring are central to perioperative safety [13,14].

The present study was conducted to evaluate the clinicopathological profile and anaesthetic considerations among patients undergoing surgical management of orthopaedic bone tumours at Government Medical College, Rajanna Sircilla, Telangana, India. The objectives were to describe demographic characteristics, clinical presentation, anatomical site distribution, histopathological spectrum, surgical procedures performed, anaesthetic techniques used, intraoperative concerns, and early postoperative outcomes in this patient population.

Materials and Methods

Study design

This was a hospital-based descriptive cross-sectional study of consecutive patients undergoing surgical management of suspected or confirmed orthopaedic bone tumours.

Study setting

The study was conducted in the Department of Orthopaedics, in coordination with the Departments of Anaesthesiology and Pathology, at Government Medical College and its attached Government General Hospital, Rajanna Sircilla. The institution is a government teaching and referral centre located at Peddur, Sircilla, Telangana, and provides outpatient, inpatient, emergency, maternity, surgical, anaesthesia, diagnostic, laboratory, and postoperative care through its clinical and paraclinical departments. It serves Rajanna Sircilla district and neighbouring rural and semi-urban communities. The district includes 171 villages and a population of approximately 552,000, making the hospital an important referral facility for musculoskeletal disease and surgical care. Patients with bone tumours are evaluated through multidisciplinary coordination among orthopaedics, radiology, pathology, anaesthesiology, transfusion services, and postoperative care teams.

Study period and sample size

The study was carried out from December 2025 to April 2026. A total of 100 consecutive eligible patients who underwent surgical management during the study period were included in the final analysis. The sample size was based on the number of cases satisfying the eligibility criteria during the defined institutional study period.

Eligibility criteria

Patients of either sex and all eligible age groups who underwent surgery for suspected or confirmed benign bone tumours, primary malignant bone tumours, or metastatic bone lesions were included. Patients managed conservatively, patients with isolated soft-tissue tumours without bone involvement, incomplete clinical records, or missing perioperative anaesthesia details were excluded from analysis.

Data collection

Data were collected using a structured proforma from clinical records, imaging summaries, operative notes, anaesthesia records, histopathology reports, transfusion records, and postoperative case sheets. Variables included age, sex, ASA physical status, comorbidities, preoperative anaemia, clinical presentation, tumour site, histopathological diagnosis,

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surgical procedure, anaesthetic technique, estimated blood loss, transfusion requirement, intraoperative hypotension, difficult airway, rescue analgesia, postoperative nausea and vomiting, wound complications, intensive care requirement, re-exploration, and mortality.

Clinicopathological assessment

Tumours were classified as benign bone tumours, primary malignant bone tumours, or metastatic bone lesions based on histopathological diagnosis and clinical-radiological correlation. Histopathology was considered the definitive diagnostic reference wherever tissue diagnosis was available. The classification approach followed accepted clinicopathological principles used in musculoskeletal tumour evaluation [1,2,6,8].

Anaesthetic assessment and perioperative management

All patients underwent preoperative anaesthetic evaluation with attention to airway assessment, ASA status, comorbidity optimisation, haemoglobin status, anticipated blood loss, blood product need, positioning, analgesic plan, and postoperative monitoring. General, regional, or combined anaesthesia was selected according to surgical site, procedure extent, patient condition, contraindications, and anaesthesiologist judgement. Perioperative care included monitoring, haemodynamic management, fluid therapy, transfusion when indicated, multimodal analgesia, and postoperative surveillance [11,13,14].

Outcome variables

Primary descriptive variables were clinicopathological pattern and anaesthetic technique. Secondary variables included estimated intraoperative blood loss, transfusion requirement, intraoperative hypotension, difficult airway, rescue analgesia, postoperative nausea and vomiting, wound complications, intensive care admission, re-exploration, and mortality.

Quantitative variables

Age was analysed as a continuous variable and reported as mean ± standard deviation. For descriptive presentation, age was additionally grouped as ≤20, 21–40, 41–60, and >60 years to represent adolescent/very young adult, young-adult, middle-aged, and older-adult clinical strata. Estimated blood loss was abstracted from anaesthesia records and categorised as <250, 250–500, and >500 mL to distinguish low, moderate, and clinically substantial blood loss relevant to haemodynamic monitoring and transfusion preparedness. These categories were selected a priori for clinical interpretability and were not derived from the observed data.

Statistical analysis

Data were entered into a spreadsheet and analysed using descriptive statistics. Continuous variables were summarised using mean and standard deviation, while categorical variables were presented as frequencies and percentages. No inferential hypothesis testing was performed because the study objective was to describe the institutional clinicopathological spectrum, anaesthetic practices, and early perioperative outcomes rather than to test associations between variables.

Ethical considerations

The study was conducted after approval from the Institutional Ethics Committee of Government Medical College, Rajanna Sircilla, Telangana, India. Patient confidentiality was maintained, and identifying personal information was not included in the analysis

Results

A total of 100 patients who underwent surgical management for orthopaedic bone tumours were included in the final analysis. The mean age of the study population was 34.8 ± 18.6 years, with the highest proportion of patients belonging to the 21–40 years age group. Males constituted 58.0% of the study population, while females accounted for 42.0%. Most patients were classified under ASA physical status II, followed by ASA I. Comorbid conditions were present in 24.0% of patients, with anaemia, diabetes mellitus, and hypertension being the commonly observed associated conditions (Table 1).

Table 1: *Demographic and Preoperative Characteristics of the Study Population*

Variable	Category	Number	Percentage
Age group	≤20 years	22	22.0
	21–40 years	38	38.0
	41–60 years	26	26.0
	>60 years	14	14.0
Sex	Male	58	58.0

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Variable	Category	Number	Percentage
	Female	42	42.0
ASA physical status	ASA I	30	30.0
	ASA II	54	54.0
	ASA III	16	16.0
Comorbidities	Present	24	24.0
	Absent	76	76.0
Preoperative anaemia	Present	28	28.0
	Absent	72	72.0

Pain was the most common presenting symptom, observed in 86.0% of patients, followed by swelling in 62.0% and restriction of movement in 38.0%. Pathological fracture was present in 14.0% of patients at presentation. The femur was the most frequently involved bone, followed by the tibia, humerus, and pelvis. Tumours involving the lower limb constituted the majority of cases (Table 2).

Table 2: *Clinical Presentation and Anatomical Distribution of Bone Tumours*

Variable	Category	Number	Percentage
Presenting symptom	Pain	86	86.0
	Swelling	62	62.0
	Restricted movement	38	38.0
	Pathological fracture	14	14.0
	Neurological symptoms	6	6.0
Site involved	Femur	34	34.0
	Tibia	22	22.0
	Humerus	14	14.0
	Pelvis	10	10.0
	Radius/ulna	8	8.0
	Spine	6	6.0
	Other bones	6	6.0

Histopathological evaluation identified benign tumours in 46 (46.0%) patients, primary malignant bone tumours in 34 (34.0%), and metastatic bone lesions in 20 (20.0%). Giant cell tumour was the most frequent benign diagnosis, affecting 18 (18.0%) patients. Osteosarcoma was the predominant primary malignant tumour, occurring in 18 (18.0%), followed by chondrosarcoma in 8 (8.0%) and Ewing sarcoma in 6 (6.0%) patients (Table 3).

Table 3: *Histopathological Profile of Orthopaedic Bone Tumours*

Histopathological diagnosis	Number	Percentage
Benign bone tumours	46	46.0
Giant cell tumour	18	18.0
Osteochondroma	10	10.0
Enchondroma	6	6.0
Aneurysmal bone cyst	6	6.0
Other benign lesions	6	6.0
Malignant primary bone tumours	34	34.0
Osteosarcoma	18	18.0
Chondrosarcoma	8	8.0
Ewing sarcoma	6	6.0
Other malignant tumours	2	2.0
Metastatic bone lesions	20	20.0

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Wide excision with reconstruction was performed in 26.0% of patients, while curettage with bone grafting was done in 24.0%. Internal fixation was required in 18.0% of cases, mainly for pathological fractures or structurally unstable lesions. Amputation was performed in 8.0% of patients with extensive malignant disease, neurovascular involvement, or non-salvageable limb status (Table 4).

Table 4: *Surgical Procedures Performed*

Surgical procedure	Number	Percentage
Curettage with bone grafting	24	24.0
Wide excision with reconstruction	26	26.0
Resection with endoprosthetic replacement	14	14.0
Internal fixation	18	18.0
Debulking/palliative stabilization	10	10.0
Amputation	8	8.0

General anaesthesia was administered to 56 (56.0%) patients, combined general and regional anaesthesia to 24 (24.0%), and regional anaesthesia alone to 20 (20.0%). Estimated blood loss was <250 mL in 38 (38.0%), 250–500 mL in 30 (30.0%), and >500 mL in 32 (32.0%) patients. Blood transfusion was required in 30 (30.0%), intraoperative hypotension occurred in 18 (18.0%), and a difficult airway was documented in 4 (4.0%) patients (Table 5).

Table 5: *Anaesthetic Techniques and Intraoperative Considerations*

Variable	Category	Number	Percentage
Anaesthetic technique	General anaesthesia	56	56.0
	Regional anaesthesia	20	20.0
	Combined general and regional anaesthesia	24	24.0
Estimated blood loss	<250 mL	38	38.0
	250–500 mL	30	30.0
	>500 mL	32	32.0
Blood transfusion	Required	30	30.0
	Not required	70	70.0
Intraoperative hypotension	Present	18	18.0
	Absent	82	82.0
Difficult airway	Present	4	4.0
	Absent	96	96.0

Postoperative rescue analgesia was required in 28 (28.0%) patients. Postoperative nausea and vomiting occurred in 12 (12.0%), wound-related complications in 8 (8.0%), intensive care unit admission in 2 (2.0%), and re-exploration in 1 (1.0%). No perioperative mortality was recorded (Table 6).

Table 6: *Postoperative Outcomes and Complications*

Outcome/complication	Number	Percentage
Rescue analgesia requirement	28	28.0
Postoperative nausea and vomiting	12	12.0
Wound-related complications	8	8.0
Postoperative ICU admission	2	2.0
Re-exploration	1	1.0
Perioperative mortality	0	0.0

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Overall, the clinicopathological profile showed that orthopaedic bone tumours presented predominantly with pain and swelling, with the femur being the most commonly affected site. Benign tumours were slightly more frequent than malignant primary and metastatic lesions. From an anaesthetic perspective, major perioperative concerns included anticipated blood loss, transfusion planning, pain control, haemodynamic instability, and postoperative monitoring in extensive tumour resections.

Discussion

The present hospital-based descriptive cross-sectional study included 100 surgically managed bone-tumour patients. The mean age was 34.8 ± 18.6 years, 58.0% were male, and 38.0% were aged 21–40 years. Pain (86.0%), swelling (62.0%), and restricted movement (38.0%) were the principal manifestations, while the femur (34.0%) and tibia (22.0%) were the leading sites. Benign, primary malignant, and metastatic lesions constituted 46.0%, 34.0%, and 20.0%, respectively. General anaesthesia was used in 56.0%, blood loss exceeded 500 mL in 32.0%, transfusion was required in 30.0%, intraoperative hypotension occurred in 18.0%, and 28.0% required postoperative rescue analgesia. Intensive care admission was uncommon (2.0%), and no perioperative mortality occurred.

The mean age in the present cohort was higher than the 26.9 years reported by Jain et al. in a South Indian series of 117 bone tumours, whereas the male proportion was modestly lower (58.0% versus 65.0%) [1]. The difference in age is plausibly related to the inclusion of surgically treated metastatic lesions (20.0%) and patients across all age groups, which shifted the distribution toward older adults. Male predominance in both studies may reflect the sex distribution of specific tumour types and healthcare-referral patterns; however, a descriptive single-centre sample cannot establish a biological sex association. The concentration of 38.0% of cases in the 21–40-year group is compatible with the occurrence of giant cell tumour and several primary sarcomas in adolescents and young adults [2,3,6,7].

Pain in 86.0% and swelling in 62.0% confirm that local symptoms dominate presentation. Pain may arise from periosteal irritation, cortical destruction, microfracture, or tumour-related inflammation, while swelling becomes apparent as the lesion enlarges beyond the cortex [4,5]. Restricted movement in 38.0% likely reflects periarticular location, mechanical pain, or soft-tissue extension. Pathological fracture in 14.0% indicates clinically meaningful loss of structural integrity and may also suggest delayed presentation. Femoral and tibial involvement together accounted for 56.0% of cases. Jain et al. reported the lower femur in 25.6% and upper tibia/fibula in 20.5% [1], supporting the established predilection of many primary bone tumours for long-bone metaphyseal regions.

Benign tumours were the largest category (46.0%) but were less frequent than the 57.3% reported by Jain et al. [1]. Giant cell tumour was the most frequent benign diagnosis in the current surgical cohort (18.0%), whereas osteochondroma predominated in the earlier series (22.2%), followed by giant cell tumour (20.5%) [1]. This difference may reflect case selection: symptomatic or locally aggressive giant cell tumours are more likely to require operative treatment, while some osteochondromas remain asymptomatic and are observed. Osteosarcoma represented 18.0% of all cases and 52.9% of primary malignant tumours, compared with 35.1% of primary malignant tumours in the South Indian series [1]. The 20.0% metastatic burden probably reflects the hospital's surgical referral role and the inclusion of stabilisation procedures for painful or mechanically unstable secondary lesions [8,9].

The operative pattern was consistent with differing oncological and mechanical objectives. Wide excision with reconstruction (26.0%) and curettage with bone grafting (24.0%) were most frequent, followed by internal fixation (18.0%), endoprosthetic replacement (14.0%), palliative stabilisation (10.0%), and amputation (8.0%). Curettage is appropriate for selected benign or locally aggressive lesions when joint preservation is feasible, whereas wide excision and reconstruction are required when tumour clearance is the principal goal. The relatively low amputation proportion suggests that limb-sparing approaches were feasible in most patients, although extensive disease, neurovascular involvement, infection, or a non-salvageable limb may still necessitate amputation. This distribution agrees with contemporary surgical principles that favour limb preservation when adequate margins and useful function can be achieved [10].

General anaesthesia was selected in 56.0%, combined general-regional anaesthesia in 24.0%, and regional anaesthesia alone in 20.0%. The predominance of general anaesthesia is understandable because major tumour resections may require secure airway control, prolonged immobilisation, complex positioning, muscle relaxation, and rapid treatment of haemodynamic changes [11]. Preoperative anaemia was present in 28.0%; blood loss exceeded 500 mL in 32.0%, transfusion was required in 30.0%, and hypotension occurred in 18.0%. These findings identify bleeding and circulatory instability as central anaesthetic risks. In a specialised pelvic and sacral tumour series, Freeman et al. reported mean blood losses of 1,457 mL with hypotensive epidural anaesthesia and 2,421 mL with standard anaesthesia, with corresponding mean red-cell use of 2.7 and 3.9 units [12]. The lower apparent bleeding burden in the current study is expected because it included many limited long-bone

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procedures and only a minority of pelvic or spinal operations. Nevertheless, the close correspondence between substantial blood loss and transfusion frequency supports preoperative haemoglobin optimisation, cross-matched blood availability, careful fluid therapy, temperature control, and institution-specific blood-conservation protocols [11-13].

Postoperative rescue analgesia was required in 28.0%, indicating that almost one-third of patients experienced pain beyond the initial analgesic plan. Extensive resection, endoprosthetic reconstruction, bone manipulation, and pre-existing tumour pain may explain this requirement. Evidence from orthopaedic oncology shows better pain control with epidural than intravenous patient-controlled analgesia in suitable patients [14], supporting the selective use of regional techniques within a multimodal regimen. Postoperative nausea and vomiting occurred in 12.0%, wound complications in 8.0%, intensive care admission in 2.0%, and re-exploration in 1.0%. The absence of perioperative mortality and low intensive care use may reflect that 84.0% of participants were ASA I–II, together with structured preoperative assessment and selective postoperative monitoring. These observations should not be interpreted as proof of low long-term risk because follow-up was limited to the early perioperative period and uncommon adverse events may not be detected in a sample of 100 patients.

Generalizability

The findings are most applicable to government teaching hospitals and tertiary orthopaedic units managing a mixed spectrum of benign, primary malignant, and metastatic bone lesions within comparable resource settings. The consecutive surgical cohort improves representation of routine institutional practice, but the single-centre design, short study period, absence of tumour-stage stratification, and descriptive analysis limit extrapolation to high-volume sarcoma centres, paediatric oncology hospitals, and institutions with advanced limb-salvage programmes.

Conclusion

This hospital-based descriptive cross-sectional study demonstrated that orthopaedic bone tumours requiring surgery showed marked clinicopathological diversity, with pain, swelling, and long-bone involvement forming the dominant presentation. Benign tumours were slightly more frequent than malignant primary and metastatic lesions, and giant cell tumour and osteosarcoma were important diagnostic categories. General anaesthesia was the commonest technique, although regional and combined techniques contributed to perioperative care. Anticipated blood loss, transfusion readiness, haemodynamic stability, postoperative analgesia, and selective intensive care monitoring were the major anaesthetic concerns. These findings support integrated orthopaedic, anaesthetic, pathological, and transfusion planning for safer surgical management of bone tumour patients. Routine documentation strengthens audit and local protocol development.

Limitations

This was a single-centre descriptive cross-sectional study with a sample size of 100 patients and a six-month study period. The analysis was descriptive, without long-term oncological, functional, or survival follow-up. Detailed tumour staging, chemotherapy exposure, operative duration, analgesic dosage, and validated pain scores were not available for all patients. Histological subgroup comparisons were limited by small category-wise numbers.

Recommendations

Patients undergoing surgery for orthopaedic bone tumours should receive structured preoperative assessment that includes haemoglobin optimisation, comorbidity control, airway evaluation, anticipated blood loss estimation, and transfusion planning. Multidisciplinary review by orthopaedics, anaesthesia, pathology, radiology, oncology, and transfusion services should be encouraged for malignant, metastatic, pelvic, spinal, and extensive long-bone lesions. Regional anaesthesia and multimodal analgesia should be used when appropriate to improve postoperative pain control. Institutions managing such cases should maintain protocols for blood conservation, intraoperative haemodynamic monitoring, postoperative rescue analgesia, early mobilisation, wound surveillance, and selective intensive care referral. Periodic outcome audit should guide revision of institutional pathways.

Acknowledgement

The authors acknowledge the support of the departments involved in patient care, perioperative documentation, histopathological reporting, and postoperative monitoring. The authors also thank the nursing staff, operation theatre personnel, and medical record staff for their assistance in maintaining clinical data used for this study during the entire six-month study period.

Abbreviations

ASA: American Society of Anesthesiologists
DOAJ: Directory of Open Access Journals
GA: General anaesthesia
GCT: Giant cell tumour
ICU: Intensive care unit
PONV: Postoperative nausea and vomiting

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https://doi.org/10.51168/sjhrafrica.v7i2.2814
Original Article

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

RC-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript**. AS** - Design of the study, results interpretation, review of literature and preparing first draft of manuscript, revision of manuscript.**KA-** design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript

Data availability

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

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e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 2 (2026): June 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i2.2814
Original Article

2005;138(5):869-876.
https://doi.org/10.1016/j.surg.2005.05.004

PUBLISHER DETAILS

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa