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Evaluation of Vocational Competency in Open Fracture Imaging Among Radiography Students and Novice Radiographers

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Abstract

Introduction

This study aims to assess the vocational competency of Proficiency Certificate Level (PCL) radiography students and recent graduates in the imaging of open fractures. Evidence-based practice requires an X-ray evaluation of the fractured area, wherein radiographers' knowledge and skills play a crucial role.

Methods

A cross-sectional survey utilizing convenience sampling was conducted to evaluate vocational competency in open fracture imaging among PCL radiography students and recent graduates within the Gandaki Province of Nepal. A total of 97 participants volunteered for the study. They were categorized into four cohorts: first-year students (27/97, 27.8%), second-year students (46/97, 47.4%), third-year students (8/97, 8.2%), and recent graduates (16/97, 16.5%) possessing at least six months of clinical experience. The study evaluated three primary domains: demographic profiles, theoretical knowledge, and practical competencies using structured questionnaires. The questionnaire consisted of 22 items: five on background information, ten on theoretical knowledge, five on practical skills, and two on attitudes and expectations. The questionnaire was prepared in alignment with international standards of radiography practice and validated by consultant radiologists. To reduce ambiguity and response bias, the survey questions were explained uniformly to all participants before administration. Data were analyzed using Statistical Product and Service Solutions (SPSS, version 25; IBM SPSS Statistics for Windows, Armonk, NY).

Results

Overall competency scores in open fracture imaging demonstrated an upward trend corresponding with advancing academic training and clinical exposure. First-year students achieved the lowest total score (210/405, 51.9%), second-year (490/690, 71.0%), and third-year (88/120, 73.3%). Recent graduates recorded the highest overall competency score (182/240, 75.8%). Additionally, a majority of participants (87/97, 89.7%) expressed a strong desire for further academic education in radiography of open fractures. Overall assessment scores differed significantly across the four academic cohorts (Kruskal-Wallis H-test: $H(3) = 38.45$, $p < 0.001$). Post-hoc pairwise comparisons using Dunn's test with Bonferroni correction confirmed statistically significant differences between entry-level learners and senior cohorts ($p < 0.05$).

Conclusion

The participants' proficiency in theoretical and practice-related knowledge demonstrated a positive association with academic seniority and clinical experience. Overall competency scores across the cohorts were 51.9% for first-year students, 71.0% for second-year students, 73.3% for third-year students, and 75.8% for recent graduates. These findings suggest that enhancing theoretical knowledge, clinical exposure, and practical training - alongside a potential revision of the existing Council for Technical Education and Vocational Training (CTEVT) Radiography diploma curriculum - may further improve radiographers' preparedness for high-acuity orthopedic emergencies.

Categories: Radiology, Medical Education, Orthopedics
Keywords: clinical competence, curriculum, medical imaging students, open fracture, practical skills, proficiency certificate level, radiographers, radiography, theoretical knowledge, vocational education

Introduction

An open fracture is a direct communication of a bone fracture with the external environment, resulting from a disruption of the overlying soft tissue envelope [1,2]. Unlike closed injuries, open fractures are considered orthopedic and surgical emergencies due to the high risk of complications, including infection, arterial

hemorrhage, and peripheral nerve damage. The complexity of these injuries often results in delayed union, nonunion, or, in severe cases, limb amputation [3,4]. Consequently, the radiographic imaging of these injuries represents a critical competency for newly graduated radiographers during their transition from supervised clinical training to independent professional practice [5].

The incidence of open fractures is notably high in Nepal. Epidemiological data indicate that a substantial proportion of high-energy industrial traumas and frequent traffic-related fractures in the western region of Nepal present as open injuries [6]. Current literature suggests a significant demographic skew, with these injuries being more than twice as prevalent in males (2.1:1 male-to-female ratio) and most frequently affecting the economically productive population aged 20-50 years [6,7]. Road traffic accidents (RTAs), particularly those involving motorcycles, remain the predominant etiology, leaving pedestrians as an exceptionally vulnerable cohort [7,8]. Given the high burden of open fracture trauma in Nepalese emergency settings, radiographers must deliver immediate, high-quality diagnostic projections without compromising limb alignment or breaching infection control barriers during the critical initial care window [9,10].

Executing diagnostic X-rays on a patient with an open fracture requires the rapid, practical application of modified positioning techniques to capture orthogonal views encompassing the joint both proximal and distal to the injury site without mobilizing unstable fragments [11]. Open fractures breach the primary dermal barrier, and hence the radiographer must strictly adhere to medical and surgical aseptic measures, sterile barriers over digital detectors, and hand hygiene protocols to mitigate the risk of deep-tissue contamination [12]. Simultaneously, the imaging professional must balance the urgency of trauma radiography with radiation safety standards. This requires optimizing exposure parameters, proper beam collimation, and use of lead shields to adhere strictly to the "As Low As Reasonably Achievable" (ALARA) principle. A radiographer should possess cognitive skills to interpret radiographic signs under pressure, psychomotor skills to manipulate equipment without worsening the trauma, and affective skills to manage the emotional trauma within the trauma care settings [13]. There is clinical importance to these skills and competencies; however, very few research studies are available assessing the preparedness of students and recent graduates in radiography for open fractures, and a standardized curriculum required for diploma-level radiographers within Nepal to tackle open fracture radiography scenarios is scarce. The study aims to evaluate the knowledge, practical skills, and overall competency level of radiography students and newly graduated radiographers in the imaging of open fractures.

Materials And Methods

Ethics and informed consent

This study was reviewed and formally approved by the Gandaki Medical College Institutional Review Committee (GMC-IRC Ref. No. 152/082/083-F). Verbal informed consent was obtained from all individual participants prior to data collection, and participant confidentiality was maintained throughout the study.

Study design and participant selection

A cross-sectional survey utilizing convenience sampling techniques was conducted among Proficiency Certificate Level (PCL) radiography student groups and novice radiographers to evaluate vocational competency in open fracture imaging. The study was carried out in two radiography colleges and three hospitals within the Gandaki Province of Nepal, and only respondents available at the time of questionnaire distribution were considered for this study.

A total of 97 participants voluntarily completed a structured questionnaire comprising open- and closed-ended questions. They were categorized into four cohorts: first-year students (27/97, 27.8%), second-year students (46/97, 47.4%), third-year students (8/97, 8.2%), and recent graduates (16/97, 16.5%) possessing a maximum of six months of clinical experience after graduation. To minimize peer-to-peer communication bias, the data were collected simultaneously on a single day, and the survey questions were explained uniformly to all participants before administration. Exclusion criteria included unavailability on the day of data collection, unwillingness to participate, and holding a bachelor's or master's degree in radiography.

Survey instruments and validation

The study captured demographic and background data (age, gender, and academic year), evaluated theoretical and practice-related knowledge competency in open-fracture management, and assessed participants' attitudes toward the survey's relevance. The questionnaire comprised a total of 22 questions (see Appendices): five elicited background information, ten evaluated theoretical knowledge, five assessed practice-related knowledge, and two derived attitudes towards the survey and expectations. This instrument aligned with the Council for Technical Education and Vocational Training (CTEVT) radiography curriculum and international health system standards [14-17]. The core domain of the questionnaire consisted of fracture pathophysiology, diagnostic imaging techniques, infection control, and practical trauma scenarios, which was validated by three consultant radiologists. The third-year cohort had fewer participants because they were assigned to various hospitals across multiple shifts for their on-the-job training (OJT).

Statistical analysis

Data were analyzed using Statistical Product and Service Solutions (SPSS, version 25; IBM SPSS Statistics for Windows, Armonk, NY) via descriptive statistics and inferential statistics. Prior to analysis, all data were double-checked for completeness and consistency. Missing or incorrect responses were treated as incorrect and accounted for in the total response volume metrics. The missing responses (3/690, 0.4%) were seen in the second-year students only for a total of 15 questionnaire items. Graphical representations and trend analysis curves were generated to visually assess performance trajectory across the varying levels of academic and clinical training. To satisfy independence assumptions, individual participants (N = 97) were evaluated using total composite scores (max 15). Group differences across the four academic cohorts were analyzed using the Kruskal-Wallis H-test with Bonferroni-corrected Dunn's pairwise comparisons, setting significance at $p < 0.05$.

Results

Demographic characteristics of the participants

A total of 97 participants were included in the study, comprising 81 students and 16 recent graduates. The participants' ages ranged from 16 to 30 years, with a mean age of 19.2 ± 3.0 years, and the majority of respondents (77/97, 79.4%) fell into the 16-20 years age bracket. Second-year students represented the largest cohort (46/97, 47.4%). The gender distribution consisted of males (45/97, 46.4%) and females (52/97, 53.6%), with a male-to-female proportion of 1:1.15. Detailed demographic characteristics, including age groups and academic cohorts, are summarized in Table *1*.

Demographic Variable	Category	Frequency (%)
Gender	Female	52/97 (53.6%)
	Male	45/97 (46.4%)
Age Group	16-20 years	77/97 (79.4%)
	21-25 years	14/97 (14.4%)
	26-30 years	6/97 (6.2%)
Academic Cohort	First-year students	27/97 (27.8%)
	Second-year students	46/97 (47.4%)
	Third-year students	8/97 (8.2%)
	Recent graduates	16/97 (16.5%)

TABLE 1: Demographic Characteristics of Participants

Prior clinical and radiological exposure

Participants answered a set of background-related questions designed to evaluate their prior exposure to clinical and radiological settings before enrollment in the PCL radiography program. Out of the total participants, 9/97 (9.3%) reported having worked in a hospital setting as community medical assistants, darkroom assistants, or lab assistants, including 3/16 (18.8%) of the recently graduated radiographers. Regarding prior radiographic exposure, 8/97 (8.2%) participants reported that they had performed X-ray examinations before obtaining a formal radiography degree. Similarly, 7/97 (7.2%) participants reported performing X-ray examinations on patients with open fractures before enrollment. A total of 33/97 (34.0%) participants had seen open fractures in the community before starting the PCL radiography course. In addition, 6/97 (6.2%) participants had witnessed surgical procedures related to open fractures, among whom 2/16 (12.5%) were recently graduated radiographers. Details regarding background metrics are presented in Table *2*.

Background Information	No. of Participants	No. of Recently Graduated Radiographers
Worked in hospital settings before the PCL radiography course	9/97 (9.3%)	3/16 (18.8%)
Performed an X-ray without a formal degree	8/97 (8.2%)	1/16 (6.3%)
Has seen open fractures before starting PCL radiography	33/97 (34.0%)	1/16 (6.3%)
Performed X-rays in patients with open fractures before starting PCL radiography	7/97 (7.2%)	1/16 (6.3%)
Watched open-fracture debridement procedures	6/97 (6.2%)	2/16 (12.5%)

TABLE 2: Background Information of the Proficiency Certificate Level (PCL) Radiography Students

A total of five questions were asked to derive the background information.

Perceived relevance of the study content

A clear majority of participants (88/97, 90.7%) reported that the survey content was relevant to the radiography profession, and a comparable subset (87/97, 89.7%) expressed a strong desire to learn more about the subject.

Theoretical and practical knowledge across education levels

Participants' theoretical knowledge and practice-related knowledge regarding open fractures were assessed across different educational levels, summarized in Table *3*. First-year students demonstrated the lowest performance, achieving 210/405 (51.9%) total correct responses. Their knowledge-based score was relatively higher, at 155/270 (57.4%), compared to their practice-based score of 55/135 (40.7%), indicating limited practical exposure. Second-year students showed a marked improvement, achieving 490/690 (71.0%) total correct responses. Their knowledge-based performance of 335/460 (72.8%) and practice-based performance of 155/230 (67.4%) were more balanced, reflecting increased academic learning and exposure to practical demonstrations. Third-year students performed slightly better, with 88/120 (73.3%) overall correct responses. Their knowledge-based score of 58/80 (72.5%) and practice-based score of 30/40 (75.0%) were comparable. Recent graduates demonstrated the highest level of competency, recording 182/240 (75.8%) total correct answers. They achieved the highest scores in both knowledge-based 124/160 (77.5%) and practice-based 58/80 (72.5%) assessments.

Academic Level	Participants	Total Correct Answers	Theoretical Knowledge-Based Correct Answers	Practical Knowledge-Based Correct Answers
1st year	27/97 (27.8%)	210/405 (51.9%)	155/270 (57.4%)	55/135 (40.7%)
2nd year	46/97 (47.4%)	490/690 (71.0%)	335/460 (72.8%)	155/230 (67.4%)
3rd year	8/97 (8.2%)	88/120 (73.3%)	58/80 (72.5%)	30/40 (75.0%)
Recent graduates	16/97 (16.5%)	182/240 (75.8%)	124/160 (77.5%)	58/80 (72.5%)

TABLE 3: Participants' Theoretical Knowledge and Practical Knowledge-Based Scores

A total of 10 questions were theoretical knowledge-based, and five questions were practical skills-based.

Distribution and trends of responses

The overall assessment scores differed significantly across the four academic cohorts (Kruskal-Wallis H-test: $H(3) = 38.45$, $p < 0.001$). Median composite scores (maximum 15 points) and interquartile ranges (IQR) demonstrated an upward trend across advancing training tiers: 7.8 (IQR: 6.5-9.0) for first-year students, 10.6

(IQR: 9.5-11.5) for second-year students, 11.0 (IQR: 10.0-12.0) for third-year students, and 11.4 (IQR: 10.5-12.5) for recent graduates, summarized in Table 4. Post-hoc pairwise comparisons using Dunn's test with Bonferroni correction confirmed statistically significant differences between entry-level learners and senior cohorts ($p < 0.05$).

Academic Level	Participants	Median Score (Out of 15)	Interquartile Range (IQR)	Q1 (25th Percentile)	Q3 (75th Percentile)
1st year	27/97 (27.8%)	7.8	2.5	6.5	9.0
2nd year	46/97 (47.4%)	10.6	2.0	9.5	11.5
3rd year	8/97 (8.2%)	11.0	2.0	10.0	12.0
Recent Graduates	16/97 (16.5%)	11.4	2.0	10.5	12.5
Total Sample	97/97 (100.0%)	10.4	3.0	8.5	11.5

TABLE 4: Median Assessment Scores and Interquartile Ranges by Acedemic Level

Total response volumes varied across educational levels in alignment with cohort sizes (Figure 1), with second-year students contributing the highest volume of responses (690), followed by first-year students (405), recent graduates (240), and third-year students (120). While second-year students and recent graduates maintained high accuracy with lower proportions of incorrect or missing responses, 200/690 (29.0%) and 58/240 (24.2%), respectively, first-year students exhibited a near-even split, with a higher proportion of incorrect responses, 195/405 (48.1%). Third-year students demonstrated strong consistency with fewer total responses but a high proportion of correct answers relative to incorrect ones, 32/120 (26.7%).

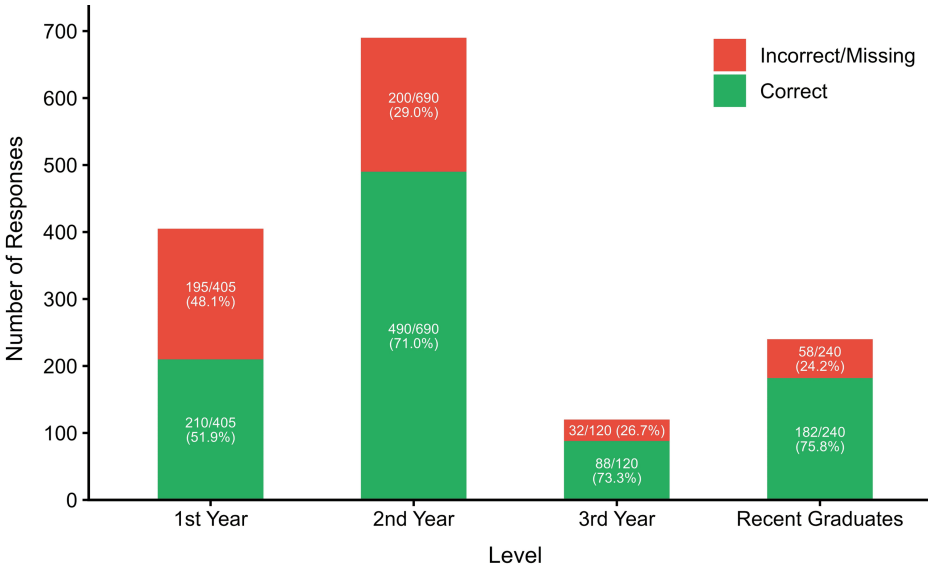


FIGURE 1: Distribution of Correct and Incorrect Responses by Educational Level

Missing responses were treated as incorrect and accounted for in the total response volume metrics.

An upward trend in overall performance (Figure 2) was observed with first-year students (210/405, 51.9%), second-year students (490/690, 71.0%), third-year students (88/120, 73.3%), and recent graduates (182/240, 75.8%). The largest difference occurred between the first and second years (+19.1%), which coincides with the introduction of clinical subjects in the second year. More gradual subsequent increases were observed, as students approached professional competency.

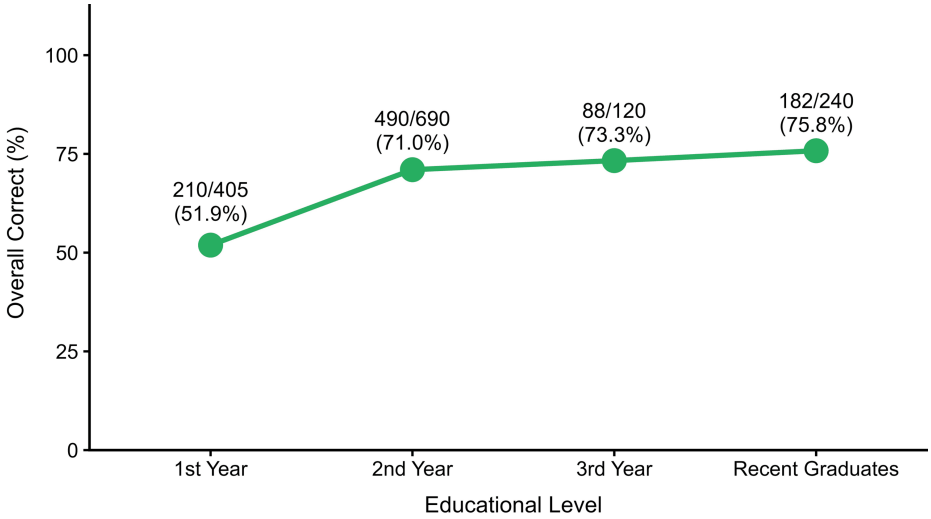


FIGURE 2: Overall Performance by Educational Level

Discussion

In the present study, a total of 97 participants - ranging from first-year students to recent PCL radiography graduates - were included, and the overall response to the questionnaire was encouraging. Most participants completed the questionnaire with interest and perceived the content as highly relevant to their academic and clinical experiences, although a few questions were left unanswered. Building upon this foundational engagement, the data demonstrate that, while pre-enrollment clinical experience is sparse across all cohorts, senior academic level corresponds to higher scores in trauma management competency. The fairly steep performance gradient observed from first-year learners to recent graduates highlights that formal institutional training is one of the foundations of proficiency in managing complex clinical scenarios of open fractures. Consequently, academic frameworks that intentionally integrate early practical simulations and structured clinical exposure can effectively accelerate professional readiness, ensuring that graduates are fully equipped for independent practice in healthcare environments.

Historically, in Nepal, Tribhuvan University established the Institute of Medicine (IOM) in 1972. IOM then initiated several diploma-level health training programs, including radiography, laboratory technology, and health assistant tracks, to address Nepal's critical healthcare workforce shortages [18,19]. Students' enrollment in radiography programs faced challenges in Nepal due to the general public's unfamiliarity with the radiography profession and a pervasive "doctor or nothing" mindset, where technical fields were viewed as career dead-ends lacking the explicit medical upgrading paths promised to other disciplines [20]. To overcome this resistance and normalize the profession, the World Health Organization, international agencies, and the Nepalese government provided crucial interventions throughout the 1970s and 1980s, funding IOM infrastructure, purchasing advanced equipment, offering direct financial support and incentives to students, and securing government job placement [18,19]. These targeted international subsidies and institutional frameworks successfully shifted public perception, transforming radiography into a highly viable, respected career path and paving the way for the contemporary multi-university bachelor's and master's level programs essential to medical imaging education. Traditionally in Nepal, the radiography profession was predominantly male; however, recent trends indicate a shift toward greater female participation. The current study reflects this shift toward gender parity, with a nearly balanced distribution of 46.4% male and 53.6% female participants.

A persistent challenge in developing countries is the shortage of qualified radiographers, leading to the involvement of untrained personnel in radiological procedures, resulting in suboptimal imaging. This issue is evident in several regions of the world, such as South Asia and Africa, where radiographer density remains low [21,22]. A similar situation exists in Nepal, including Gandaki Province. High patient volumes and limited workforce capacity often necessitate the reliance on underqualified personnel, contributing to compromised diagnostic yield. This study also shows that a small proportion of participants performed X-rays on patients prior to enrollment in the PCL radiography program. However, the introduction of formal short pre-enrollment orientation programs or observational postings in radiology departments may be beneficial in later stages for improving student preparedness and performance [5,20,21].

The results revealed significant performance differences across academic cohorts, with higher theoretical and practical knowledge observed in advanced training tiers compared to entry-level students. First-year students showed comparatively lower performance, particularly in practice-related knowledge, likely due to limited clinical exposure and less radiography-related content in the first-year syllabus of CTEVT. In contrast, second- and third-year students, as well as recent graduates, demonstrated improved

questionnaire performance, with minimal differences observed between third-year students and graduates. This may be attributed to clinical postings in the hospital in the final third year, which provided hands-on experience and bridged the gap between theoretical knowledge and practical application [17].

Exposure to open fracture cases and related surgical debridement procedures was limited among participants. However, such exposure is crucial in enhancing understanding of patient management, infection control, and appropriate radiographic techniques. Incorporating observational learning opportunities, including exposure to surgical procedures, into the curriculum could improve students' clinical competence and sensitivity towards patient care. Given that many PCL graduates are required to work independently in tertiary healthcare centers as well as in smaller setups, they must possess comprehensive knowledge not only in radiographic techniques but also in anatomy, pathology, and basic clinical radiology. Strengthening the curriculum, along with implementing structured training programs and competency-based assessments, may help ensure better preparedness of graduates [23].

Overall participant perception was highly positive, with 88/97 (90.7%) noting that the survey content was directly relevant to the radiography profession and 87/97 (89.7%) expressing a strong desire for further education. These findings highlight the necessity of incorporating targeted open fracture management modules into the core curriculum.

Study limitations

This study has several limitations. First, the cross-sectional design restricts analysis to cohort comparisons at a single point in time, precluding inferences regarding longitudinal competency growth across academic years. Second, convenience sampling and unequal cohort sizes - particularly the small third-year cohort (n = 8) - introduce potential selection bias and limit statistical reliability. Third, competency was evaluated exclusively via a questionnaire without direct clinical observation or comprehensive psychometric validation, which may not fully reflect real-time decision-making during trauma radiography. Finally, because sampling was restricted to Gandaki Province, the generalizability of these findings across the broader Nepalese context remains limited.

Conclusions

The participants' proficiency in theoretical and practice-related knowledge demonstrated a positive association with academic seniority and clinical experience. Overall competency scores across the cohorts were 51.9% for first-year students, 71.0% for second-year students, 73.3% for third-year students, and 75.8% for recent graduates. These findings suggest that enhancing theoretical knowledge, clinical exposure, and practical training - alongside a potential revision of the existing CTEVT radiography diploma curriculum - may further improve radiographers' preparedness for high-acuity orthopedic emergencies.

Appendices

Name:..... Age:..... Sex:..... Qualification: a) 1st Year, b) 2nd Year, c) 3rd Year, d) Recent Graduates		
Q. No.	Question Statement	Option/Answer type
1	Did you work in hospitals before starting PCL radiography?	a) Yes, b) No
2	Have you performed X-rays before starting the PCL radiography course?	a) Yes, b) No
3	Have you seen open fractures before starting PCL radiography?	a) Yes, b) No
4	Have you performed X-rays of open fractures before starting the PCL radiography course?	a) Yes, b) No
5	Have you watched open fracture surgery/debridement procedures?	a) Yes, b) No
6	What is an open fracture?	Short answer
7	How is first aid provided for open fractures?	Short answer
8	Where in the body do open fractures mostly occur?	Short answer
9	Why are open fractures always considered	Short answer

	contaminated, whereas closed fractures are not?	
10	Open fractures usually result from:	a) Osteoporosis, b) Repetitive stress, c) High-velocity injuries, d) Chronic diseases
11	A patient with a fracture comes with blood-soaked bandaging; what would you do?	a) Seek advice first, b) Send the patient back to E.R. c) Ask the patient's party to shift the patient. d) Apply more bandages and take a radiograph.
12	What will you do first if you come across a patient with an open fracture for radiography?	a) Check patient identity and history, b) Take an X-ray, c) Chat with patient, d) Consult senior
13	Why is hygiene extremely important for patients with open fractures?	a) Make the patient comfortable, b) Reduce infection rate, c) Reduce mortality rate, d) Reduce further trauma
14	What are the potential hazards of coming in contact with patients' blood/body fluids?	a) Nothing will happen, b) Possibility of acquiring infectious diseases (HIV, Hep B/C), c) Possibility of non-infectious diseases, d) Possibility of skin rashes
15	Assume all blood/body substances are infectious. Standard precautions include:	a) Good hygiene, b) Use of PPE, c) Correct waste handling, d) All of the above
16	Workers may be at risk of exposure to infectious diseases or biological hazards if they receive:	a) Skin-penetrating injury, b) Fluid contact with broken skin/eyes/mouth, c) Contaminated equipment, d) All of the above
17	Personal protective equipment should be provided to:	a) First aid personnel/radiographers, b) Injured person, c) Both (a) and (b), d) Only (a)
18	How do you place the cassette under the fracture part?	a) Carry proximal/distal parts simultaneously, b) Carry from any region, c) Ask the patient to place it, d) Rotate tube
19	Hands should be washed using soap and water:	a) Before/after contact, b) When in contact with blood/substance, c) When PPE is not used, d) All of the above
20	Whom would you ask to accompany you during an X-ray of an uncooperative child?	a) Volunteer yourself, b) Colleagues, c) X-ray attendants, d) Patient party
21	Was the content relevant to your radiography practice?	a) Yes, b) No
22	Do you feel you need to learn more about handling open fractures in the future?	a) Yes, b) No

TABLE 5: Structured Questionnaires for Radiography Students and Novice Radiographers

The open-ended questions (Q.N. 6-9) were assigned binary coding: 1 for a correct/acceptable response and 0 for an incorrect or missing response.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Gandaki Medical College Institutional Review Committee issued approval 152/082/083-F. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects

or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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References

1. Kumar M, Kharbanda H, Khan AA, Singh GK: Microbial profile and antibiotic sensitivity patterns in open fractures: a retrospective study from a tertiary care center. J Orthop Case Rep. 2025, 15:274-81. 10.13107/jocr.2025.v15.i11.6380
2. Aneja A, Kavolus MW, Teasdall RJ, Halvorson JJ: Does prophylactic local tobramycin injection lower open fracture infection rates?. OTA Int. 2022, 5:210. 10.1097/oi9.0000000000000210
3. Natoli RM, Marchand LS, Bzovsky S, et al.: Infection and nonunion rates in open fractures . J Bone Joint Surg Am. 2025, 107:2541-53. 10.2106/JBJS.24.01055
4. Dheenadhayalan J, Nagashree V, Devendra A, Velmurugesan PS, Rajasekaran S: Management of open fractures: a narrative review. J Clin Orthop Trauma. 2023, 44:102246. 10.1016/j.jcot.2023.102246
5. Makanjee CR, Zhang J, Bergh AM: Roles and responsibilities in the transition to working independently: a qualitative study of recently graduated radiographers' perspectives in Australia. J Multidiscip Healthc. 2023, 16:2471-83.
6. Shrestha BK, Joshi SR, Regmi S: Long bone open fractures among orthopedic trauma patients presenting in a tertiary care center: a descriptive cross-sectional study. Nepal Orthop Assoc J. 2024, 10:31-3.
7. Banskota C, Shrestha S, Sapkota K, et al.: Patterns of orthopaedic injuries among motorbike accident admissions presenting to a tertiary care hospital in Kathmandu. J Nepal Health Res Counc. 2016, 14:51-6.
8. Karkee R, Lee AH: Epidemiology of road traffic injuries in Nepal, 2001-2013: systematic review and secondary data analysis. BMJ Open. 2016, 6:e010757. 10.1136/bmjopen-2015-010757
9. Halawi MJ, Morwood MP: Acute management of open fractures: an evidence-based review . Orthopedics. 2015, 38:e1025-33. 10.3928/01477447-20151020-12
10. Godfrey J, Pace JL: Type I open fractures benefit from immediate antibiotic administration but not necessarily immediate surgery. J Pediatr Orthop. 2016, 36:6-10. 10.1097/BPO.0000000000000762
11. Almazedi B, Smith CD, Morgan D, Thomas G, Pereira G: Another fractured neck of femur: do we need a lateral X-ray?. Br J Radiol. 2011, 84:413-7. 10.1259/bjr/57316056
12. Jimenez YA, Lewis SJ: Infection prevention and control in the medical imaging environment: a scoping review. Insights Imaging. 2023, 14:121. 10.1186/s13244-023-01470-1
13. Webb EM, Naeger DM, Fulton TB, Straus CM: Learning objectives in radiology education: why you need them and how to write them. Acad Radiol. 2013, 20:358-63. 10.1016/j.acra.2012.10.003
14. Health and Care Professions Council: standards of proficiency for radiographers . (2016). Accessed: August 20, 2026: https://www.hcpc-uk.org/globalassets/resources/standards/standards-of-proficiency---radiographers.pdf.
15. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. (2007). Accessed: August 15, 2026: https://www.cdc.gov/infection-control/media/pdfs/Guideline-Isolation-H.pdf.
16. World Health Organization: WHO guidelines on hand hygiene in health care . (2009). Accessed: August 10, 2026: https://www.who.int/publications/i/item/9789241597906.
17. Council for Technical Education and Vocational Training, Curriculum Development Division: proficiency certificate level in diagnostic radiography: curriculum framework. (2024). Accessed: August 15, 2026: https://ctevt.org.np/curriculum/diplomapcl/radiography.
18. Dixit H: History of health professional education in Nepal . J Kathmandu Med Coll. 2018, 6:161-6. 10.3126/jkmc.v6i4.20122
19. Dixit H: Role of private sector for HRH (Human Resource for Health) production in Nepal . J Kathmandu Med Coll. 2013, 2:97-103. 10.3126/jkmc.v2i2.10634
20. Subedi KS, Sharma P: Development of radiology in Nepal: gearing up for mountainous challenges . J Am Coll Radiol. 2013, 10:291-5. 10.1016/j.jacr.2012.12.020
21. Ohene-Botwe B, Antwi WK, Amedu C, et al.: Challenges and strategies for retaining Africa's radiography workforce in the continent amidst a competitive global market: insights from 17 countries. Radiography (Lond). 2025, 31:103001. 10.1016/j.radi.2025.103001
22. Suwal S, Koirala S, Chataut D: Evaluation of the diagnostic quality of chest radiographs . Nepalese J Radiol. 2022, 12:13-7. 10.3126/njr.v12i1.42266
23. McNulty JP, England A, Shanahan MC: International perspectives on radiography practice education . Radiography (Lond). 2021, 27:1044-51. 10.1016/j.radi.2021.04.004