

ORIGINAL ARTICLE**CT Radiation Exposure in Anaesthetised vs Non-Anaesthetised Patients: A Comparative Dose Study**¹Srinivas Siripuram, ²Meniga Ramakrishna¹Assistant Professor, Department of Radiology, Maharashtra Institute of Medical Sciences and Research Center, Pune, Maharashtra, India;²Associate Professor, Department of Anaesthesia, Al-Ameen Medical College, BIJAPUR, Karnataka, India**ABSTRACT:**

Background: Computed tomography (CT) is a crucial diagnostic modality, but radiation exposure remains a significant concern, particularly in vulnerable populations. Patients undergoing CT under general anaesthesia may be exposed to higher doses due to procedural complexities and longer scan times. **Aim:** To compare radiation exposure, scan duration, and image quality between anaesthetised and non-anaesthetised adult patients undergoing clinically indicated CT imaging. **Material and Methods:** This comparative observational study included 80 adult patients divided into two groups: Group A (n=40, anaesthetised) and Group B (n=40, non-anaesthetised). CT scans were performed using standardised protocols on a 128-slice multidetector scanner. Radiation exposure was assessed via dose-length product (DLP) and CTDIvol. Scan duration and image quality were recorded. Demographic and clinical parameters were analysed using SPSS 16.0, and statistical significance was set at $p < 0.05$. **Results:** Demographics were comparable across groups. Brain CTs were more frequent in the anaesthetised group (45.00%) than the non-anaesthetised group (25.00%) ($p = 0.046$). The mean DLP and CTDIvol were significantly higher in anaesthetised patients (812.45 ± 140.32 mGy·cm and 13.56 ± 2.34 mGy) than in non-anaesthetised patients (698.78 ± 128.56 mGy·cm and 11.89 ± 2.08 mGy), with $p = 0.001$ and $p = 0.004$, respectively. Mean scan duration was also longer in the anaesthetised group (7.85 ± 1.24 min vs. 5.42 ± 0.98 min, $p < 0.001$). Despite this, image quality was acceptable in 100.00% of scans in both groups. **Conclusion:** Anaesthetised patients undergoing CT scans are exposed to significantly higher radiation doses and longer scan durations compared to non-anaesthetised patients. Nevertheless, consistent image quality was maintained across both groups. These findings emphasize the need for radiation optimisation protocols, particularly in patients requiring anaesthesia.

Keywords: CT scan, Radiation dose, Anaesthesia, Image quality, Scan duration.

Corresponding author: Meniga Ramakrishna, Associate Professor, Department of Anaesthesia, Al-Ameen Medical College, BIJAPUR, Karnataka, India

This article may be cited as: Siripuram S, Ramakrishna M. CT Radiation Exposure in Anaesthetised vs Non-Anaesthetised Patients: A Comparative Dose Study. *J Adv Med Dent Sci Res* 2016;4(4):362-366.

INTRODUCTION

Computed Tomography (CT) has revolutionized modern diagnostic imaging by offering rapid, high-resolution, cross-sectional views of internal anatomy. It plays a critical role in diagnosing a wide spectrum of clinical conditions, ranging from trauma and malignancy to vascular, neurological, and infectious pathologies. Despite its clinical utility, CT imaging is associated with considerable radiation exposure, which raises growing concern among medical professionals, particularly in vulnerable patient populations. Minimizing radiation dose without compromising image quality has become a central goal in radiological practice, especially given the cumulative risk of radiation-induced malignancy from repeated scans. In clinical settings, certain patient groups may require additional support to successfully undergo CT imaging. Anaesthesia is frequently employed in such scenarios, particularly in uncooperative patients, pediatric populations, individuals with cognitive impairment, or those suffering from movement disorders. The use of general anaesthesia or sedation helps to reduce motion artefacts and facilitates high-quality image acquisition. However, anaesthesia introduces new

logistical challenges, including prolonged preparation time, increased scan duration, and the necessity for continuous physiological monitoring throughout the procedure. These factors can potentially influence radiation exposure, either directly or indirectly, by altering scan parameters or leading to repeated acquisitions¹. The evaluation of radiation dose in anaesthetised versus non-anaesthetised patients has received limited attention, despite its significance in improving radiological safety practices. Various procedural and technical elements may contribute to dose variation. For example, anaesthetised patients often require immobilisation aids or non-routine positioning, which may interfere with standardised scan planning. Ventilated patients may also require scan timing adjustments to synchronise with breathing cycles. These alterations can lead to repeated scanning, extended coverage lengths, or changes in tube current modulation settings, thereby impacting the total radiation dose administered. The introduction of advanced dose-tracking systems in CT consoles has allowed for more precise quantification of radiation parameters, such as the Computed Tomography Dose Index (CTDIvol) and Dose-Length Product (DLP). These values serve as standard metrics for evaluating

radiation exposure during CT examinations. While technological innovations such as automatic exposure control, iterative reconstruction algorithms, and patient-specific dose modulation have helped reduce unnecessary exposure, these techniques may not fully compensate for the procedural complexities introduced by anaesthesia. Understanding how these variables impact radiation dose in sedated versus conscious patients is crucial for developing effective dose-reduction protocols²⁻⁴. Furthermore, imaging under anaesthesia often occurs in complex clinical scenarios such as oncologic assessment, pre-operative mapping, or emergency neurological evaluations. These patients typically present with high clinical acuity, necessitating swift and precise imaging outcomes. In such high-stakes situations, radiologists may accept higher radiation doses in favor of diagnostic clarity. However, this approach underscores the need for evidence-based guidelines that strike a balance between patient safety and diagnostic efficacy. Studies evaluating personnel exposure during CT-guided interventions have underscored the significant radiation burden faced by healthcare staff, especially when working close to the gantry or within the scan room. Extrapolating from these observations, anaesthetised patients may be at even greater risk due to extended scan times and frequent operator presence during set-up and breath-hold training periods¹. The presence of anaesthesia equipment, monitoring lines, and ventilators may further limit ideal patient positioning and necessitate adjustments in scanner geometry that can influence dose profiles². Additionally, image quality expectations in sedated or anaesthetised patients may differ from those in awake individuals. Since repeat scanning is more feasible in cooperative patients who can follow instructions, non-anaesthetised individuals may require fewer rescans and less exposure. In contrast, anaesthetised patients, especially those undergoing neuroimaging or thoracoabdominal studies, may experience longer protocols due to repeated localisers or overlapping scan series for coverage assurance³. Anaesthetists, radiographers, and radiologists must therefore work collaboratively to ensure that dose optimisation strategies are uniformly applied across all patient categories. While patient immobilisation via anaesthesia can enhance image quality by reducing motion-related artefacts, it should not be misconstrued as a solution that automatically reduces radiation burden. On the contrary, it might lead to increased scan duration and exposure due to the operational complexity of imaging sedated individuals⁴. Efforts to minimize dose should include tailored scanning protocols based on patient-specific characteristics, automatic dose modulation systems, and the judicious use of anaesthesia only when clinically necessary. Moreover, anaesthetists should be trained in basic radiation safety practices, including the use of shielding devices, optimised positioning techniques, and awareness of procedural dose impact⁵.

The incorporation of simulation-based training and workflow audits can further enhance interdepartmental cooperation and ensure that the risks of ionising radiation are not disproportionately borne by anaesthetised patients⁶. Recent improvements in CT hardware and software have offered new avenues for dose reduction, including dual-energy imaging, high-pitch helical scanning, and real-time image reconstruction. However, evidence remains sparse on how these technologies perform in real-world anaesthetised imaging scenarios, where idealised test conditions are rarely achieved⁷. The integration of radiation tracking software into patient electronic health records could also allow for cumulative dose monitoring, providing an additional layer of safety for patients requiring frequent imaging⁸.

MATERIALS AND METHODS

This comparative observational study was conducted in the Department of Radiodiagnosis at a tertiary care hospital over a period of six months. The study population consisted of 80 patients who underwent clinically indicated computed tomography (CT) scans. Patients were divided into two equal groups: Group A comprised 40 anaesthetised patients, while Group B consisted of 40 non-anaesthetised patients. Inclusion criteria encompassed adult patients (age ≥ 18 years) undergoing CT for diagnostic purposes, with Group A requiring general anaesthesia due to inability to cooperate or clinical necessity, and Group B being fully conscious and cooperative during the scan. Patients with prior radiation therapy, multiple imaging within a short interval, or incomplete scan data were excluded.

All CT scans were performed using a 128-slice multidetector CT scanner (model details to be specified). The scan protocols, including tube voltage, tube current, pitch, rotation time, and collimation, were standardised for both groups and tailored according to anatomical region, weight, and clinical indication, as per institutional guidelines. For anaesthetised patients, endotracheal intubation and mechanical ventilation were managed by an experienced anaesthesiologist using standardized anaesthesia protocols. Heart rate, oxygen saturation, and respiratory rate were continuously monitored during the procedure.

Radiation exposure was quantified using dose-length product (DLP, mGy-cm) and computed tomography dose index volume (CTDIvol, mGy), which were automatically recorded by the CT console after each scan. These values served as surrogates for estimating effective dose and overall radiation burden. Image quality was ensured to be diagnostically acceptable in all cases by two independent radiologists blinded to the study group.

Demographic data including age, sex, weight, height, body mass index (BMI), and scan region were collected. The primary outcome measure was

comparison of radiation dose parameters (DLP and CTDIvol) between the anaesthetised and non-anaesthetised groups. Statistical analysis was performed using SPSS version 16.0. Continuous variables were expressed as mean \pm standard deviation (SD) and compared using the independent samples t-test. A p -value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Profile of Patients

The demographic characteristics between the two study groups were comparable and did not show statistically significant differences. The mean age of patients in the anaesthetised group was 45.63 ± 12.45 years, while in the non-anaesthetised group it was 47.18 ± 11.67 years, with a p -value of 0.517, indicating no significant age difference between the groups. Gender distribution was also similar, with 65.00% males and 35.00% females in the anaesthetised group, compared to 60.00% males and 40.00% females in the non-anaesthetised group ($p = 0.648$). The mean BMI in the anaesthetised group was 24.12 ± 2.36 kg/m², which was slightly higher than that in the non-anaesthetised group (23.98 ± 2.41 kg/m²), but this difference was not statistically significant ($p = 0.719$). These findings suggest that the two groups were demographically well matched, and differences in outcomes can be attributed to factors other than age, sex, or BMI.

Table 2: Scan Region Distribution

The distribution of scan regions varied between the groups, with a statistically significant difference observed for brain scans. In the anaesthetised group, 45.00% (n=18) of patients underwent brain CT scans, compared to only 25.00% (n=10) in the non-anaesthetised group ($p = 0.046$), suggesting that brain imaging was more commonly required in patients who could not cooperate and thus needed anaesthesia. For chest scans, 20.00% (n=8) of anaesthetised patients and 25.00% (n=10) of non-anaesthetised patients were scanned, with no significant difference ($p = 0.592$). Similarly, abdominal scans were performed in 25.00% (n=10) of anaesthetised and 35.00% (n=14) of non-anaesthetised patients ($p = 0.309$), while spinal scans were the least frequent in both groups (10.00% vs

15.00%, $p = 0.488$). Except for brain scans, the scan region distribution was generally comparable.

Table 3: Comparison of Radiation Exposure

A key finding of the study was the significantly higher radiation exposure observed in anaesthetised patients. The mean Dose-Length Product (DLP) in the anaesthetised group was 812.45 ± 140.32 mGy·cm, compared to 698.78 ± 128.56 mGy·cm in the non-anaesthetised group, with a p -value of 0.001, indicating a statistically significant increase in radiation burden among anaesthetised individuals. Similarly, the mean CTDIvol (volume computed tomography dose index) was also higher in anaesthetised patients at 13.56 ± 2.34 mGy, as compared to 11.89 ± 2.08 mGy in the non-anaesthetised group ($p = 0.004$). These findings suggest that patient movement control via anaesthesia, while ensuring image acquisition, may inadvertently lead to increased scan duration or repeated acquisitions, resulting in higher radiation doses.

Table 4: Image Quality Acceptability

Despite the differences in radiation exposure, image quality was rated as acceptable in 100.00% of scans in both groups. There were no cases of unacceptable image quality recorded in either the anaesthetised or non-anaesthetised patients. As there was no variation in outcomes, statistical analysis was not applicable. This highlights that standardised scanning protocols and machine settings were effective in achieving diagnostically acceptable images across both patient groups regardless of consciousness level.

Table 5: Mean Scan Duration

The scan duration was significantly longer in anaesthetised patients compared to their non-anaesthetised counterparts. The average scan time for anaesthetised patients was 7.85 ± 1.24 minutes, whereas for non-anaesthetised patients it was significantly lower at 5.42 ± 0.98 minutes ($p < 0.001$). The prolonged scan time in anaesthetised patients could be attributed to the logistical complexities of managing anaesthesia, patient positioning, ventilator adjustments, or repeat scans in certain cases. This finding may also partly explain the higher radiation exposure observed in this group.

Table 1: Demographic Profile of Patients

Variable	Anaesthetised Group (n=40)	Non-Anaesthetised Group (n=40)	p -value
Mean Age (years)	45.63 ± 12.45	47.18 ± 11.67	0.517
Male (%)	26 (65.00%)	24 (60.00%)	0.648
Female (%)	14 (35.00%)	16 (40.00%)	0.648
BMI (kg/m ²)	24.12 ± 2.36	23.98 ± 2.41	0.719

Table 2: Scan Region Distribution

Scan Region	Anaesthetised (n=40)	Non-Anaesthetised (n=40)	p -value
Brain	18 (45.00%)	10 (25.00%)	0.046
Chest	8 (20.00%)	10 (25.00%)	0.592
Abdomen	10 (25.00%)	14 (35.00%)	0.309

Spine	4 (10.00%)	6 (15.00%)	0.488
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Table 3: Comparison of Radiation Exposure (DLP and CTDIvol)

Radiation Parameter	Anaesthetised (Mean \pm SD)	Non-Anaesthetised (Mean \pm SD)	p-value
DLP (mGy·cm)	812.45 \pm 140.32	698.78 \pm 128.56	0.001
CTDIvol (mGy)	13.56 \pm 2.34	11.89 \pm 2.08	0.004

Table 4: Image Quality Acceptability

Image Quality	Anaesthetised Group (n=40)	Non-Anaesthetised Group (n=40)
Acceptable	40 (100.00%)	40 (100.00%)
Unacceptable	0 (0.00%)	0 (0.00%)

Table 5: Mean Scan Duration

Parameter	Anaesthetised Group (n=40)	Non-Anaesthetised Group (n=40)	p-value
Scan Duration (min)	7.85 \pm 1.24	5.42 \pm 0.98	<0.001

DISCUSSION

The demographic comparability between anaesthetised and non-anaesthetised patients in this study reflects a well-matched cohort, eliminating potential confounding variables such as age, gender, or BMI. These findings are consistent with the results reported by Huda et al. (2010), who also demonstrated that patient demographic characteristics, including age and body habitus, did not significantly influence radiation dose in standardised CT protocols when stratified across controlled study groups. Their study included adult patients with a similar BMI range, where radiation dose differences were attributed more to procedural factors than patient demographics⁹.

In terms of scan region distribution, this study observed a statistically significant predominance of brain CTs in the anaesthetised group (45.00%) compared to the non-anaesthetised group (25.00%), indicating that neurological indications are a frequent cause for scanning under anaesthesia. This is in agreement with the observations by Frush et al. (2002), who found that neuroimaging, especially in less cooperative patients (including paediatric or cognitively impaired adults), was more likely to necessitate sedation or anaesthesia. Their study emphasized the higher likelihood of brain imaging in patients requiring immobilization during high-resolution CT acquisition¹⁰.

The higher radiation exposure in the anaesthetised group observed in the present study (DLP: 812.45 \pm 140.32 mGy·cm; CTDIvol: 13.56 \pm 2.34 mGy) compared to the non-anaesthetised group (DLP: 698.78 \pm 128.56 mGy·cm; CTDIvol: 11.89 \pm 2.08 mGy) aligns with findings reported by Kalra et al. (2004). They noted that immobilization methods such as sedation or anaesthesia can inadvertently lead to multiple scan repetitions or protocol adjustments, especially in head and spine imaging, thereby increasing radiation exposure even in the context of protocol standardisation¹¹.

Notably, this study reported 100.00% image quality acceptability in both groups, underscoring the efficacy of consistent scanning protocols. This is supported by the study by Mettler et al. (2008), which demonstrated

that image quality could be reliably maintained across varying patient conditions when institutional scanning protocols and experienced radiology staff were in place. Despite variations in patient cooperation, the application of established scanning parameters ensured diagnostically useful imaging without compromise¹².

The mean scan duration was significantly longer in anaesthetised patients (7.85 \pm 1.24 minutes) than in non-anaesthetised patients (5.42 \pm 0.98 minutes), a finding that mirrors the observations of Donnelly et al. (2001). Their study, conducted in a paediatric cohort but relevant in procedural terms, demonstrated that preparation time and scan execution in sedated patients tend to be prolonged due to the need for airway management, monitoring setup, and adjustment for involuntary movements—even if image acquisition time remains brief¹³.

Although longer scan durations are often viewed as a consequence of anaesthesia-related logistical delays, they can indirectly impact radiation exposure. Smith et al. (2003) suggested that extended scan times may increase the likelihood of repeat acquisitions due to transient artefacts, thereby raising the radiation burden. In this context, the higher scan duration in the anaesthetised group in the current study potentially contributed to their significantly elevated DLP and CTDIvol values¹⁴.

Interestingly, despite elevated radiation parameters and scan durations, the absence of any unacceptable image quality in this study correlates with findings by McCollough et al. (2005), who concluded that patient motion was a more significant determinant of image degradation than modest increases in radiation dose. In their investigation, scans performed under controlled or immobilised conditions—even at higher exposure levels—yielded superior image clarity than low-dose scans with motion artefacts, affirming the trade-off between dose and diagnostic utility¹⁵.

CONCLUSION

In conclusion, this study demonstrated that anaesthetised patients undergoing CT scans are exposed to significantly higher radiation doses and

longer scan durations compared to non-anaesthetised patients. Despite these differences, image quality remained uniformly acceptable in both groups. The increased exposure in anaesthetised patients may be attributed to procedural complexities and the need for enhanced immobilisation. These findings highlight the importance of optimising scan protocols and minimising dose, especially in vulnerable or uncooperative populations.

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