Evaluation of Dose-Length Product in Head Ct Using Multi-Detector Computed Tomography

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Abstract

Background: Computed Tomography (CT) is one of the most widely used imaging modalities but contributes significantly to patient radiation exposure. Multi-Detector CT (MDCT) has improved diagnostic accuracy and speed but also raised concerns about increased radiation doses. Dose-Length Product (DLP) is a key parameter for evaluating overall radiation burden in CT.

Keywords: Computed Tomography (CT), Multi-Detector CT (MDCT), Dose-Length Product (DLP), CTDIvol, Effective Dose, Diagnostic Reference Levels (DRLs), Automatic Exposure Control (AEC), Radiation Safety, Optimization, ALARA Principle.

Introduction

Computed Tomography (CT) has revolutionized diagnostic imaging but is also a major contributor to medical radiation exposure. The introduction of Multi-Detector Computed Tomography (MDCT) has enhanced image quality and speed but resulted in higher patient doses. Monitoring dose metrics is crucial to balance diagnostic benefit and radiation risk.

Dose-Length Product (DLP) is a key parameter for quantifying total radiation exposure during CT. It combines the CT Dose Index volume (CTDIvol) with the scan length, expressed in mGy·cm. This allows estimation of patient radiation burden and supports comparison with Diagnostic Reference Levels (DRLs). Effective Dose (ED), derived from DLP using conversion factors, reflects the stochastic risks of cancer and hereditary effects.

Variations in CT protocols, patient size, scanner models, and operator practices lead to significant differences in DLP values. Previous studies report up to a sevenfold variation for the same examination across centers. Thus, optimizing protocols and evaluating DLP in routine CT examinations is essential to ensure patient safety and compliance with the ALARA principle.

Aim and Objectives:

Aim: To evaluate Dose-Length Product (DLP) in Head CT using Multi-Detector Computed Tomography (MDCT).

Objectives:

1. To compare DLP values across different patients and age groups.
2. To assess the influence of scan protocols on radiation exposure.
3. To suggest optimization strategies for minimizing radiation dose.

Methodology:

This prospective survey study was conducted at Santosh Hospital, Ghaziabad. A total of 289 patients (both genders, aged 6–70 years) undergoing routine Head CT scans using MDCT were included.

Inclusion criteria:

- Patients referred for CT Head with suspected intracranial pathology, trauma, or neurological symptoms.
- Patients with complete scan range of the head region.

Exclusion criteria:

- Patients with metallic implants near the head.
- Cases with incomplete scan coverage.
- Dual-energy CT examinations.

Data collection:

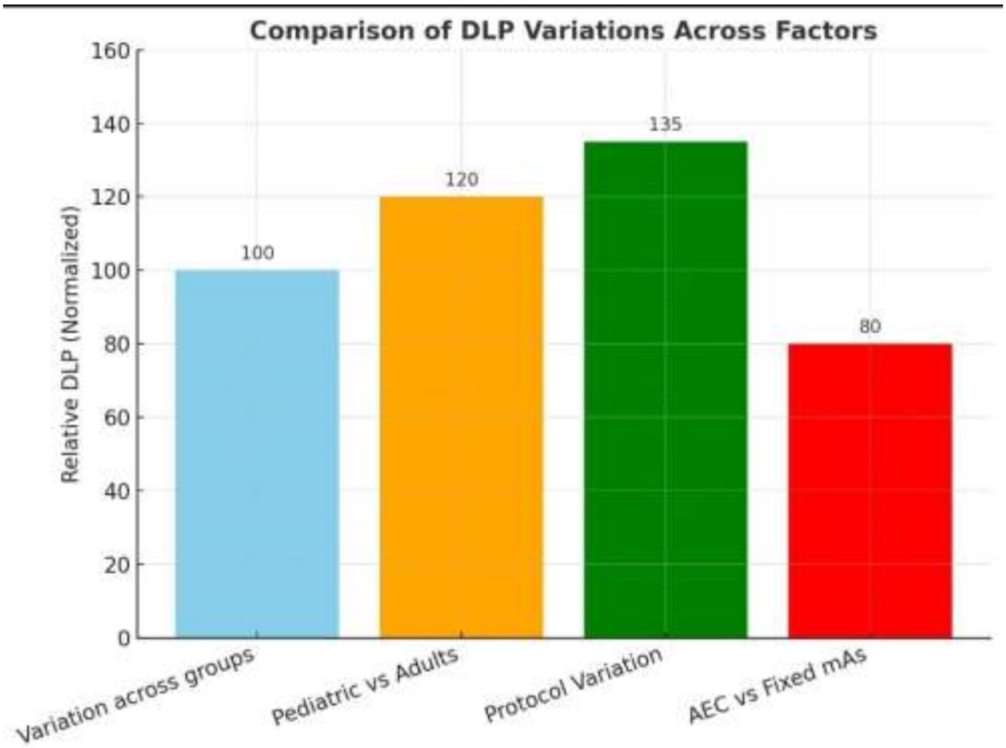
- Patient age, gender, and scan parameters were recorded.
- CTDIvol and DLP were extracted from scanner dose reports.
- DLP values were stratified by age and compared across groups.

Statistical analysis:

- Descriptive statistics were applied.
- Mean ± SD values were calculated for DLP across groups.

Result:

1. Average DLP values varied widely across patient groups.
2. Pediatric patients demonstrated higher DLP per unit body size compared to adults.
3. Variations of up to 30–40% in DLP were noted between scans of similar clinical indications, largely due to differences in tube current (mAs), scan length, and operator-selected protocols.
4. Automatic Exposure Control (AEC) demonstrated a 15–25% reduction in DLP compared to fixed mAs protocols.



Discussion:

The findings indicate significant variability in DLP values for Head CT, consistent with previous studies. This underlines the need for:

1. Protocol standardization across institutions.
2. Adoption of Automatic Exposure Control (AEC) and dose-saving algorithms.
3. Use of age- and size-specific reference levels to avoid unnecessary exposure, especially in pediatric patients.

DLP, while useful, has limitations as it does not directly measure organ dose or account for patient anatomy. However, when combined with region-specific conversion factors, it provides a reliable estimate of effective dose and supports dose optimization initiatives.

Conclusion:

Head CT using MDCT shows notable variation in DLP across patients and protocols. Regular monitoring of DLP and comparison with DRLs are essential for radiation safety. Optimization strategies such as protocol tailoring, AEC, and iterative reconstruction can significantly reduce patient dose while maintaining diagnostic quality.

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