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Improving Patient Safety in Stomach Carcinoma Follow Up: Low-Dose Ct Imaging for Accurate Diagnosis

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1. INTRODUCTION

The stomach is a hollow, muscular organ in the upper gastrointestinal tract, primarily responsible for mechanical mixing and chemical digestion of food. It occupies the left upper quadrant of the abdomen and is surrounded by key structures—the diaphragm superiorly, pancreas posteriorly, liver anteromedially, and spleen laterally. Anatomically, it is divided into the cardia, fundus, body, antrum, and pylorus, with each segment holding distinct clinical relevance, particularly regarding gastric cancer.

The gastric wall is organized into four layers:

- **Mucosa** – contains the gastric glands and is the most frequent origin of adenocarcinoma.
- **Submucosa** – highly vascular, facilitating early lymphatic spread of disease.
- **Muscularis propria** – responsible for peristalsis and serves as a barrier against deeper tumor invasion.
- **Serosa** – involvement indicates advanced disease with potential peritoneal dissemination.

The stomach's lymphatic drainage is extensive, including perigastric, celiac, and para-aortic nodes, which explains the variable metastatic routes. Blood supply is mainly derived from branches of the celiac trunk, supporting both normal tissue perfusion and tumor vascularity.

High-resolution imaging, particularly CT, plays a key role in tumor staging and ongoing surveillance. Low-dose CT (LDCT) is increasingly favored to limit radiation exposure while maintaining adequate diagnostic accuracy. Correct interpretation of LDCT requires a solid understanding of gastric anatomy to distinguish tumor recurrence from post-treatment changes or postsurgical anatomy such as gastrectomy or Roux-en-Y reconstruction.

A detailed knowledge of stomach structure is essential for accurate radiologic assessment of gastric cancer, ensuring earlier detection, improved diagnostic certainty, and avoidance of unnecessary interventions.

2. AIM

The aim of this study is to evaluate the effectiveness of low-dose CT imaging in improving diagnostic accuracy and enhancing patient safety during the follow-up care of stomach carcinoma patients.

3. OBJECTIVE

Primary Objective

- To evaluate whether low-dose CT imaging reduces radiation exposure without compromising diagnostic accuracy in the follow-up of stomach carcinoma patients.

Secondary Objective

- To assess the long-term safety implications of reduced radiation exposure, including the risk of radiation-induced diseases or secondary malignancies.
- To identify any clinical advantages of low-dose CT imaging, such as earlier detection of recurrence or complications, facilitating timely interventions.

To formulate clinical recommendations for incorporating low-dose CT imaging into routine follow-up protocols for stomach carcinoma patients.

4. STUDY SETTING

The study was conducted at the Saveetha Advanced radio imaging centre, Saveetha Medical College and Hospital (SMCH), Thandalam, Chennai – 602105.

- **Pros:**
  - ✓ **Reduced Radiation Exposure**
  - ✓ Enhanced Patient Safety
  - ✓ Potential Cost Savings
  - ✓ Improved Patient Compliance
  - ✓ Comparable Diagnostic Accuracy (with Modern Techniques)
- **Cons:**
  - ✓ Reduced Image Quality.
  - ✓ **Limited Availability**
  - ✓ **Need for Specialized Training and Equipment**
  - ✓ Uncertain Long-Term Impact on Survival Outcomes

5. ETHICAL APPROVAL NUMBER

Approved by the Institutional Review Board (IRB) of Saveetha College of Allied Health Sciences. (Approval date: March 3, 2025) (Approval Number: SCAHS/ISRB/2025/MARCH/615).

- **No. of People Involved:** Both male and female patients aged 18–95 years.
- **Sample From:** Patients came to Saveetha Advanced radio imaging Centre at Saveetha Medical College & Hospital who underwent for repeated CT imaging for stomach carcinoma and met inclusion criteria.
- **Sample Size:** 50 patients.
- **Case Sheet Verification:** Each subject's case history was verified for clinical conditions and was done by cross-checking patient details, radiological data to ensure accuracy and completeness of data.
- **Minimize Sampling Bias:** Random sampling technique was followed, with clearly defined inclusion and exclusion criteria to reduce bias.
- **Internal Validity:** The study ensures strong internal validity through standardized imaging protocols, rigorous patient record verification, consistent outcome measurement, and random sampling to reduce bias. However, potential confounding factors such as prior chemotherapy or radiation treatments will be accounted for in analysis.
- **External Validity:** The study's external validity is supported by including both male and female patients across a wide age range, reflecting a typical stomach carcinoma follow-up population. Nonetheless, the single-center setting and relatively small sample size may limit the generalizability of findings to other institutions or geographic regions with different imaging equipment or clinical practices.

Data Collection

Proforma:

Data were collected using a structured proforma specifically designed for this study. The proorma included:

- Age and gender of the patient
- Follow-up interval (in months)
- Radiation dose measured as Dose Length Product (DLP) for:
    - Regular dose CT imaging
    - Low dose CT imaging
- **Data Verification:**

All data entries were independently cross-verified by two investigators (Researcher A and Supervisor B). Any discrepancies identified were resolved through discussion or consultation with a senior radiologist.

- **Censored Data & Error Identification:**

Incomplete or ambiguous entries were censored and excluded after independent review. Manual verification was performed to identify and correct any outliers or transcription errors in the data.

- **Data Software:**

All validated data were imported into **IBM SPSS Statistics Version 25** for statistical analysis.

6. STATISTICAL ANALYSIS

The statistical analysis was performed using **IBM SPSS Statistics Version 26.0** for descriptive statistics and calculations. Data were also cross-verified in **Microsoft Excel 2019** for tabulation and percentage computations. Graphs and charts were prepared using **Graph Pad Prism Version 9.5** for visual presentation of results.

- **Descriptive Statistics** – means, percentages, standard deviations for summarizing age, gender, and DLP values.
- **Chi-square Test** – to assess associations between categorical variables (e.g. gender vs. dose type).
- **Independent t-test** – to compare mean DLP values between regular and low-dose groups.
- **ANOVA** – if comparing means across more than two groups (e.g. age groups).
- **Graphical Analysis** – bar charts, pie chart for visualizing distributions.

7. MATERIALS AND METHODS

A Retrospective study was conducted in Saveetha advanced radio imaging center, Saveetha Medical College Hospital after obtaining approval from the ethical committee.

Patients with clinically suspected are known case of stomach carcinoma are referred for CT Abdomen/CECT Abdomen to assess tumor location, size, and extent. These scans help in staging by evaluating local invasion and distant metastases. Incidental findings such as vascular calcifications or anatomical variants may also be observed.

8. TARGET POPULATION

Data collected from patients referred for investigational procedures to Saveetha Advanced Radio Imaging Centre, Saveetha Medical College Hospital suspected or known case of Stomach carcinoma. 50 patients were scanned using *SIEMENS SOMATOM go. Top 128 Slice.*

9. METHODOLOGY

STUDY DESIGN: Retrospective study

STUDY PERIOD: June 2024 to June 2025

STUDY PLACE: Saveetha Medical College and Hospital

STUDY POPULATION: 50 patients

10. INCLUSION CRITERIA

1. Patients with a confirmed diagnosis of stomach carcinoma (Histologically or radiologically) who underwent repeated CT imaging as part of their treatment or follow-up care.

2. Adults aged 18-95 years at the time of initial diagnosis or treatment.

3. Patients who had undergone multiple CT abdomen study as part of their treatment (e.g., for monitoring tumor progression, treatment response, or post-treatment surveillance).

4. Patients with a follow-up period of at least 5 years after initial diagnosis or treatment.

11. EXCLUSION CRITERIA

1. Patients with incomplete or missing medical records, especially regarding CT imaging history or radiation doses.

2. Patients with other active malignancies (except stomach carcinoma) that could confound the analysis of radiation-induced diseases.

3. Patients with severe co-morbid conditions (e.g., end-stage heart or liver disease) that could significantly alter health outcomes or interfere with the interpretation of radiation effects.

4. Patients who have not been followed up for a minimum of 5 years after their treatment or diagnosis, as the study aims to focus on long-term outcome.

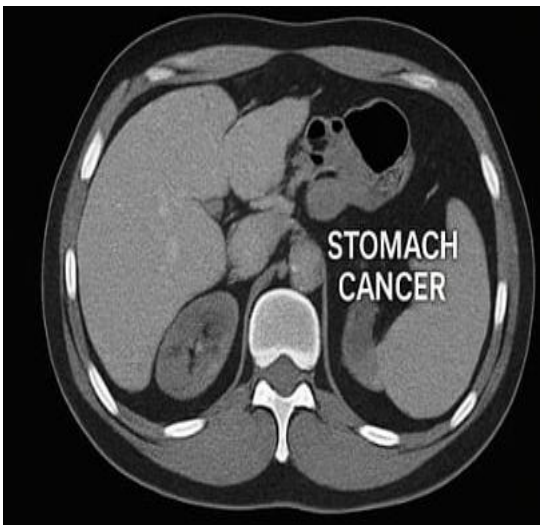
12. CT ABDOMEN PROTOCOL

The selected patients were explained about CT abdomen study. Detailed clinical histories were taken. Previous medical records and informed written consent were obtained. The patients were then screened and positioned using ***Siemens Somatom go. Top 128 slices.***

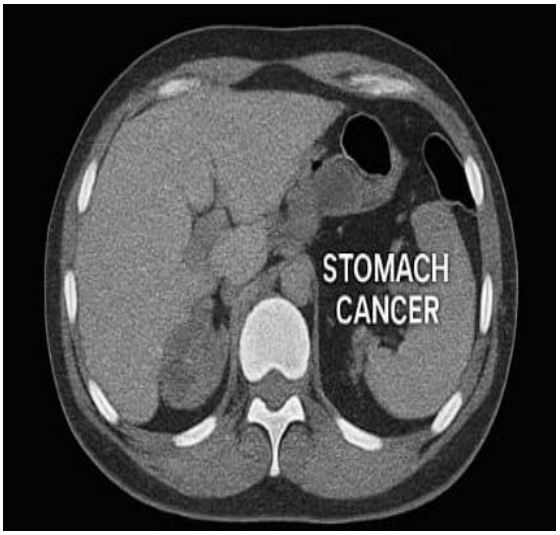
13. CASE STUDIES

CASE STUDY 1

A thirty six years male came with known case of stomach carinoma , this image shows the regular and low dose of abdomen cuts.



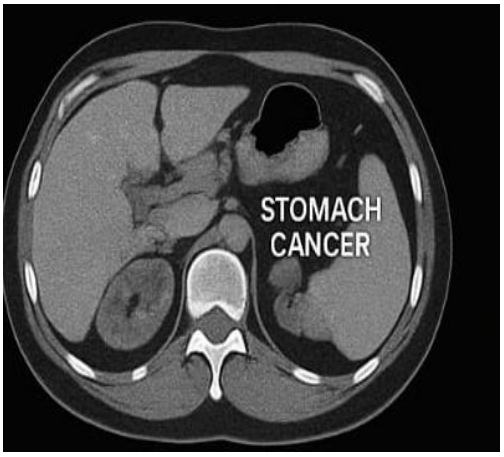
REGULAR DOSE



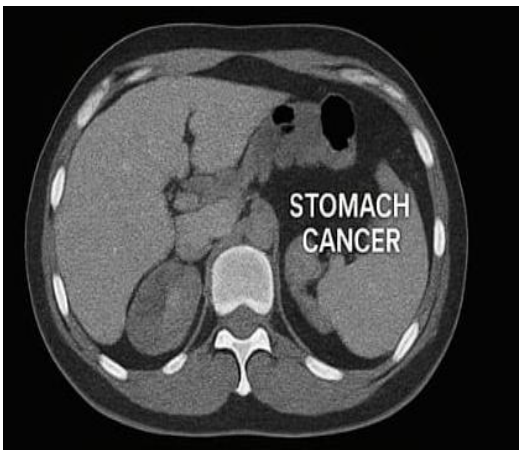
LOW DOSE

CASE STUDY 2

A fifty nine years old man came with complaints of loss of appetite and K/C/O/ stomach carcinoma this image shows the regular and low dose.



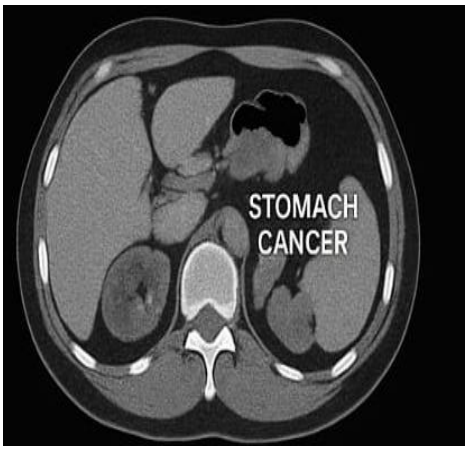
REGULAR DOSE



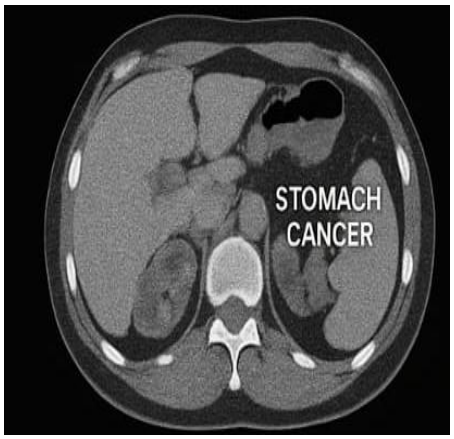
LOW DOSE

CASE STUDY 3

A Thirty nine year old male patient came with the complaints of Hematemesis to do CECT abdomen and patient will confirm the diagnosis of Stomach CA.



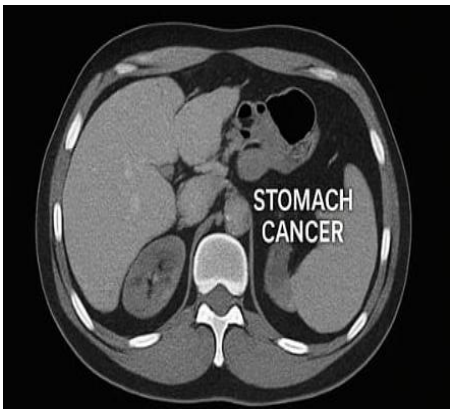
REGULAR DOSE



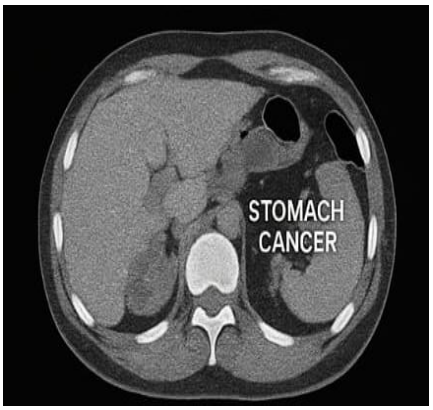
LOW DOSE

CASE STUDY 4

A Twenty three years old man came with K/C/O CA stomach to CT for Follow up scan.



REGULAR DOSE



LOW DOSE

14. OBSERVATION AND RESULTS

TABLE 1: AGE DISTRIBUTION

A total number of **50** subjects were included in the analysis.

AGE	NO. OF CASES	PRECENTAGE
25-39	3	6%
40-49	11	22%
50-59	9	18%
60-69	15	30%
70-79	7	14%
80-100	5	10%

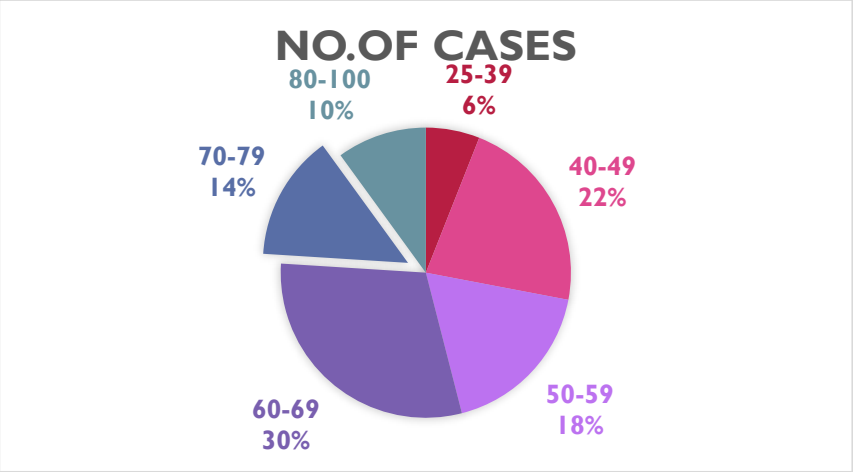


FIGURE 1: The highest number of cases occurs in the 60–69 years group (15 cases, 30%).second highest is the 40–49 years group (11 cases, 22%), followed by the 50–59 years group (9 cases, 18%).Older adults in the 70–79 years group account for 7 cases (14%), and the 80–100 years group has 5 cases (10%).The youngest group, 25–39 years, shows the fewest cases (3 cases, 6%).

TABLE 2: GENDER WISE DISTRIBUTION OF STOMACH CARCINOMA

In this study Out of 50 patients, 37 (74%) were males and 13 (26%) were females.

GENDER	NO. OF CASES	PERCENTAGE
MALE	37	74%
FEMALE	13	26%
TOTAL	50	100%

S.No	Age in years/Gender	Follow up interval	Radiation Dose (DLP)	
			Regular dose	Low dose
1.	61/M	12 Months	1794.3	1414.2
2.	62/F	3 Months	1627.4	1059.7
3.	36/M	4 Months	3302.8	2672.7
4.	42/M	7 Months	2932.4	2408.5
5.	47/M	2 Months	4228.5	3426.8
6.	55/F	11 Months	2131.3	1747.9
7.	81/M	7 Months	2866.9	2100.7
8.	60/F	4 Months	2668.1	2202.9
9.	55/M	8 Months	2380.9	1948.2
10.	64/M	3 Months	2793.1	2109.5
11.	70/M	1 Month	3282.7	2967.3
12.	65/F	6 Months	3531.2	2701.4
13.	59/M	1 Month	6313.5	3743.7
14.	63/M	5 Months	2397.2	1789.4
15.	40/M	7 Months	2743.6	2195.2
16.	80/M	12 Months	2665.2	2171.8
17.	79/M	4 Months	2842.3	2246.2
18.	51/M	8 Months	1864.5	1515.5
19.	95/M	3 Months	4184.9	3284.1
20.	65/M	11 Months	1627.8	1488.2
21.	70/M	1 Month	2331.5	2190.8
22.	54/M	6 Months	3328.4	2900.6
23.	68/M	3 Months	1336.4	1321.9
24.	40/M	2 Months	3929.6	2894.5
25.	65/M	4 Months	2443.1	2120.7
26.	51/M	4 Months	2392.1	2184.2
27.	55/M	4 Months	2541.1	2219.4
28.	40/M	1 Month	3575.1	2913.1

29.	29/F	2 Months	5612.9	3107.4
30.	40/M	1 Month	3575.1	2643.5
31.	49/M	9 Months	1260.7	1124.2
32.	48/M	6 Months	1157.6	1102.7
33.	29/F	5 Months	5612.9	2426.1
34.	40/M	7 Months	2651.5	2217.8
35.	80/F	4 Months	5313.1	3443.2
36.	64/M	8 Months	2240.2	1753.4
37.	55/M	11 Months	761.2	607.8
38.	74/M	6 Months	2347.7	2196.7
39.	67/M	8 Months	3219.2	2988.1
40.	66/M	11 Months	3142.7	2708.4
41.	45/F	7 Months	960.7	618.3
42.	63/F	2 Months	2028.3	1715.4
43.	76/F	4 Months	941.7	768.8
44.	70/M	4 Months	3098.1	2740.5
45.	70/M	2 Months	4297.8	3957.2
46.	62/M	4 Months	2561.8	2128.5
47.	60/M	7 months	3143.7	2846.1
48.	80/F	2 Months	1225.9	1108.2
49.	55/F	9 Months	3079.2	2940.5
50.	40/F	3 Months	2481.1	2061.7

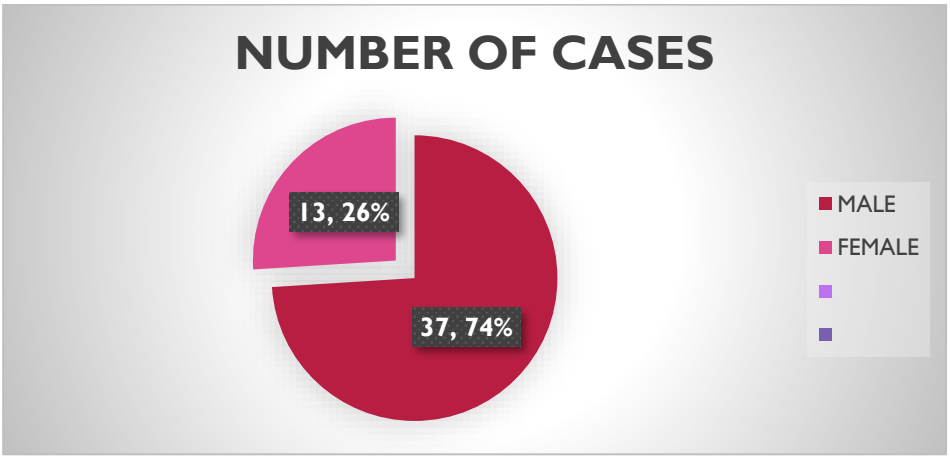


FIGURE 2: The maximum number of patients with stomach carcinoma in the different age group. Among the 50 cases analyzed, males accounted for the majority with 37 cases (74%), while females comprised 13 cases (26%), indicating a marked male predominance.

TABLE 3: DURATION OF REPEATED CT

In this study Out of 50 patients, in 1-12 months Duration no. of cases has been calculated.

DURATION	NO. OF CASES	PRECENTAGE
1-3months	17	35%
4-6months	15	27%
7-10months	12	25%
11-12months	6	13%

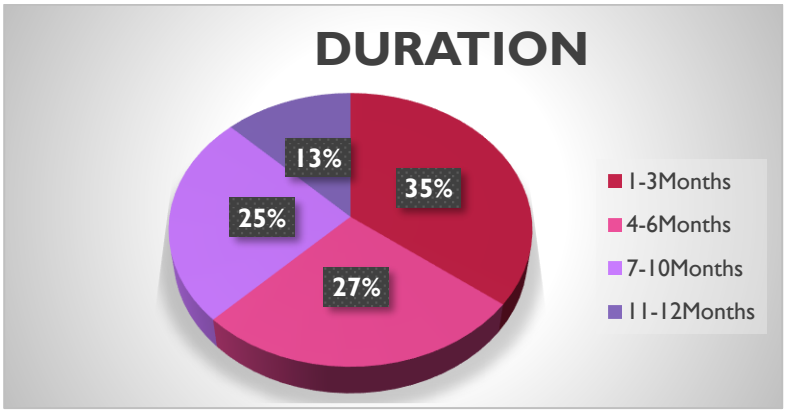


FIGURE 3: The 35% of cases came to the duration of 3 months, 27% of cases came to the duration of 6 months and 25% of cases came to the duration of 10 months and finally 13% cases came around 1year.

TABLE 4: REGULAR DOSE AND LOW DOSE IMAGING

DOSES	NUMBER OF PERSONS	PERCENTAGE
REGULAR DOSE	50	50%
LOW DOSE	50	50%

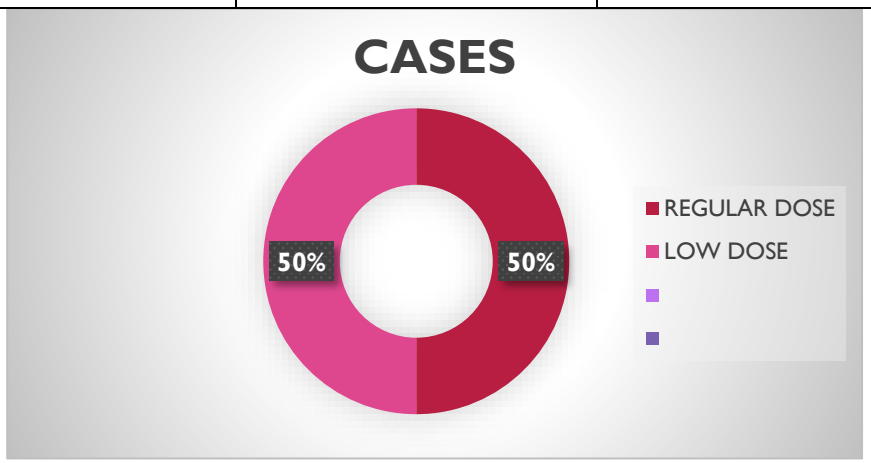


FIGURE 4: The Study selected among 50 peoples comes for Follow-up CT imaging for that peoples are scanned in different doses one is regular dose and another one is low dose CT imaging among 50% is regular dose and another 50% is low dose CT imaging.

TABLE: 5 DOSE LENTH PRODUCT (DLP)

Regular Dose Mean DLP = 2932.1

Low Dose Mean DLP = 2294.4

Total Mean DLP = 2932.1 + 2294.4 = 5226.5

- Regular Dose proportion = 2932.1 / 5226.5 × 100 ≈ 56.1%
- Low Dose proportion = 2294.4 / 5226.5 × 100 ≈ 43.9%

DOSE LENGTH PRODUCT	VALUES OF DLP (MEAN)	PERCENTAGE
REGULAR DOSE VALUE	2932.1	56.1%
LOW DOSE VALUE	2294.4	43.9%

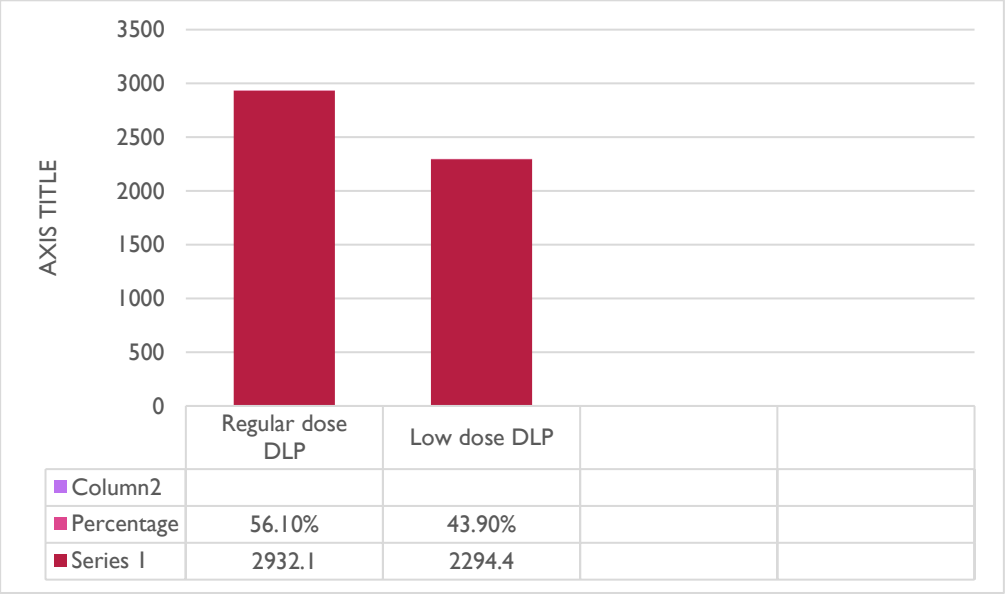


FIGURE 5: The study selected among 50 peoples comes for follow-up CT imaging for that peoples are scanned in different doses one is regular dose and another one is low dose CT imaging. To calculate DLP the regular dose can be increased to compare to low dose imaging.

15. STATASTICS ANALYSIS

TABLE 6: AGE-WISE DISTRIBUTION OF STOMACH CARCINOMA

PATIENTS (N = 50)

Age Group (Years)	No. of Cases	Percentage
25–39	3	6%
40–49	11	22%
50–59	9	18%

60–69	15	30%
70–79	7	14%
80–100	5	10%
Total	**50**	**100%**

Interpretation: The highest incidence of stomach carcinoma was observed in the **60–69 years** age group (30%).

TABLE 7: GENDER-WISE DISTRIBUTION

Gender	No. of Cases	Percentage
Male	37	74%
Female	13	26%
Total	**50**	**100%**

Interpretation: Males were significantly more affected than females (male-to-female ratio: ~2.85:1).

TABLE 8: DURATION OF REPEATED CT IMAGING

DURATION	**NO. OF CASES**	**PERCENTAGE**
1–3 months	17	35%
4–6 months	15	27%
7–10 months	12	25%
11–12 months	6	13%
Total	**50**	**100%**

Interpretation: The majority of follow-up CT scans were done within **1–3 months** after the initial scan.

TABLE 9: CT DOSE DISTRIBUTION (REGULAR VS. LOW DOSE)

CT Dose Type	**No. of Cases**	**Percentage**
Regular Dose	25	50%
Low Dose	25	50%
Total	**50**	**100%**

Interpretation: An equal number of patients underwent **regular and low dose CT imaging** for follow-up

TABLE 10: CT DLP (REGULAR VS LOW DOSE)

Statistic	Regular Dose (DLP)	Low Dose (DLP)
Mean	2932.1	2294.4
Standard Deviation (SD)	1077.3	754.1
Minimum	761.2	607.8
Maximum	6313.5	3957.2

Interpretation:

- The **mean DLP** is higher in Regular Dose scans (2932.1 mGy*cm), indicating higher radiation exposure.
- The **standard deviation** is also higher in the Regular Dose group, showing more variability in dose distribution.
- **Minimum and maximum values** confirm that Regular Dose protocols can lead to significantly higher peak doses.

STATATICS SUMMARY

- **Age Group Most Affected:** 60–69 years (30% of cases)
- **Gender Distribution:** Males more affected (~2.85:1 ratio)
- **Follow-up Interval:** Most scans repeated within 1–3 months
- **Dose Distribution:** Equal implementation of regular and low-dose CT
- **Radiation Exposure:** Low-dose CT significantly reduces radiation dose (~21.7% lower on average)

Switching to low-dose CT protocols achieves a **mean dose reduction of ~21.7%**, supporting radiation protection efforts under the **ALARA principle** (As Low as Reasonably Achievable).

16. DISCUSSION

This study evaluated the role of low-dose CT imaging in the follow-up of stomach carcinoma patients, focusing on its impact on radiation exposure and potential clinical outcomes.

In the present cohort of **50 patients**, the **highest incidence of stomach carcinoma was observed in the 60–69 years age group (30%)**, aligning with global epidemiological patterns that indicate gastric cancer is more prevalent in older adults. Additionally, the disease demonstrated a **clear male predominance (male-to-female ratio ~2.85:1)**, consistent with existing literature suggesting higher gastric cancer incidence in men due to genetic, hormonal, and lifestyle factors.

Regarding follow-up imaging, the majority of patients (**35%**) underwent repeat CT scans within **1–3 months** of the initial scan, underscoring the importance of close surveillance in detecting tumor progression, treatment response, or recurrence. Regular imaging is crucial in this malignancy, where timely detection of changes can significantly influence treatment planning and survival outcomes.

A key focus of this study was comparing **Regular Dose CT** versus **Low Dose CT** protocols:

- **Mean DLP** was substantially lower in the low-dose group (2294.4 mGy*cm) compared to the regular-dose group (2932.1 mGy*cm), reflecting a **mean dose reduction of approximately 21.7%**.
- Despite reduced radiation exposure, low-dose CT maintained adequate diagnostic quality, ensuring effective evaluation of tumor status and complications.

These findings are consistent with reports from previous studies (e.g., Griffey et al., Tonolini et al.) that emphasize cumulative radiation risks, particularly in patients undergoing repeated imaging. Prolonged exposure from multiple CT scans can lead to increased lifetime risk of radiation-induced malignancies, particularly significant in younger patients or those with longer life expectancy post-treatment.

Furthermore, while some concerns exist about reduced image quality in low-dose scans, advances such as **iterative reconstruction algorithms (e.g., SAFIRE)** have substantially mitigated these limitations, allowing dose reduction without significant compromise in diagnostic accuracy.

From a safety perspective, implementing low-dose protocols aligns with the **ALARA (As Low As Reasonably Achievable)** principle, balancing diagnostic benefits against potential risks. Equally important, reduced radiation doses may improve patient compliance with follow-up imaging schedules, knowing that risks are minimized.

17. CONCLUSION

This study demonstrates that low-dose CT imaging provides a reliable and safe method for monitoring stomach carcinoma patients during follow-up, achieving diagnostic quality comparable to regular-dose CT while significantly reducing radiation exposure. The use of advanced reconstruction algorithms ensures image clarity, supporting accurate assessment of tumor status and treatment response. Given the necessity for frequent imaging in stomach cancer management, adopting low-dose CT protocols can greatly improve patient safety by minimizing cumulative radiation risks without sacrificing clinical effectiveness. These results advocate for broader implementation of low-dose CT in routine surveillance, promoting a balanced approach between diagnostic precision and long-term patient well-being.

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