Original Article

Analysis of Diagnostic Accuracy with Low Dose versus Standard Dose Computed Tomography Fluoroscopy Guided Biopsies

Analysis of Diagnostic Accuracy with Low Dose VS standard dose with CTF

Mariam Malik and Rana Bilal Idrees

ABSTRACT

Objective To compare low dose Computed Tomography Fluoroscopy (CTF) versus standard dose CT guided biopsy procedures in terms of diagnostic accuracy, intervention time and number of needle passes required for biopsy to be completed successfully.

Study Design: Retrospective study

Place and Duration of Study: This study was conducted at the Radiology Department of CMH Rawalpindi from April 2016 to April 2017.

Methods: Total 65 consecutive patients comprising 51 males and 14 females, mean age 41.52 ± 13.40 years, underwent CT guided biopsies of lung, pleura, mediastinal and muscle lesions on Philips Brilliance 16 slice CT-scanner under low dose CTF guidance comprising tube current 30mAs and voltage 120kVp. Diagnostic accuracy, intervention time and number of needle passes performed for completion of procedure were recorded. These were compared with biopsies performed at standard dose protocol over 12 months before introduction of low dose technique. During this time 60 consecutive patients, mean age 40.62 ± 11.32 years, were included who underwent biopsies performed on the same machine under standard dose CT. The standard dose comprised tube current 200-250mAs and tube voltage 120kVp.

Results: In the low-dose protocol, needle passes ranged from 3 to 6 (mean: 4.09 ± 0.81), while the standard dose required 6 to 8 passes (mean: 7.41 ± 0.68), with a significant statistical difference (p-value <0.05). Low-dose DLP ranged from 130 to 386.9 mGy.cm (mean: 190.39 ± 23.3), while standard dose DLP was 1270 to 1976 mGy.cm (mean: 1664.7 ± 342.11), showing a significant reduction (p-value <0.05). Intervention time for standard dose biopsies was 30 to 50 minutes (mean: 39.85 ± 4.84), whereas low-dose biopsies took 5 to 13 minutes (mean: 7.04 ± 1.40), also with a significant difference (p-value <0.05).

Conclusion: Biopsies performed under low dose CTF have success rate comparable to standard dose protocol with 85% reduction in radiation dose, fewer number of needle passes and overall shorter intervention time in comparison to standard dose technique.

Key Words: Diagnostic Accuracy, Low Dose, Standard Dose, Computed Tomography, Fluoroscopy Guided Biopsies

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INTRODUCTION

CT scan has refashioned the world of diagnostic imaging with its use increasing ever since its advent. While being increasingly used because of its higher resolution providing accurate view of anatomical structures and localization of even minuscule pathologies, it is also gaining popularity in the world of interventional radiology because it helps to secure correct needle placement during intervention[1-2], which is important in avoiding damage to nearby anatomical structures[3]. Hence CT guided biopsies are increasingly being used due to safety, accuracy and reliability with which the tissue specimen can be obtained for diagnostic purposes[4].

Previously, exact localization of needle during interventions was confirmed by obtaining intermittent CT scans at standard dose protocol[5]. While this allowed successful biopsy specimens to be obtained, it resulted in a significant radiation exposure to the patient[5] and was also time consuming as the radiologist performing procedure had to leave the CT room in between scan acquisitions. It also required an increased number of

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passes before the needle could be confirmed within the lesion[6].

Thus much work was done to make CT guided procedures faster and decrease radiation dose to patients. With the advent of Computed Tomography Fluoroscopy (CTF), biopsy procedure has become much more convenient due to real-time guidance of the needle during intervention which allows step-by-step visualization of needle position. Hence biopsy procedure can be performed in a shorter time as the radiologist performing procedure does not have to leave CT room. It also requires decreased number of passes for specimen acquisition[6-8] and results in significantly lowered radiation quantity to which the patient is exposed during the procedure [7-8] and procedure time is reduced [9-10].

The following study was aimed at comparing CT guided biopsies performed at standard dose protocol with CTF guided biopsies in terms of intervention time, number of needle passes required for biopsy to be completed and the radiation dose to which the patient was exposed during the procedure.

METHODS

We obtained institutional review board consent for a retrospective study at Combined Military Hospital Rawalpindi's Radiology Department. The study compared low-dose CTF-guided biopsies (April 2016 to April 2017) with standard-dose protocol biopsies (March 2015 to March 2016) in lung, pleura, mediastinum, and muscle. The low-dose protocol involved 65 patients (57 males, 8 females) aged 16-66, inpatients and outpatients, conducted by two experienced radiologists using 30 mAs and 120 kVp.

For comparison, we reviewed standard CT protocol biopsies performed from March 2012 to March 2013, involving 60 patients (54 males, 6 females) aged 20 to 64 (mean age: 41.97 ± 9.88). Both low-dose and standard-dose biopsies were performed on a Philips Brilliance 16-slice CT scanner. Localizing scans and biopsies were conducted with lead protection, using low-dose protocol and CT fluoroscopy for intermittent guidance.

We recorded radiation exposure, CT acquisitions, and procedure time for both protocols. Biopsies used Monopty 20 gauge, 10 cm and TSK Stericut 20 gauge, 16cm needles, with careful advancement and periodic CT checks. Core biopsy specimens were fixed in 7.5% formalin and sent for cytopathological examination. Additional passes were performed as needed, followed by a final CT check at 30 mAs for complications.

Clinical and interventional data were collected retrospectively. Standard-dose protocol biopsies involved initial scanograms, localizing scans at higher doses, and cluster images obtained at axial guiding scans. The radiologist had to leave the CT room for image confirmation, resulting in more scans, longer procedure times, and higher radiation exposure compared to the low-dose CTF-guided biopsies. Image 1, 2 and 3 show the CTF guided biopsy of soft tissue density lung mass in one patient (Image 1), a large mediastinal mass in another patient (image 2), and cavitating lung pathology in left lung in the third patient (image 3).

We collected patient data, including age, gender, weight, and medical history. We also noted lesion size and location. Procedure details recorded included the number of needle passes for biopsy completion, radiation exposure measured as DLP (calculated by our scanner), and total biopsy time. We calculated the frequency of diagnostic specimens in each group, considering specimens as non-diagnostic if they were inadequate or not representative of the lesion.

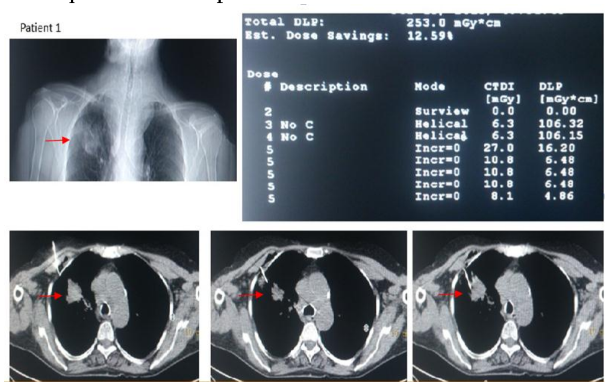

Figure No. 1: CTF guided biopsy of a soft tissue density mass in the right lung. Image on top left is scanogram image obtained for lesion localization.

The needle was advanced into the lesion under CTF guidance and 8 CTF images were obtained. Total DLP was 253 mGy.cm as indicated in image on top right.

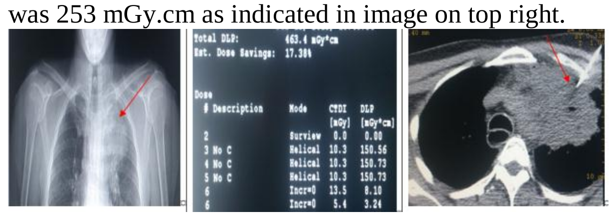

Figure No. 2: CTF guided biopsy of a soft tissue density mediastinal mass. Scanogram image is show on top left for lesion localization.

The needle was advanced step by step under CTF and a total of 6 CTF images obtained for core biopsy samples for histopathological characterization. Total DLP for this procedure 463. 4 mGy.cm.

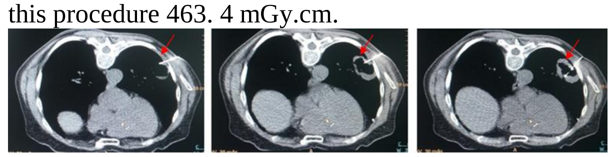

Figure No. 3: Cavitating lesion in the left lung.

The needle was advanced under CTF guidance into the lesion and cores were obtained from the solid component along its medial wall as shown.

RESULTS

Statistical analysis was done using SPSS v 21. Data was summarized with mean values and standard deviation. Quantitative variable including number of needle punctures attempts, duration of biopsy, dose-length product were analyzed with "Student t-test". A p value of <0.05 was considered significant. Diagnostic turn out of biopsy specimen for each group was expressed as frequency and percentage.

Total number of needle passes for biopsies to be carried out under low dose protocol was 3 to 6 with mean 4.09 ± 0.81, while that at standard dose was 6 to 8 with a mean of 7.41 ± 0.68 (Table 1). There was significant statistical difference between two groups (p-value <0.05). DLP for low dose group was 130 – 386.9 mGy.cm with a mean of 190.39 ± 23.3 while that for standard dose group ranged from 1270 – 1976 mGy.cm with mean of 1664.7 ± 342.11 (Table 2). This reduction was statistically significant (p-value < 0.05).

Intervention time for biopsies to be completed successfully in standard dose protocol ranged from 30 to 50 minutes with mean time of 39.85 ± 4.84 minutes compared to only 5 to 13 minutes and mean of 7.04 ± 1.40 minutes in low dose technique (Table 3). This difference was statistically significant. (P-value < 0.05).

In CT Fluoroscopy, biopsy procedures were histologically diagnostic in 88% patients. In remaining patients the biopsy specimen was deemed inadequate or not representative of true lesion. Under standard dose protocol diagnosis was made in 90% patients.

Table No. 1: Difference in the number of passes between the low dose and standard dose technique.

Technique	Number of passes	Mean
Low dose	3 to 6	4.09 ± 0.81
Standard dose	6 to 8	7.41 ± 0.68

Table No. 2: Difference in Dose length product (DLP) between the low dose and standard dose technique.

Technique	DLP (mGy.cm)	Mean DLP (mGy.cm)
Low dose	130 – 386.9	190.39 ±23.3
Standard dose	1270 – 1976	1664.7 ± 342.11

Table No. 3: Difference in the intervention time between the low dose and standard dose technique.

Technique	Intervention Time (minutes)	Mean Intervention Time (minutes)
Low dose	30 – 50	39.85 ± 4.84
Standard	5 – 13	7.04 ± 1.40

DISCUSSION

Computed tomography (CT) is the primary imaging choice for diagnostic and guided interventional procedures, particularly when other imaging modalities are inadequate. However, CT lacks real-time imaging capabilities like ultrasound and fluoroscopy, leading to slow conventional CT-guided procedures that involve multiple acquisitions to place the needle, guide it to the pathology, and visualize it within the lesion to be biopsied. [11-12]. Introduction of Computed Tomographic Fluoroscopy (CTF) is a significant advancement in interventional radiology, enabling real-time needle position imaging during CT-guided procedures. This innovation allows continuous needle monitoring, reducing passes and shortening biopsy times compared to conventional CT-guided procedures[13].

One of the most important aspects of CTF is the reduction of radiation dose to the patient during the interventional procedures. CT scans are established contributors of radiation dose to the patients, on average responsible for 47 % of radiation exposure due to radiological investigations and it was estimated that CT resulted in 0.4% of cancers[14]. Therefore, with growing need the radiologists are attempted to comply with "As Low As Reasonably Achievable" (ALARA) principle[15]. The hazards of radiation exposure are well established, one of the most important of which has been widely studied is radiation induced cancer[16]. CTF offers a significant time advantage as the radiologist remains in the CT room throughout the biopsy, ensuring quicker procedures. Rapid intermittent CT acquisitions for needle position checks further enhance time savings. This rapidity is especially beneficial for critically ill patients and those with difficulties lying on the scanner table or holding their breath.

Real time imaging has led to decrease in number of needle passes required for biopsy specimen to be obtained especially in lesions subject to anatomical sites where breath hold is essential[17]. This leads to lesser chances of puncturing adjacent viscera and vessels and subsequently lesser chances of developing of complications. Real-time visualization has made biopsies of small lung nodules possible in patients who cannot co-operate by holding their breath[18-19].

CONCLUSION

Our study concluded that CTF-guided biopsies reduce patient radiation exposure, require fewer passes, and result in shorter intervention times compared to standard-dose biopsies. In CMH Rawalpindi's busy department, CTF allows more efficient biopsies, reducing patient waiting times and enhancing cost-effectiveness.

Author's Contribution:

Concept & Design of Study:	Mariam Malik, Rana Bilal Idrees
Drafting:	Mariam Malik, Rana Bilal Idrees
Data Analysis:	Mariam Malik

Revisiting Critically:	Mariam Malik, Rana Bilal Idrees
Final Approval of version:	Mariam Malik, Rana Bilal Idrees

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