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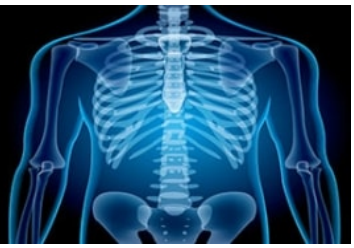

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Technical feasibility, safety and efficacy of percutaneous imaging guided biopsies in a tertiary cancer care hospital in North Eastern India

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Abstract
This study aims to evaluate the technical feasibility, safety, and efficacy of percutaneous imaging-guided biopsies performed at a tertiary cancer care hospital in Northeastern India. Over 20 months, 540 patients underwent either ultrasound-guided or CT-guided biopsies for suspected malignancies across various body sites. Biopsies were performed using coaxial techniques with core needle systems, and histopathological analysis was conducted. The technical success rate was 95.7%, with minimal complications such as pneumothorax, hemothorax, and hemoptysis. Ultrasound-guided biopsies showed a sensitivity of 91.9% and CT-guided biopsies showed 91.7%, with an overall diagnostic accuracy of 94.8%. The study concludes that imaging-guided biopsies are safe, effective, and essential for accurate cancer diagnosis, especially in resource-limited settings.

Keywords: Percutaneous biopsy, imaging-guided biopsy, cancer diagnosis, ultrasound-guided biopsy, ct-guided biopsy, diagnostic accuracy, tertiary cancer care

Introduction
The term "interventional oncology" refers to a wide range of minimally invasive procedures that interventional radiologists perform to diagnose and treat cancer. These procedures are specific to interventional radiology and have proven to have clear clinical benefits. As such, they have established themselves as essential members of the multidisciplinary oncologic cancer care team [1, 2].

Obtaining sufficient pathologic specimens is always necessary for an accurate diagnosis. Targeted therapy is now the mainstay of cancer treatment thanks to advances in molecular biology knowledge and the use of molecularly targeted agents in the arsenal. According to this new paradigm, the requirements for obtaining tumor tissue for diagnosis have an impact on both the malignancy diagnosis and the potential to yield valuable information that could be used to customize patient therapy and, in the end, provide an objective clinical response in a subset of patients. 10 Percutaneous image-guided biopsy (PIB) is the alternative for the great majority of biopsies because it is a well-researched, safe, and frequently utilized method for obtaining tissue specimens with a high diagnostic yield and minimal complications among the modalities for obtaining tumor tissue for histologic diagnosis. Additionally, PIB shortens hospital stays, lowers biopsy costs, and lessens patient anxiety before a major surgical procedure [2, 3].

Percutaneous biopsies are guided by different forms of imaging. These include computed tomography (CT), magnetic resonance imaging, positron emission tomography-CT, fluoroscopy, ultrasonography, and combinations of these modalities. The biopsy site, preferred method of operation, possible access points, lesion visualization, and equipment cost and availability all play a role in the imaging modality selection. Coaxial technique is preferred by the majority of interventional radiologists for PIB. Initially, a thin-walled needle is inserted into or near the target lesion, and then, to obtain tissue samples, cutting and fine-needle aspiration needles are advanced through the thin-walled needle. This technique minimizes patient discomfort and complications by obtaining multiple tissue samples without requiring additional passes through the overlying structures. Moreover, this technique permits constant access to the target lesion. Cutting needles, also called core needles, come in different sizes and offer core specimens for histologic analysis.

Cutting needles with modern small calibers (18 to 20 gauge) reliably deliver excellent quality cores with better safety margin [2].

Imaging guided percutaneous interventions including fine needle aspirations, biopsies and drainages are an indispensable gamut of procedures especially in cancer care and treatment. In addition to these, special drainage procedures lie PTBD with or without SEM stenting, PCN with or without DJ stenting, Vacuum assisted Pleurx indwelling catheter placement, basic vascular interventions like intravenous lines (PICC) and portacath placements are other common procedures being done at our hospital. Here we have summarised the data for imaging guided biopsies being done at a 200 bedded tertiary cancer care hospital in a tier-3 city of Northeastern India where such procedures have been a novel introduction in the healthcare system. Thus, we aim to review how these simple yet risky imaging guided procedures can be done with good patient safety margin even in a place with relatively limited resources. Careful case selection, proper planning and trained approach are the key to achieving high success rates for such procedures.

Materials and Methods

All consecutive imaging-guided (USG or CT) core needle biopsies performed in outpatients at our institution between September 2022 and April 2024 i.e. over a period of 20 months were analyzed retrospectively. All patients gave written informed consent. Before the biopsy, all patients had to have platelets above 50 thousand per ml as well as normal clotting parameters with a normal prothrombin time (PT range 11to 13.5 secs) with an international normalized ratio (INR) < 1.5 and an activated partial thromboplastine time (aPTT)<50 secs. All CT guided biopsies were performed in a coaxial technique with semi-automated core needle biopsy systems of 18-gauge. Very rarely 20 G semiautomated needles with coaxial system were used especially for CT guided biopsy of small or difficult lesions. USG guided biopsies were performed with either automated or semiautomated 18 or 16 gauge. Most USG guided biopsies were performed withoit coaxial technique to reduce cost constraints.16 G needles were preferred for breast lesions. Most biopsies were performed with local anesthesia on outpatient basis. Some biopsies were performed after hospital admission especially for patients with poor performance status (ECOG 1 or 2) or other comorbidities. All biopsies were performed between two radiologists, lead consultant radiologist and trainee/senior resident with four and one years of experience respectively.

Intravenous line was secured in all patients prior to procedure with 20 G cannula. Blood pressure, heart rate and oxygen saturation (spo2) was noted before starting procedure. In case of high blood pressure, diastolic > 100mm Hg, procedure was postponed after starting patient on oral antihypertensive medication and patient was called at a later date. In few cases, where blood pressure was not controlled with oral medication, short acting IV labetalol 2 to 4 mg was administered periprocedurally.

The intervention was started with skin disinfection and subcutaneous local anesthesia using 20 ml lidocaine 1%. After detection of the tumor with CT, the entry point of the biopsy needle was determined using X-ray-dense markers. Before biopsy, the position of the needle was controlled by CT. Then, 4-5 core biopsies were taken from the tumor, fixed in 4% formalin, and sent directly to the department of pathology. After biopsy, a CT-scan of the region that was biopsied (thorax, or abdomen) was performed to look for bleeding complications and pneumothorax. Realtime localization and skin marking was done with ultrasound for those planned for US guided biopsy. Under sterile conditions, a small skin nick was given and the biopsy needle was pushed towards the tumor. Then, 4-5 core biopsies were taken from the tumor, fixed in 4% formalin, and sent directly to the department of pathology. Autologous blood plug technique was used in deep seated lung and liver lesions in some cases.

All patients were observed and monitored for 2–4 h after the biopsy in outpatient waiting area of our department before they were discharged. Stable patients were discharged with prescribed oral paracetamol 500mg SOS in case of any post procedure pain. Anbiotic coverage with Coamoxiclav 625 mg BD and Pause 500 mg BD for 3 to 5 days (In case of post procedure hematuria) was advised for patients undergoing transrectal ultrasound guided prostatic biopsies. Patients were asked to follow up after 2 weeks in case of any delayed complications like local wound infection, bleeding or haematoma formation however none were reported in our study. In case of a pneumothorax, large volumes were sucked out using a needle and syringe under CT-control. The resorption of small pneumothoraces was controlled by repetitive CT-scans only. If a pneumothorax could not be sucked out, the patient was sent to surgery department for a chest tube. In the case of bleeding, it was decided by repetitive CT-scanning and monitoring of vitals whether the bleeding stopped spontaneously or a surgical intervention was necessary. IV tranexamic acid stat dose was given in such patients before shifting.

Study subjects

Inclusion criteria: All patients who were referred to our department for biopsy from medical, surgical and radiation oncology were included in our study.

Exclusion criteria: haemodynamically unstable, poor performance status (ECOG – 3 and 4), on oxygen or life support.

Statistical Analysis

All relevant patient characteristics (Age, gender, localization of the tumor (Intrathoracic, intra-abdominal, peripheral tumors, central lymph nodes, peripheral lymph nodes, bone etc), date of biopsy, complications (Pneumothorax, bleeding, other), histology, and need for hospital treatment after the biopsy (Reason and duration) were obtained from patient files. Missing data were completed by asking patients, relatives, general practitioners, specialists, and hospital staff either by phone or by using a questionnaire.

Histological Classification Histological results were classified as follows: True positive (TP): Histology showed a malignant tissue. True negative (TN): Histology showed no malignant tissue plus an uneventful follow-up. False positive (FP): Histology wrongly showed a malignant tissue. Rebiopsy, subsequent surgery, or follow-up proved that it was not malignant tissue. False negative (FN): Histology wrongly showed a benign tissue. Rebiopsy, subsequent surgery, or follow-up proved that it was malignant tissue.

Calculations

For the calculation of sensitivity, specificity, overall accuracy, the following formulas were used: Sensitivity = TP / (TP+FN). Specificity = TN / (TN+FP). Overall accuracy: (TP + TN) / all results.

The endpoints of this study were defined as follows:

Technical Success. Technical success was defined as completion of the biopsy procedure with obtaining adequate 4-5 good quality tissue cores for histopathologic examination.

Rate of Complications. The rate of complications included "minor" and "major" complications. Complications were assessed during post procedure observation period or hospitalization. Most complications, such as pneumothorax and/or pulmonary bleeding, were assessed using the CT scan obtained directly after the intervention. In addition, secondary infections were delayed complications and patient were asked to follow up after 10 to 14 days.

Results

A total of 540 patients with potentially malignant lesions underwent either USG or CT-guided biopsy. The study population included 323 men and 217 women. Most patients were between the age group 40 to 55 years. All site / region specific imaging guided biopsies were included as mentioned in table below.

Table 1: Showing the localization of various biopsied lesions

Region	Site specific	US guided biopsy	CT guided biopsy
Intrabdominal	Liver	132	2
	Omentum/ peritoneal deposit	36	2
	Pelvic/adnexal	15	0
	Prostate(transrectal route)	13	0
	Mesorectal/pelvic (transperineal route)	0	1
	Mesentery/exophytic hollow viscus	5	0
	Renal	3	1
	Adrenal	1	2
	GB	5	0
	Retroperitoneum	2	28
Intrathoracic	Lung mass/nodule	1	122
	Mediastinal mass/node	1	22
	Hilar lesion	0	13
	Pleural /chest wall	2	5
Bones & Vertebrae	Axial skeleton	1	17
	Appendicular	1	3
Head& neck	Nodal mass	18	0
	Deposit/recurrence	8	0
Others	Breast	33	0
	Axillary node	12	0
	Inguinal node	9	0
	Soft tissue tumors	19	0
	Abdominal/thoracic wall	5	0
Total	540	322	218

Technical success rate Technical Success. Technical success was defined as completion of the biopsy procedure with 4-5 satisfactory solid cylindrical cores for histopathological testing.

Table 2: Showing the technical success rate of different biopsies

	USG guided	CT guided	Overall
Satisfactory cores	307	210	517
Non satisfactory cores	15	8	23
Total	322	218	540
Percentage success rate	95.34	96.3	95.7

Table 3: Showing histopathology results of biopsies performed

HPE result	USG guided	CT guided
Malignant	296/322	200/218
Benign	8/322	8/218
Inconclusive	18/322	10/218
Total	322	218
Repeat	15/18	8/10

Of the total 322 US guided, 218 CT guided biopsies performed, a total of 28 histopathology examinations showed inconclusive result, 10 and 18 respectively for CT guided and US guided procedure. Out of these 28 cases, 23 cases were taken up for repeat biopsy and histopathological testing which yielded adequate specimen. 5 cases underwent surgical excision biopsy. Of these 28 cases, 26 were malignant and 2 were benign histopathologically.

Table 4: Showing various complications after biopsy procedure.

Complication	USG guided(n)	%	CT guided (n)	%
Pneumothorax	0	0	15/162	9.2
Haemothorax/pleural effusion	0	0	10/162	6.1
Haemoptysis	0	0	17/162	10.4
Small focal haemorrhage/ intracavity fluid	12/322	3.7	12/218	5.5
Pain	35/322	10.8	22/218	10.0
Vasovagal syncope requiring resuscitation	0/322	0	5/218	2.2
Total	322		218	

Management of complications

- Mild stable pneumothorax was managed conservatively with patient monitoring for 4 to 6 hours. At the end of observation period, CT scan was done to check whether pneumothorax volume was stable and not progressing. In such case where pneumothorax volume was moderate or increasing CT guided aspiration of air volume was done with 18G cannula and 3 way system with the help of a 20 or 50 cc syringe to close off any potential space. However, if pneumothorax persisted or recurred after 24 hour period patient was admitted and sent for intercostal drainage tube insertion.
- Newly detected mild pleural effusion /bleed or mild intraperitoneal fluid, mild intraparenchymal haemorrhage post biopsy with stable patient vitals on post procedure monitoring was managed conservatively and patient discharged after 2 to 4 hours after reassurance and counselling.
- Haemoptysis was commonly noted during biopsy of large vascular lung lesions however in most cases it subsided spontaneously within he observation period. Constant monitoring of vitals was done and occasionally IV tranexamic acid stat dose was injected in some patients alongwith reassurance.
- Post procedure pain was managed with oral paracetamol (Ultracet) or IM tramadol.
- In few patients, 5 in number, where vasovagal syncope occurred immediate resuscitation measures like intravenous fluid and oxygenation mask was secured before raising Code Blue. 3 patients required admission subsequently however were discharged after 24 hours. No ICU admission, intubation or patient death was reported.

Table 5: Showing the sensitivity, specificity and overall accuracy of biopsies (based on histopathology results) performed through US or CT guidance

	US guided	CT guided	Overall
Sensitivity%	91.9	91.7	91.8
Specificity%	100	100	100
Overall accuracy%	94.4	95.4	94.8
Total	322	218	540

For US guided biopsies, True positive (Tp)= 296, False positive (Fp)= 0
True negative (Tn) =8, False negative (Fn)/ inconclusive=18
For CT guided biopsies, True positive (Tp)= 200, False positive(Fp)= 0
True negative (Tn) =8, False negative (Fn)/ inconclusive=10

Discussion

An 18-gauge needle was used in the majority of studies, which may have ensured patient safety and a precise histologic diagnosis. In our study only 3.7 % of patients undergoing US guided biopsy had minor intraperitoneal bleed. It's possible that the low rate of bleeding in this study was understated because it was discovered during US examinations and may not have been immediately apparent [4]. The American College of Radiology practice guidelines on percutaneous needle biopsy states suggest a threshold for major complications. This includes a bleeding rate of 10%, infection rate of 2%, and peritonitis rate of 2%. [5]. Although complications arose in 3.7% of USG guided procedures, most of them were minor and none were hospitalized. Complication was slightly higher for CT guided procedures, pneumothorax in 9.2%, mild intrapleural/ intraparenchymal bleed in 11.6% patients, haemoptysis in 10.4 %. However only 2.2% patients had an episode of vasovagal syncope requiring immediate resuscitation. Furthermore, delayed complications (eg, hematomas, infection or abscess) did not report in our study. No deaths were attributed to the procedure.

Our study confirms the efficacy of the procedure in yielding a pathologic diagnosis. In the 28 of 540 biopsy procedures in which a specimen was inadequate for diagnosis, 23 patients subsequently returned to the department and had a successful repeat biopsy without complications. Overall accuracy of imaging guided biopsies in our study was 94.8%, whereas 94.4% for USG guided and 95.4 % for CT guided separately. Other studies have shown the efficacy and safety of real-time sonographic-guided biopsy of the liver. Rossi *et al* reported an efficacy rate of 99.3% with complications arising in 2.1% of patients in a series of 142 real-time sonographic guided biopsies using a subcostal route. Cheval lier *et al*. reported an efficacy rate of 97.8%, yet 8.2% had severe pain after the procedure. Tan *et al* studied 70 patients undergoing real-time sonographic-guided liver biopsy and found a low rate of significant postprocedural pain. They also found no statistically significant difference in pain between the subcostal and intercostal approaches. Of 70 biopsies, 2 samples were deemed inadequate for histologic diagnosis [6-9].

A wide spectrum of percutaneous hepatic biopsy complication rates is present in the literature, due to the fact that most studies are retrospective, and there is no consensus on what is defined as a major or minor complication. In the largest series, the morbidity rate ranges from 0.4% to 5.9%. In the above-mentioned large retrospective study, death, serious hemorrhagic compli cations, pneumothorax, and biliary peritonitis were observed with a frequency of 4 in 1000 patients. Although in our study the complication rate was slightly higher (overall 3.7% for USG guided, around 15% for CT guided), all of the complications were mild and only 2.2% require medical intervention. According to the literature, significant hemorrhage requiring transfusion occurs in 0.35–0.5% of all procedures while subclinical bleeding detectable by post-biopsy liver imaging is observed in up to 23% of patients. In our study, though 15% patients

developed a small bleed/ collection most resolved spontaneously. Pain is a common complaint of patients after the procedure, occurring in up to 20% of the cases, with mild and moderate pain occurring in majority of the cases which was managed conservatively [10].

Core needle biopsy is preferred over fine needle aspiration biopsy and use of 18 to 20 G core biopsy needles with coaxial system is recommended nowadays. This achieves diagnostic yield and accuracies of the percutaneous imaging guided procedures to upto 74 to 95%. In our study overall accuracy of these percutaneous imaging guided procedures was as high as 95% [11, 12].

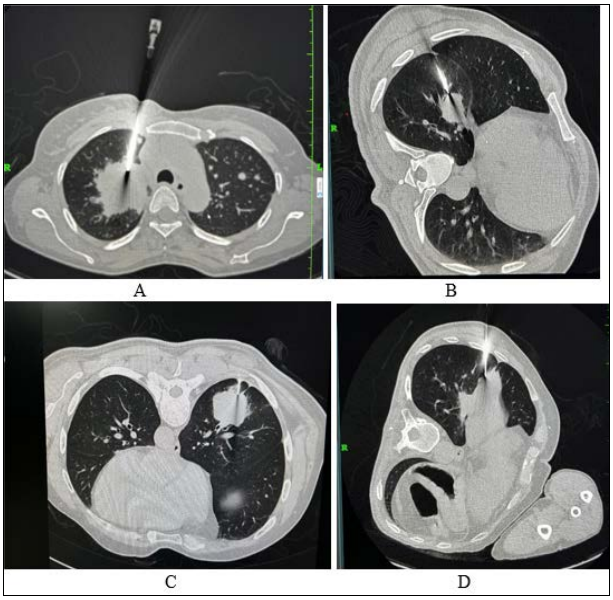

Fig 1 a, b, c, d: Showing CT guided biopsy planning for different lung primary lesions in supine, prone and lateral oblique positions.

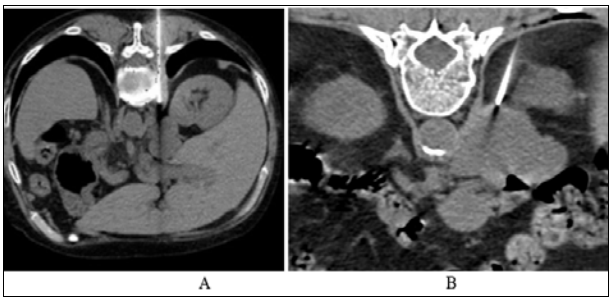

Fig 2 a, b: Depicting CT guided biopsy of retroperitoneal lymph nodes in prone posture.

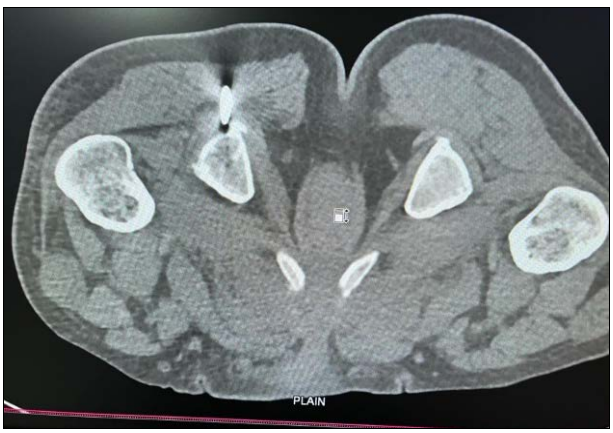

Fig 3: CT guided biopsy of lytic bone lesion in left ischium.

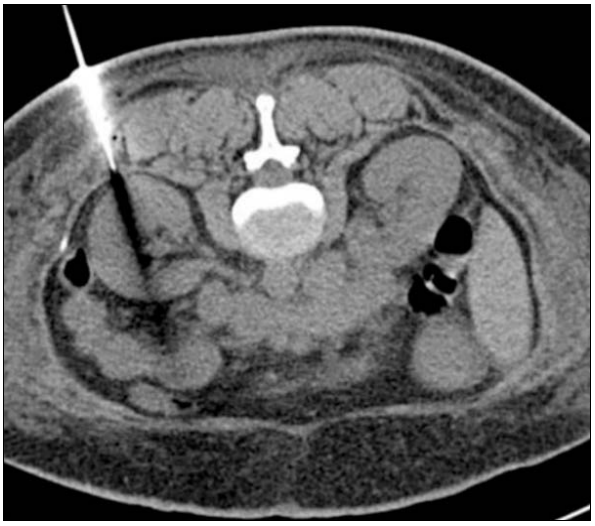

Fig 4: CT guided biopsy of left kidney using 20G semiautomated biopsy gun with 19G coaxial system.

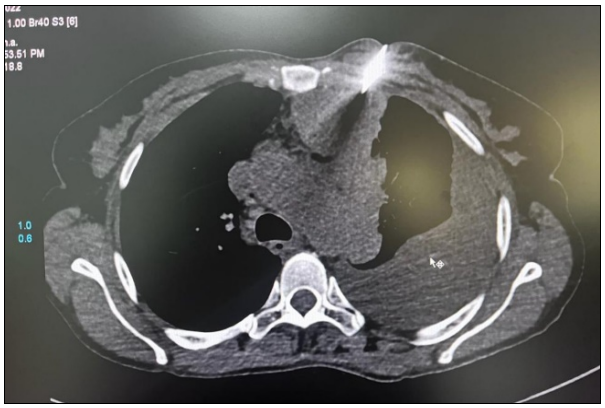

Fig 5: CT guided biopsy of anterior mediastinal mass.

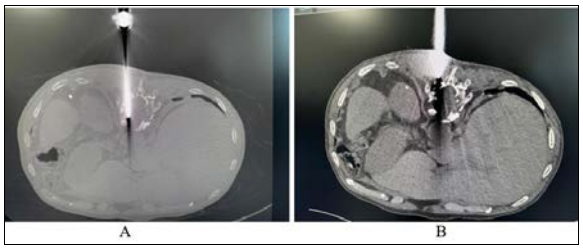

Fig 6a, b: CT guided biopsy of lytic vertebral lesion approached through transpedicular route in prone position (bone and soft tissue window settings). 11G Jamshidi bone biopsy needle was used.

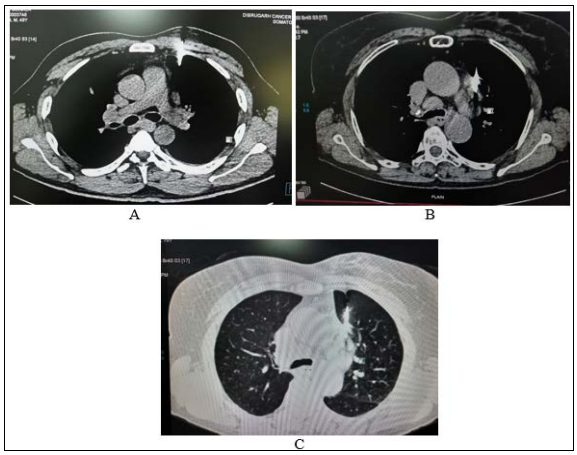

Fig 7 a, b, c: Showing CT guided biopsy of a prevascular station lymph node, transpulmonary approach.

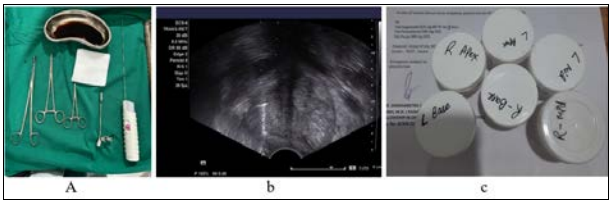

Fig 8 a, b, c: Showing tray preparation, transrectal USG guided prostate biopsy. 18G 25 cm automated biopsy gun was used to obtain 12 cores from prostate gland from specific sites as labelled.

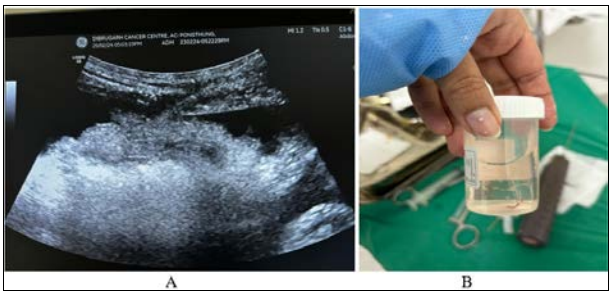

Fig 9a, b: Showing USG guided biopsy of omentum with satisfactory 4-5 solid cylindrical whitish biopsy cores sent in formalin solution for histopathology.

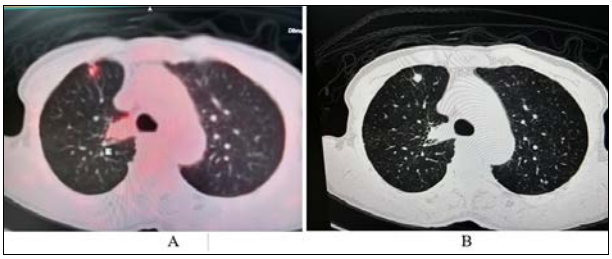

Fig 10 a, b: Fibronodular opacity on right upper lobe anterior lobe showing FDG avidity in a known case of colorectal carcinoma whose biopsy was planned later on and showed biopsy positive for metastatic adenocarcinoma.

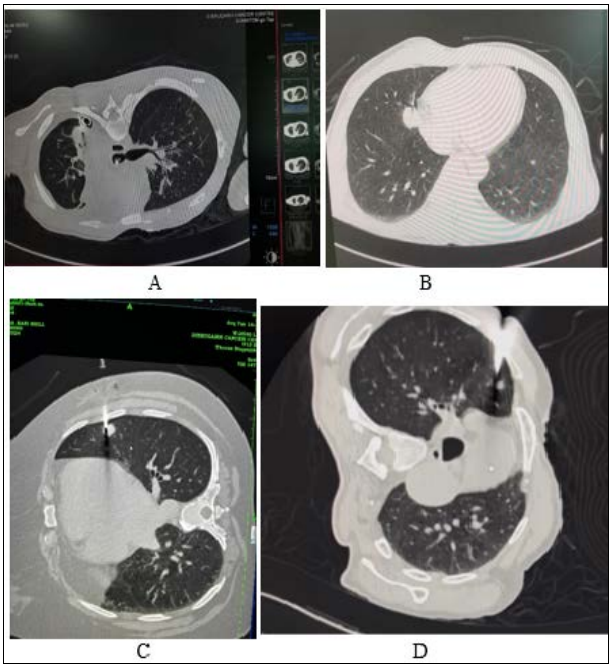

Fig 11 a, b, c, d: Showing CT guided biopsy of small pulmonary nodules in varied and difficult locations accessed with prior planning and patient positioning. The small lung nodules had to be sampled to rule out possibility of metastatic disease and hence guide the multidisciplinary team.

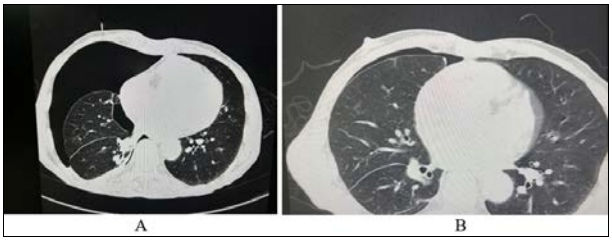

Fig 12 a, b: Depicting post biopsy pneumothorax was immediately aspirated under CT guidance using a simple 18G cannula, 3 way system and 50cc syringe in same sitting.

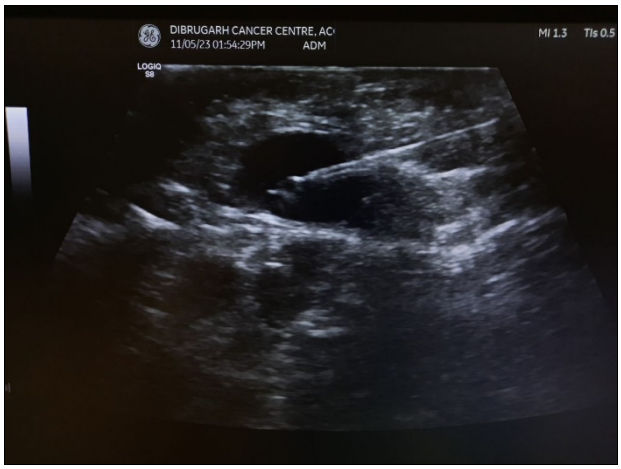

Fig 13: USG guided biopsy of a small 1cm cervical lymph node done (suspected case of recurrent lymphoma) with 18G semiautomated biopsy gun. Coaxial method was not preferred due to very small size of the node.

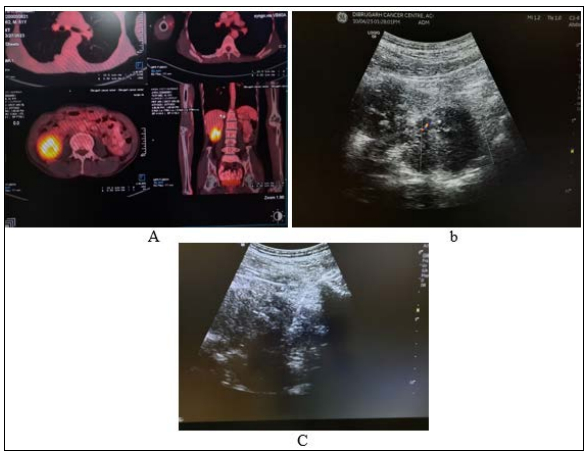

Fig 14 a, b, c: Showing FDG avid lesion in lower pole of right kidney on PET scan which was subsequently targeted using USG guidance and biopsy cores obtained. Prior study of PET scan images if available help in better planning of biopsy revealing central necrotic cores versus more FDG avid periphery which yield better tissue cores for sampling.

Conclusion

Percutaneous imaging guided biopsies are relatively safe and an indispensable part of evidence based cancer care especially in far flung areas where tertiary cancer care and interventional radiology is gradually emerging. The impact of such interventions and procedures alongside its usefulness in catering cancer care to remote populations is enormous. The technical efficacy and diagnostic yield of these procedures in hands of trained personnel is considerably good and hence there is need to increase training opportunities for budding radiologists as well as

increase infrastructural and logistics support so that interventional radiology may expand and diversify in the relatively remote parts of the country.

Conflict of Interest
Not available

Financial Support
Not available

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