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International Journal of Current Research
Vol. 9, Issue, 10, pp.59245-59247, October, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

COMPUTED TOMOGRAPHY (CT) GUIDED BIOPSY USING ROBOTIC GUIDANCE SYSTEM- A PILOT STUDY

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ARTICLE INFO

Article History:
Received 17th July, 2017
Received in revised form
10th August, 2017
Accepted 19th September, 2017
Published online 31st October, 2017

Key words:

Robotic guidance,
Biopsy,
CT guided.

ABSTRACT

Introduction: Robotic guidance system is particularly useful in reaching and targeting complex lesions in critical or difficult to reach areas for CT guided procedures.
Aims and Objectives: To perform a pilot study of CT guided biopsy using a new commercially available robotic guidance system on a group of challenging lesions.
Methods and Materials: Six patients underwent the procedure using 18G coaxial biopsy needle, and ease, procedure time, radiation dose and success rates were evaluated by two operators.
Results: The procedure was uneventful in all cases and patients were sent back home after about one hour post-procedure observation. Average DLP was 238.03 (47.5-552), and time of procedure was 37.5 min. (30-50 min.) including patient positioning, preparation, planning and the actual biopsy procedure. 100% was the sampling rate and success result.
Conclusion: Robotic guidance system offers ease of usage with low radiation dose and good procedure success rates.

Citation: Ruchi Gupta, Subhash Kumar, Prem Kumar, Neetu Sinha, Neha Nischal and Abhishek Anand, 2017. "Computed Tomography (CT) guided biopsy using robotic guidance system- A pilot study", *International Journal of Current Research*, 9, (10), 59245-59247.

INTRODUCTION

Computed tomography (CT) guidance has been used extensively for percutaneous biopsies. In certain situations the procedure can be extremely challenging with poor sampling rates. A new robotic guidance system has been made commercially available for performing such cases.

Aims and Objectives

To perform a pilot study of CT guided biopsy on a series of cases with challenging anatomical sites for conventional CT guided biopsy procedure, with regards to the ease of performance, procedure success rates, radiation dose and patient satisfaction.

MATERIALS AND METHODS

A commercially available system (MAXIO-CT, Perfint Healthcare, Chennai, India) was used for robotic assisted planning, navigation and targeting the lesions. This system helps to achieve precise planning and targeting in diagnostic procedures like biopsy, FNAC, drainage and therapeutic interventions in pain management, radiofrequency ablations, etc. Major advantage lies in guiding multiple needles in tumour ablation procedures in single sitting.

The procedure steps were as below:

1. Patient was immobilised on CT table with the help of special immobilisation bed available with the system. (Figure 1)
2. CT scan of the region of interest was done (2mm thick sections) and the series was loaded in Maxio system for further planning. 256 slice CT scanner (Somatom Definition Flash, Siemens Erlangen, Germany) was used, and the Maxio automated system was synced with the CT machine beforehand.
3. Target lesion was selected, its entry point and centre of the lesion was planned in 2D/3D. Probe trajectory was reviewed. (Figure 2A)
4. Patient skin was cleaned and the robotic arm was moved to place in the required trajectory. Biopsy needle (18G biopsy gun with coaxial needle and 20 mm throw, Cook Medical) was inserted into needle holder of robotic arm and entry point on patent skin was anaesthetised.

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5. Biopsy needle was manually inserted into the target at calculated depth and check CT was done to confirm the position of the biopsy needle. (Figure 2B,C)
6. Multiple cores were taken. In cases of lung biopsy, patient was observed in hospital for 4 hours for possible pneumothorax management.

RESULTS

Total of 6 patients (4 Males, 2 Females) with mean age 39 years (range 26 to 60 years), were included in the study. (Table 1) Two radiologists (SK and PK) had beforehand evaluated the contrast CT scans of the patients. The procedure was uneventful in all cases and patients were sent back home after about one hour post-procedure observation. Average DLP was 238.03 (47.5-552), and time of procedure was 37.5 min. (30-50 min.) including patient positioning, preparation, planning and the actual biopsy procedure. (Table 2) In none of the cases, pain was perceived by the patient and adequate cores were obtained so that all patients had positive biopsy reports. Minimum size of the lesion biopsied was from lung measuring 2 x 2 cm, however was situated peripherally. Average size of the lesion was 4.9 x 4.2 cm.

Table 1. Patient details, size and site of lesion, time of procedure and final histopathological diagnosis

S.No.	Age	Sex (M/F)	Site of lesion	Size of lesion	Time taken for procedure (min)	Histo-pathology
1.	26	M	Segment V mass reaching upto the porta with seperation of primary confluence	6 x 6.5cm	30	Metastatic adenocarcinoma
2.	37	M	Periportal lymph nodal mass	4.7 x 3.5 cm	45	High grade adenocarcinoma
3.	25	F	Periportal mass	4.7 x 4 cm	35	Tuberculous lesion with presence of Acid fast bacilli
4.	55	M	Mass lesion in segment VIII of liver close to diaphragm	6.5 x 5.7 cm	35	Hepatocellular carcinoma
5.	31	M	Retroperitoneal mass with eccentric calcification	6 x 4 cm	50	Undifferentiated round cell tumour
6.	60	F	Left upper lobe non resolving pneumonia radiologically	2 x 2cm	30	Organising pneumonia

Table 2. Radiation dose was calculated by adding the exposure in Dose length product (DLP) of Topogram, Plain/Contrast CT and Check CT done for final biopsy needle position

S.NO	Topogram			CT			Biopsy			Total DLP	Time taken for procedure(min)
	KV	mAs	DLP	KV	mAs	DLP	KVP	mAs	DLP	DLP	
1.	120	35	5.0	100	150	112	100	149	55	172	30
2.	120	34	4	240	337	421	120	174	121	546	45
3.	80	34	1.1	80	90	35	80	87	16.9	53	35
4.	120	35	4.7	80	88	28.1	80	101	14.7	47.5	35
5.	120	35	5.0	230	340	425	120	175	122	552	50
6.	80	35	1.1	80	152	34.2	80	145	22.4	57.7	30

Fig. 1. Immobilisation bed and robotic biopsy system used for positioning of patient

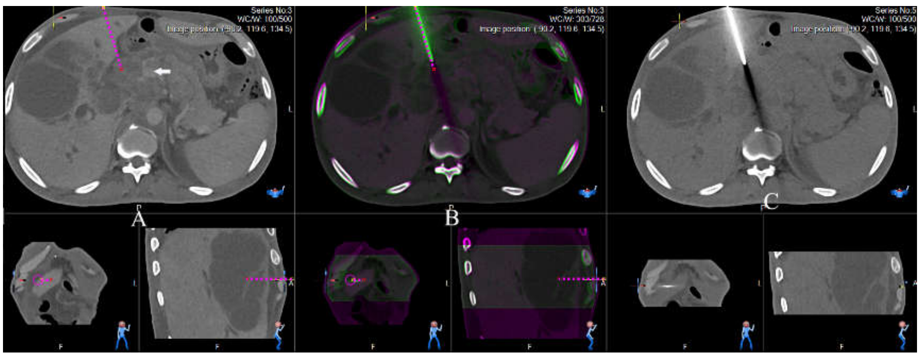

Fig. 2. Images of planning and biopsy path in three planes. Patient had been injected with 30 ml 300mg/ml iohexol prior to acquiring the CT images (A) Axial, Coronal and Sagittal reformatted images showing the planned trajectory to the nodal mass at porta (dashed line); the portal vein lies adjacent to the node (white arrow) (B) the biopsy needle has been inserted, and the image shows the trajectory overlapping the needle (C) the biopsy needle is visualised in this check CT, with tip at the peripheral portion of the targeted node

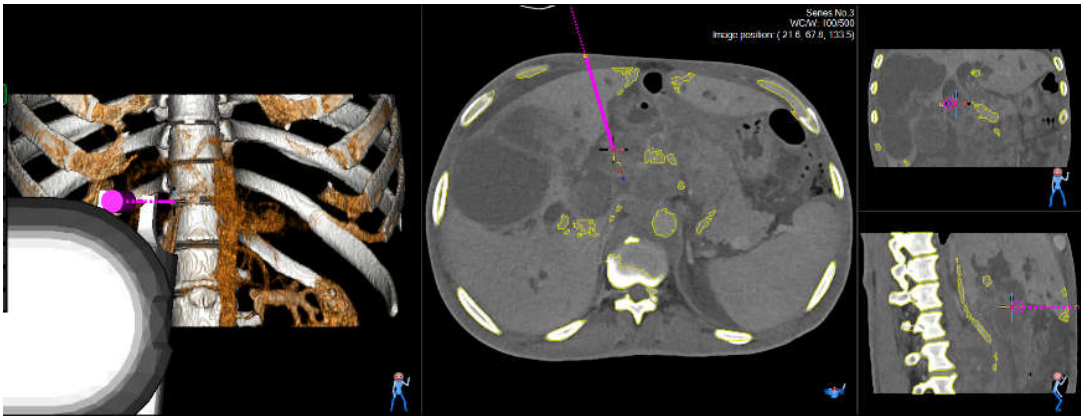

Fig. 3. Images showing outlining of high HU structures to mark out the contrast filled vessels in the MAXIO system (yellow dotted lines)

DISCUSSION

A significant advantage of this guiding robotic system was immobility of the patient during the procedure due to the use of special immobilisation bed and hence reduced punctures, reduced time and less pain to the patient. Entry point and target site was very well positioned by the system, hence increased the accuracy of sampling. In our study, 100% sampling rate and positive result were obtained. For the radiologist, decreased time of procedure and no radiation exposure were added advantages. Average Dose length product (DLP in mGycm) was 238.03. We gave intravenous contrast in two patients before-hand in reduced dosage, so as to delineate vascular anatomy better, which is a standard practice for CT guided procedures. The MAXIO system is able to mark out the contrast filled structures separately and allow precise positioning. (Figure 3) Chellathurai *et al* compared manual planning with automated biopsy system by performing chest biopsies on 36 patients and concluded that less needle adjustments are required with automated system reducing the procedure time, however positive sampling results were comparable in both. (Chellathurai *et al*., 2009) Schulz *et al* compared manual with robotic system by performing percutaneous biopsy of target dummies inserted in corpse liver and concluded robotic system is more superior for angulated procedures and zero radiation for radiologist is an added advantage. (Schulz *et al*., 2015) Chu *et al* compared the effectiveness and radiation exposure by performing lung tumor biopsies of 50 patients using robotic system, conventional CT and CT Fluoroscopy and found the radiation exposure was nearly equal in CT fluoroscopy and Robotic system and their target success was 100%. (Chu and Yu, 2014) Using robotic system, average DLP calculated was 480, however in our study, it was 238.03. It could be because we did not do check CT to look for the tip of anaesthesia needle and post procedure CT, since patients were stable after the procedure. Limitation of our study was small sample size and comparison was not done with either conventional or CT fluoroscopy. The major disadvantages of this equipment are if patient moves during any of the steps, repeat CT and planning is to be done thereby increasing the radiation dose and time of procedure. Initial docking of machine takes about 8 to 10 minutes. Due to limited range of motion, very lateral interventions are quite difficult to be done. (Schulz *et al*., 2015) We had procedure completion timing ranging from 30-50 minutes, which is higher than routine techniques, however it could be because of the initial exposure to the system and is likely to improve with further usage.

Conclusion

As a first hand experience of this robotic navigation system, it seems to be promising both for the patient as well as the radiologist, reduces the needle adjustment time, number of punctures, accurate placement of needle, almost immobility of patient due to the use of special immobilisation bed, more promising for deeper lesions and where angulation is required and last but not the least, no radiation exposure to the radiologist. More comparison studies need to be done to study the radiation exposure in Robotic biopsy system.

Ackowledgement

We are really thankful to radiographers (Mr Sanjeev Kumar, Mr Ranjeet Kumar, Mr Suresh Kumar) and Maxio Perfint Engineers for their contribution.

Conflict of Interest : None

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