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ORIGINAL ARTICLE

Cervical Vertebral Bone Biopsy: Challenges and Tricks

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ABSTRACT

Objective: *Biopsies of cervical spinal lesions are often challenging procedures with significant risk of complications. Although computed tomography (CT)–guided biopsy of the thoracic and lumbar spine is considered a safe and accurate procedure, cervical spine biopsies are less commonly performed. The aim of this retrospective study was to evaluate the diagnostic accuracy of CT-guided needle biopsies for lesions of the cervical spine.*

Methods: *Results of 27 CT-guided biopsies of cervical spine lesions performed between February 2000 and May 2020 in a tertiary care teaching institute in India were retrieved and analysed.*

Results: *An adequate diagnostic yield was obtained in all 27 cases (100%). There were no major complications. The common pathologies, approaches to the lesions, and the method of biopsy were studied.*

Conclusion: *CT-guided biopsy of the cervical spine with appropriate case selection and planning is a safe procedure with high diagnostic yield.*

Key Words: *Retrospective Studies; Tertiary Healthcare; Biopsy, Needle; Tomography, X-Ray Computed; Cervical Vertebrae*

中文摘要

頸椎骨活檢：挑戰與技巧

PK Chinniah、B Gopal、V Moses、SN Keshava

目的：頸椎病變活檢常是具有挑戰性的操作，具有較高的併發症風險。儘管CT引導下的胸椎和腰椎活檢被視為是一種安全且準確的操作，但頸椎活檢並不常見。本回顧性研究的目的在於評估 CT 引導下針刺活檢對頸椎病變的診斷準確性。

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Data Availability: All data generated or analysed during the present study are available from the corresponding author on reasonable request

Ethics Approval: This study was approved by the Institutional Review Board of Christian Medical College, Vellore, India (IRB No.: 13125). Informed consent was waived by the Institutional Review Board because of the retrospective nature of this study.

方法：分析 2000 年 2 月至 2020 年 5 月間在印度一所三級教學醫療機構完成的 27 例 CT 引導下頸椎病變活檢的結果。

結果：全部27名患者（100%）都獲得了足夠的診斷率。沒有重大併發症。本文描述常見的病理、病變的活檢路徑和活檢方法。

結論：在適當的病例選擇和規劃的前提下，CT引導下頸椎活檢是一種安全、診斷率高的手術。

INTRODUCTION

Biopsies of cervical spine are challenging procedures due to the relatively small size of the cervical vertebrae, limited access, difficult approach, and proximity to vital organs. The present study addresses the case selection, different approaches and techniques of computed tomography (CT)–guided biopsy of cervical spinal lesions to evaluate the diagnostic yield of this approach.

METHODS

In this study, data of 27 cases of percutaneous cervical spine biopsy performed in a tertiary care hospital between February 2000 and May 2020 were collected retrospectively from the PACS (picture archive and communication system) [GE Centricity 3.2; GE Healthcare IT, Barrington [IL], US] and analysed. Preprocedural evaluation included plain radiography, CT or magnetic resonance imaging of the cervical spine, and bone scan. Spine lesions with large exophytic soft tissue components were not included, as soft tissue biopsy was performed in those cases. Biopsies were performed after a coagulation profile, including prothrombin time, activated partial thromboplastin time, and platelet count. All the patients in the study had normal coagulation profile. Most of the biopsies were performed in an outpatient setting.

The approach of biopsy was decided based on the location of the lesion, the proximity of the lesion to the critical structures of the neck (such as neurovascular bundles), and the patient's comfort. Some of these patients may be on a supportive neck collar. Care must be taken while removing the neck collar to avoid inadvertent injury to the spinal cord.

A radiopaque guidewire was used to plan and mark the needle entry site in patient's skin, following which local area was painted with 10% povidone iodine for 3 times (approximately for 30 seconds) and 1% lignocaine was administered as local anaesthesia. Usually, the procedures are done under local anaesthesia for adults, while general anaesthesia is required for children and may be required sometimes for adults. Partial pressure of oxygen and blood pressure were continuously monitored during the procedures. While advancing the needle, CT in the region of interest and ultrasound usage will ensure safe trajectory. All spinal biopsies were done under CT guidance. Dedicated CT scanners (Siemens Somatom, Erlangen, Germany and Philips Brilliance, Amsterdam, Netherlands) for biopsy equipped with patient-monitoring devices were used. Biopsy samples were sent for histopathology and culture analysis.

Anterior / Lateral Approach for Vertebral Body or Prevertebral Lesions

Coaxial Graded Needle Exchange Technique

Anterior approach is usually used for vertebral body lesions. Needle direction is planned on CT. A 22-gauge lumbar puncture needle or Chiba needle (Cook Medical, Bloomington [IN], US) is first passed along the expected direction of the target. Ultrasound guidance is used to avoid major vascular structures such as carotid artery and internal jugular vein. The direction of the needle and its tip on the bone surface is confirmed on CT. The stylet is removed and the stiff end of a short 0.018-inch Mandril guidewire (Cook Medical, Bloomington [IN], US; Figure 1a) is passed into the lumen of the Chiba needle for a distance approximating the length of the stylet, till it touches the bone. The Chiba needle is removed over the wire and the tract is dilated by a catheter (Neffset; Cook Medical, Bloomington [IN], US), which is withdrawn and then reinserted along with a wide-bore bone biopsy cannula (Ostycut bone biopsy needle [Figure 1b] or Ackermann bone biopsy needle [Figure 1c]; Cook Medical, Bloomington [IN], US) over the guidewire until it again touches the bone. After confirming the direction on CT, the catheter and the guidewire are replaced by a bone biopsy needle inserted into the cannula and biopsy is performed (Figures 2 and 3). The position of the biopsy needle is confirmed on CT. Adequate numbers of samples are collected for histopathology and culture. A final CT scan is performed after removal of the needle to assess for haemorrhage.

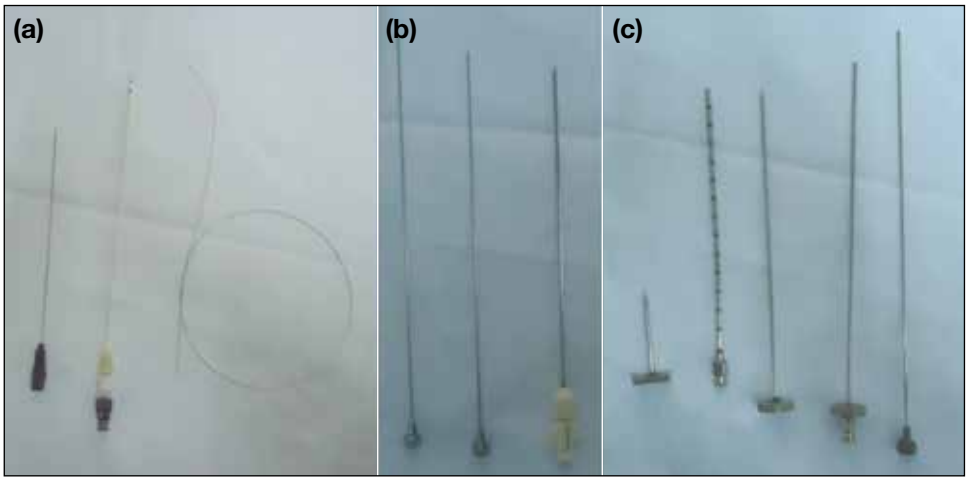

Figure 1. Equipment needed for coaxial graded needle exchange technique: (a) Chiba needle and 0.018-inch Mandril guidewire, (b) Ostycut bone biopsy needle, and (c) Ackermann bone biopsy needle.

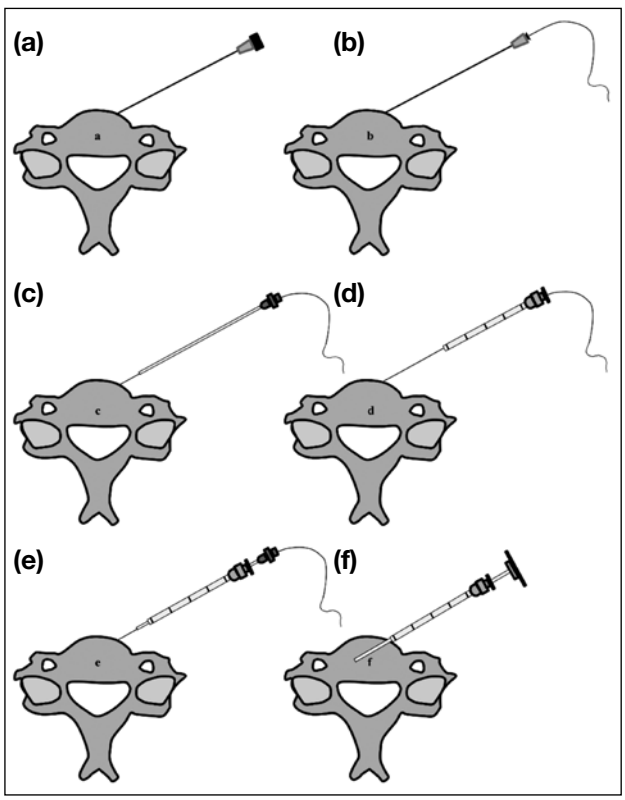

Figure 2. Coaxial graded needle exchange technique is shown in step-by-step manner. (a) Chiba needle is first used to access the lesion (under ultrasound guidance). (b) The stylet is removed, and the stiff end of the Mandril guidewire is passed into the lumen of the Chiba needle for the length approximating the length of the stylet. (c) The Chiba needle is removed, and the Neffset catheter is passed over the guidewire. (d) The Neffset catheter is removed, and the wide-bore bone biopsy needle is passed over the guidewire. (e) Once again, the Neffset catheter is passed over the guidewire till the level of the vertebral bone and the wide-bore bone biopsy needle is inserted into the deeper planes. The Neffset catheter and the guidewire are removed from the unit assembly. (f) Bone biopsy needle is inserted into the cannula and biopsy of the cervical vertebra is performed.

The coaxial graded needle exchange technique may be used for other approaches, as well as with other similar suitable combinations of the needles.

Transthyroid Technique

This is done keeping the patient in supine position. Traversing of the needle through the thyroid is done with ultrasound guidance to avoid vessels along the track (Figure 4). Ultrasound offers real-time visualisation of the great vessels of the neck and to plan the needle trajectory safely.

Posterior Approach for Posterior Element Lesions

The posterior approach is performed similar to biopsies of the thoracolumbar spine (Figure 5). The patient is positioned either prone or in lateral decubitus position for the purpose of stabilising the cervical spine. After localising the lesion, local anaesthesia is injected. Biopsy of the lesion or soft tissue is done using a coaxial system. Pillows are used below the head and neck to support the cervical spine and provide comfort to the patient.

Transoral Approach for C1 or C2 Lesions

The transoral approach can be attempted for lesions in the atlanto-axial region and is performed under general anaesthesia. After retracting the soft palate and uvula, a bone biopsy needle is slowly advanced through the posterior pharyngeal wall and further into the underlying C1 or C2 vertebra (Figure 6).

RESULTS

The study population comprised 27 cases that included 19 males and 8 females with age ranging from 17 to

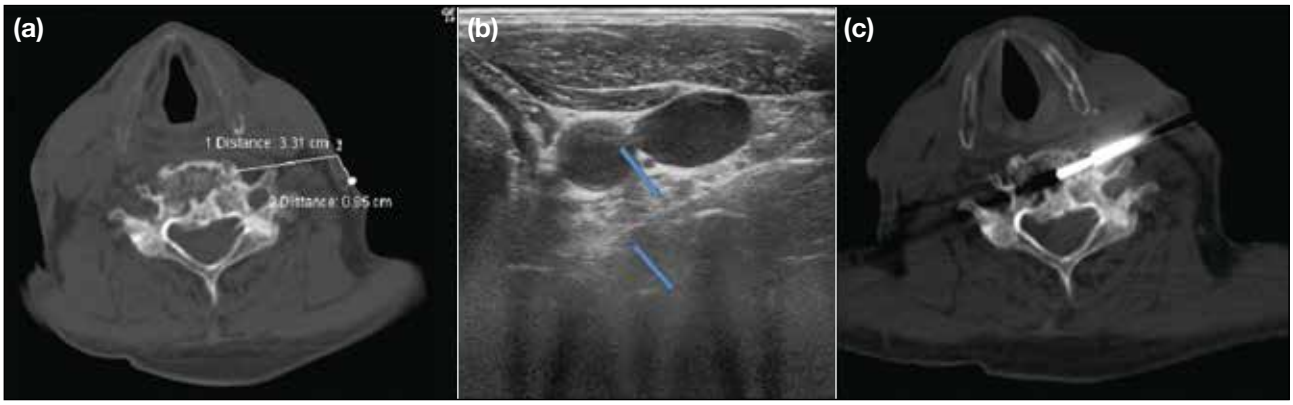

Figure 3. Biopsy performed using coaxial graded needle exchange technique. (a) Computed tomography (CT) showing a lesion in the C5 vertebral body and initial planning. (b) Ultrasound was used to avoid the carotid artery and internal jugular vein and the needle track is marked by blue arrows. (c) CT showing placement of the short Ackermann needle in the lesion.

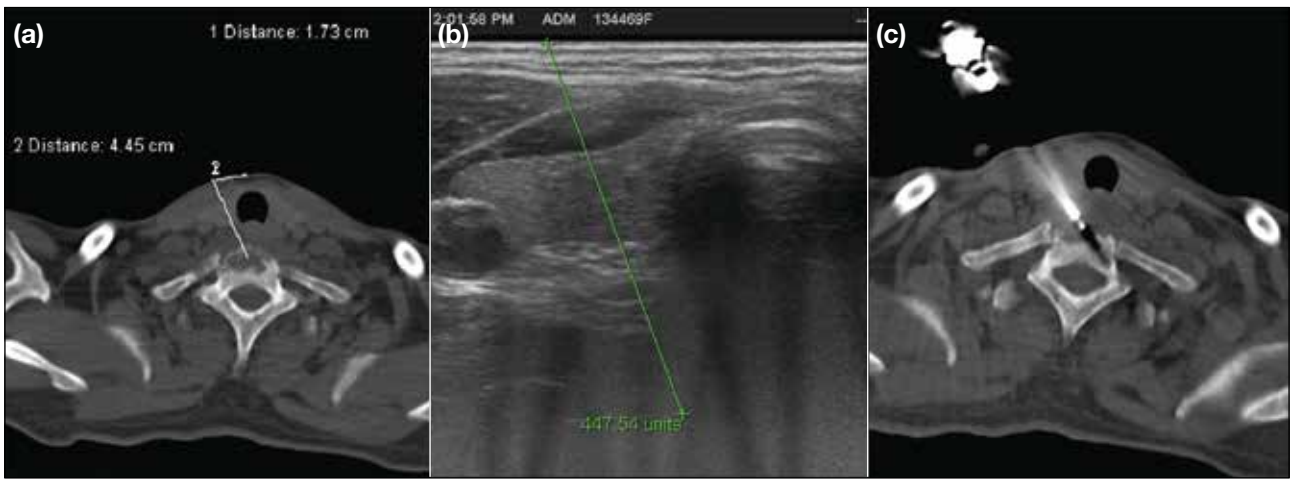

Figure 4. Transthyroidal biopsy of the C7 vertebral body. (a) Computed tomography (CT) showing the lesion in the C7 vertebral body. Plan was developed to reach the lesion. (b) Ultrasound was used to avoid vessels along the track. (c) CT showing placement of the short Ackermann needle in the lesion.

77 years. A summary of the cases and the techniques used is given in the Table. The diagnostic yield was considered adequate if the material was enough for histopathological interpretation or there was a positive microbial growth on culture. Such an adequate diagnostic yield was possible in all the 27 cases (100%). Some patients experienced mild discomfort and pain related to the procedure, which was adequately controlled with analgesics. There were no major complications.

Proximity to vital structures such as the carotid artery, vertebral artery, and spinal cord is the challenge in this location with respect to avoiding complications. It is important to evaluate for complications even after considering all the precautions. Postprocedural CT, clinical examination, and follow-up are vital.

DISCUSSION

Percutaneous spine biopsy was first described by Ball in 1934. Image-guided biopsy was reported in 1949 with conventional radiographs, followed by fluoroscopy in 1969, CT in 1981, magnetic resonance imaging in 1986, and CT fluoroscopy in 1996. Initially, open biopsies were performed, but percutaneous needle biopsy offers a faster, more cost-effective approach with fewer complications.[1-4] Compared to surgical biopsies, percutaneous needle biopsy is less invasive and can usually be performed under local anaesthesia.

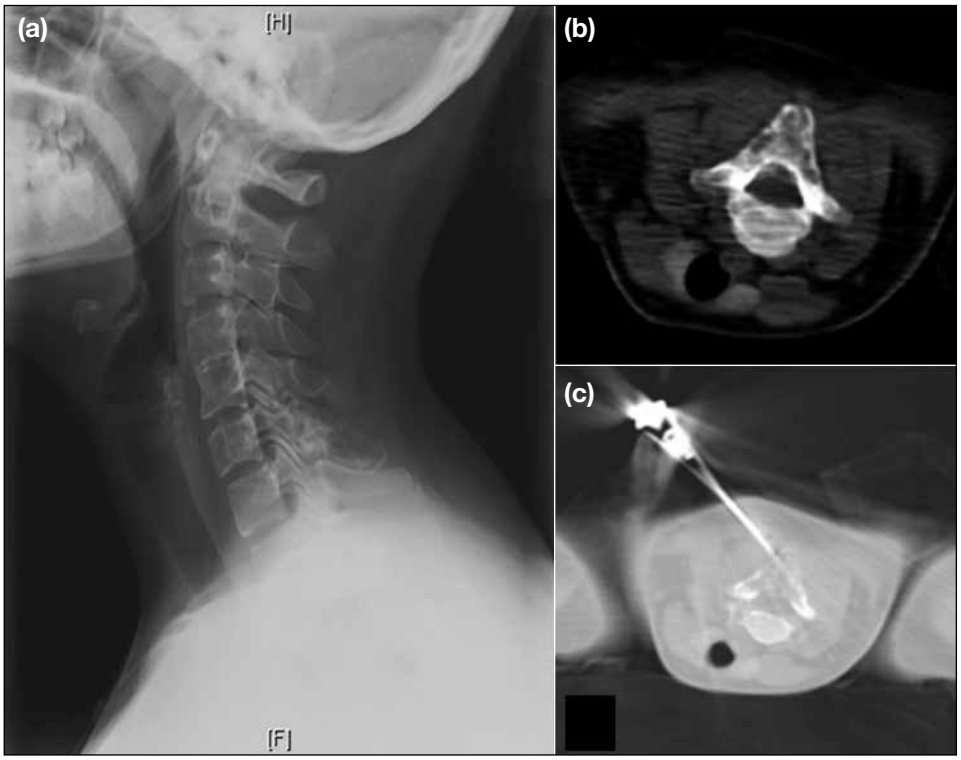

Figure 5. Biopsy of the C7 vertebral body using posterior approach. (a) Lateral radiograph of the cervical spine showing an expansile lytic lesion in the C6 vertebral spine. (b) Computed tomography (CT) confirmed the findings observed in the cervical spine radiograph. (c) CT showing placement of the short Ackermann needle in the lesion.

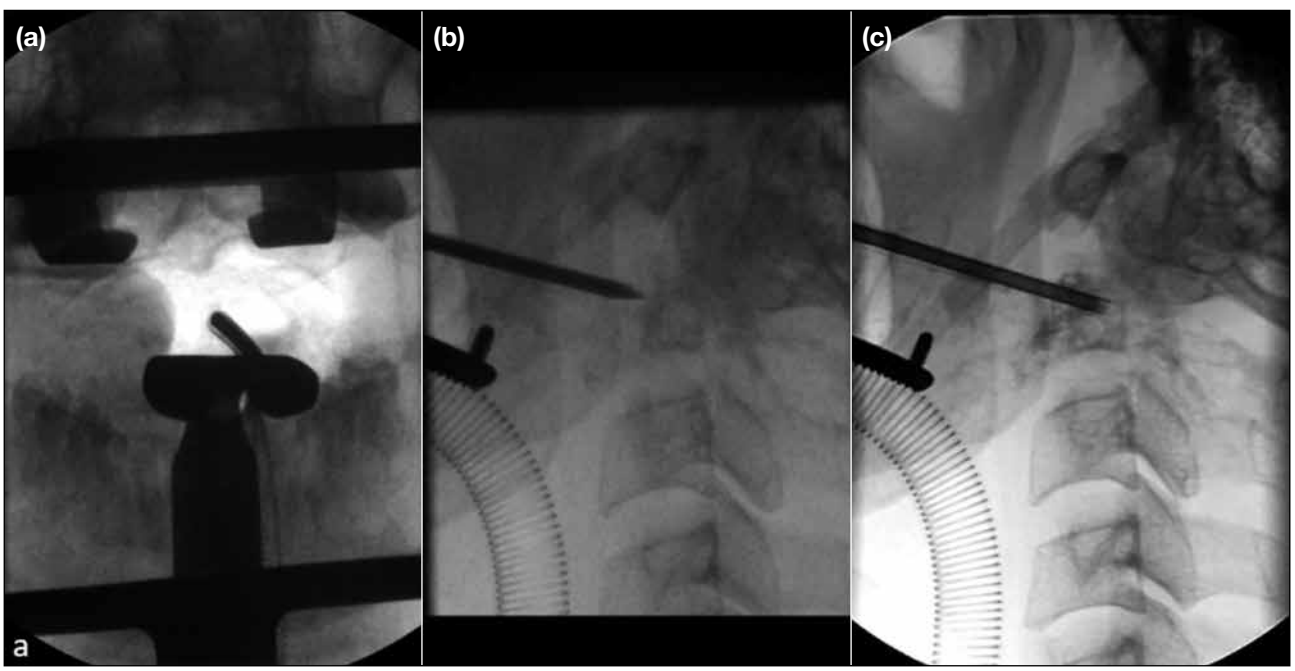

Figure 6. Companion case of vertebroplasty of the C2 vertebra using a transoral approach, in a case of plasma cell neoplasm. Fluoroscopy images showing Murphy's needle in an end-on view (a) and a profile view (b). Figure 6c shows the needle within the C2 vertebral lesion delineated by the injected contrast.

Table. Patient demographics and results.

Case #	Age	Sex	Site	Patient position	Needle path	Result
1	44	F	C2	Supine	Lateral	Tuberculosis
2	72	M	C3	Supine	Lateral	Multiple myeloma
3	23	M	C5	Supine	Lateral	Reactive bone changes
4	47	M	C6	Supine	Lateral	Plasmacytoma
5	53	M	C7	Supine	Transthyroidal	Chronic osteomyelitis
6	55	M	C7	Prone	Posterior	Malignant round cell neoplasm
7	65	F	C7	Prone	Posterior	Metastatic thyroid carcinoma
8	40	M	C7	Supine	Transthyroidal	Non-specific inflammation
9	43	M	C7	Prone	Posterior	Tuberculosis
10	66	M	C7	Supine	Lateral	Poorly differentiated carcinoma
11	21	F	C7	Supine	Transthyroidal	Tuberculosis
12	55	F	C5	Prone	Posterior	Leiomyosarcoma
13	56	M	C2	Prone	Posterior	Metastatic lung carcinoma
14	17	M	C4	Supine	Anterior	Germ cell tumour
15	39	M	C4	Prone	Posterior	Metastatic adenocarcinoma
16	54	M	C5	Supine	Anterior	Tuberculosis
17	59	M	C6	Supine	Anterior	Tuberculosis
18	21	F	C6	Prone	Posterior	Giant cell tumour
19	47	M	C7	Prone	Posterior	Osteosarcoma
20	60	F	C7	Prone	Posterior	Aneurysmal bone cyst
21	53	F	C7	Prone	Posterior	Melanocytic melanoma
22	56	M	C6	Prone	Posterior	Metastatic lung carcinoma
23	38	M	C7	Prone	Posterior	Myeloma
24	35	M	C4	Supine	Lateral	Metastatic squamous cell carcinoma
25	77	M	C3	Prone	Posterior	Chronic osteomyelitis
26	42	M	C6	Supine	Lateral	Plasma cell myeloma
27	47	F	C7	Supine	Transthyroidal	Metastatic thyroid carcinoma

Abbreviations: F = female; M = male.

For cervical vertebral biopsy, different approach routes are selected depending on position of the lesion.[5,6] The routes to access the cervical bone lesions in the suprahyoid neck include transoral, sub mastoid, and posterior approaches. Lesions in the infrahyoid neck can be approached either medial or lateral to the carotid sheath with the patient supine or via a posterior approach with patient prone.

Compared to the much more commonly performed CT-guided biopsy of the thoracic and lumbar spine, cervical spine biopsies are considered more challenging. This is because of the relatively smaller size of the vertebrae and proximity to major vessels and spinal cord. In contrast to the thoracolumbar spine, for cervical vertebral body lesions, the patient needs to be positioned supine. Figures 7 and 8 show the vital structures surrounding the cervical spine. The accuracy of the results is also lower in the cervical spine compared to thoracolumbar spine.[7]

Indications for imaging-guided spine biopsy include confirming or excluding metastasis in a patient with a known primary malignancy; excluding malignancy, especially metastases or myeloma in vertebral body compression; and to confirm the diagnosis of infection and to obtain sample of organism, e.g., spondylodiscitis or osteomyelitis.[8]

There are no absolute contraindications for spine biopsy.[8] Relative contraindications include bleeding disorder, thrombocytopenia-platelet count (<50,000/mm^3) and inability of the patient to cooperate, which may require general anaesthesia.

Complications include haematoma/active bleeding, infection, neurological injury (e.g., cord compression), pneumothorax, and tumour seeding along the needle track if the lesion is a primary tumour (e.g., sarcoma).[8,9] Injury to vital structures can be minimised by real-time ultrasound guidance during the initial course of needle insertion to avoid major vessels, using a thinner needle (21G) at the start of the procedure and exchanging for a larger needle when avoidance of major structures has been assured.[10] The cases did not have any major complications.

The coaxial graded needle exchange technique described ensures maximum safety by avoiding injury to major

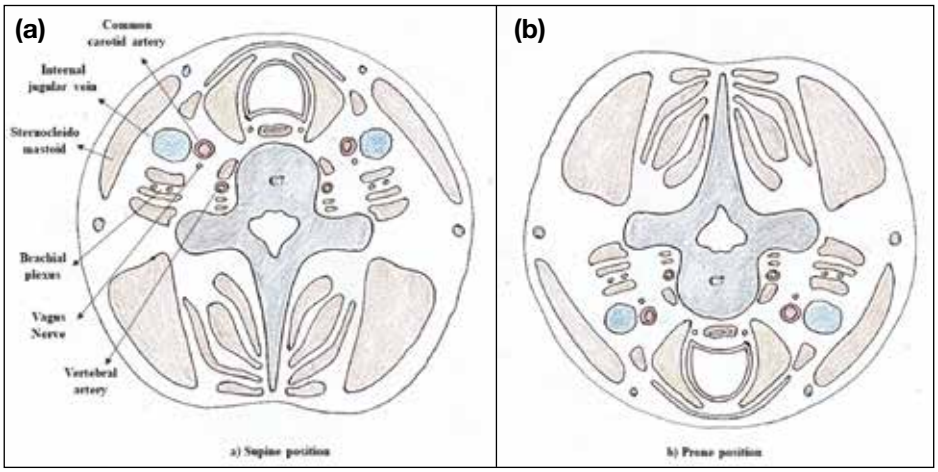

Figure 7. Cross sectional diagram through the seventh cervical vertebra (a) in supine position and (b) in prone position showing the surrounding vital structures.

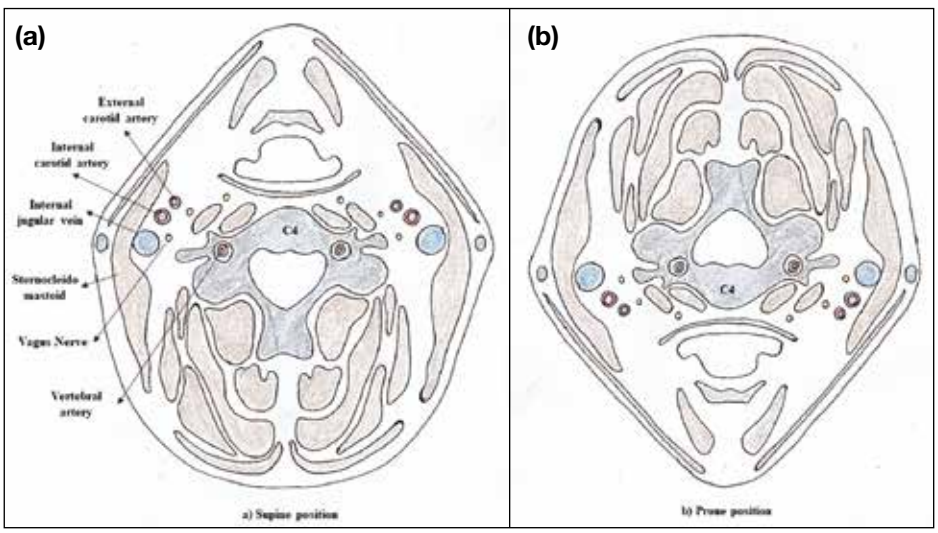

Figure 8. Cross sectional line diagram through the fourth cervical vertebra (a) in supine position and (b) in prone position showing the surrounding vital structures.

neurovascular structures. In our study, we were able to achieve 100% results in attaining the diagnosis with no major complications.

Wiesner et al[11] obtained sufficient sample in 96% (70/73) cases and reported complications in 2/73 patients, in which the patients became hypotensive during the procedure. These patients were conservatively managed. In one patient, the procedure was repeated after 2 days. Cox et al[12] were able to get sufficient material for histopathologic analysis in 41 out of 43 cases (95%).

Yang et al[13] observed a diagnostic yield of 80% in spinal tumours in 197 out of 247 patients including cervical spine (23 lesions), thoracic spine (92 lesions), lumbar spine (96 lesions), and sacral spine (36 lesions). Out of the 23 lesions in the cervical spine, four turned out to be non-diagnostic. McKnight et al[14] were able to perform CT-guided biopsies safely in endoscopically inaccessible areas of head and neck.

Garg et al[15] were able to obtain core sample in all 122 cases (100%) in vertebral bone biopsy by using coaxial needle biopsy and noted that core sampling provided more specific diagnoses in 104/122 patients (85%).

Gala et al[16] found CT-guided percutaneous biopsy is safer than open surgical biopsy with lower rates of complications and shorter hospital stays.

In conclusion, CT-guided percutaneous biopsy of the cervical spine is a minimally invasive, safe, and cost-

effective procedure. Appropriate case selection and planning are important. Additional ultrasound guidance to avoid vessels and use of graded needle exchange technique are helpful in certain cases to obtain adequate diagnostic yield. The limitation of our study is its retrospective nature.

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