Original article:

Fluoroscopy-guided transpedicular biopsy of the spine — Technical aspects, clinical use and safety

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ABSTRACT:

Introduction: The presence of a spinal lesion raises many questions and with accompanying neurodeficit it becomes an urgency. Clinic radiological analysis helps in the diagnosis of these conditions; however in many cases it is prudent to know the exact histopathology or microbiological diagnosis for proper management. Also in cases of infection (especially Tuberculosis) drug sensitivity is essential for management.

Material and methods: A retrospective observational study was done for 22 patients who underwentFluroscopic guided percutaneous transpedicular biopsy for thoracic and lumbar spinal pathology. Demographic and clinico-radiological data; pre-procedure provisional diagnosis; procedur related complications.

Result & Conclusion: Percutaneous Transpedicular biopsy of spinal vertebral lesions can be done safely under local anaesthesia with a high incidence of positivity, helping in clinching the diagnosis and can be performed as a day care procedure.

Introduction:

The presence of a spinal lesion raises many questions and with accompanying neurodeficit it becomes urgency. Clinicoradiological analysis helps in the diagnosis of these conditions; however in many cases it is prudent to know the exact histopathology or microbiological diagnosis for proper management. Also in cases of infection (especially Tuberculosis) drug sensitivity is essential for management. Early stages of spondylodiscitis may be difficult to differentiate from degenerative Modic 1 changes, inflammatory lesions (e.g.sero-negative spondyloarthropathy), amyloidosis, or crystal deposition disease[1,2]on MR imaging, and scintigraphy[3].Hence, biopsy may be required in order to make a distinction amongst these conditions. Also abnormal foci of marrow replacement within the vertebral column that are detected with noninvasive imaging modalities, such as Computed Tomography (CT) or

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Magnetic Resonance Imaging (MRI), also are often referred for spine biopsy. Spine biopsy is often performed to evaluate destructive or space- occupying lesions within the spinal axis.

Various methods for vertebral biopsy have been described. With time, biopsy techniques have evolved from open biopsy to image guided targeted biopsy techniques. Traditionally open biopsy has been the gold standard for musculoskeletal lesions, providing adequate material, however in vertebral lesions, performing an open biopsy can be difficult procedure, which has significant risk of complications.[4,5] Percutaneous biopsy of spine can be performed under various image guided modalities such as fluoroscopy[6,7], computed tomography (CT)[8,9], Ultrasonography (USG)[10,11] and magnetic resonance (MR) imaging[12,13]. The minimally invasive approach reduces recovery time and patient morbidity. Percutaneous transpedicular biopsy of spine under fluoroscopy guidance is faster and cost effective method of performing a biopsy. Unlike CT-guided biopsy it does not require a big set up and can be done when only fluoroscopic C-arm is available. Fluoroscopic guided biopsy has less radiation exposure (compared to CT guided biopsy). More than 50% of the vertebral body tissue is accessible through this approach[14] Thus transpedicular biopsy is a safe, economical and clinically useful procedure in the diagnosis of spinal pathology with or without neurological involvement. The results of the biopsy will affect the subsequent clinical management of the patient and influence treatment decisions in such areas as surgery, chemotherapy, radiation therapy, and antibiotic therapy.

Aims & objectives:

To study the safety and clinical usefulness of Fluoroscopic guidedpercutaneous transpedicular biopsy technique to get an adequate volume of the representative sample of the pathological area accessible through the pedicle

Material and Methods:

A retrospective observational study was done for 22 patients who underwentFluroscopic guided percutaneous transpedicular biopsy for thoracic and lumbar spinal pathology. Demographic and clinico-radiological data; pre-procedure provisional diagnosis; procedur related complications; histopatholgical and microbilogical reports of the biopsy were recorded.

Surgical Technique:

Preparation: Percutaneous transpedicular spinal biopsy can be performed either on an inpatient or outpatient basis. The patients who underwent a percutaneous transpedicular biopsy had all his routine blood investigations, which included hemoglobin, total blood cell count, serum electrolytes, serum creatinine, Blood Urea Nitrogen(BUN), Prothrombin Time(PT) , International Normalized Ratio(INR) and blood sugar levels. Patients who had past history of ischemic heart disease or stroke and were on blood anticoagulants were advised to with hold the medicines seven

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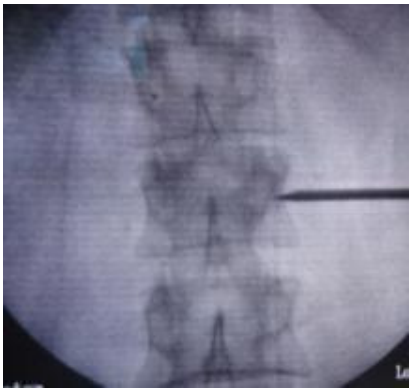
days prior to biopsy and continued thereafter. All the imaging studies (X-rays, MRI, CT scan) were scrutinized and level of biopsy was predetermined. Patients written informed consent was taken prior to the procedure and in case of children guardians consent was taken.

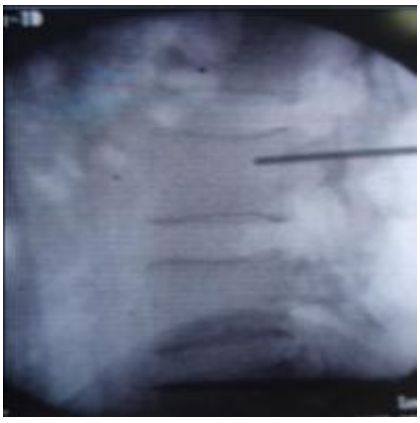
Procedure of Percutaneous Transpedicular biopsy of spine:

The procedure was done under Local anaesthesia except in children and anxious patients were general anesthesia was used.

Steps:

Percutaneous transpedicular biopsy was performed in prone position on a radiolucent table in the operating room. The table on which biopsy was performed had a soft cushion or bolsters arranged onto it to avoid any undue





Antero-posterior and lateral view with a marker placed at L2 vertebra

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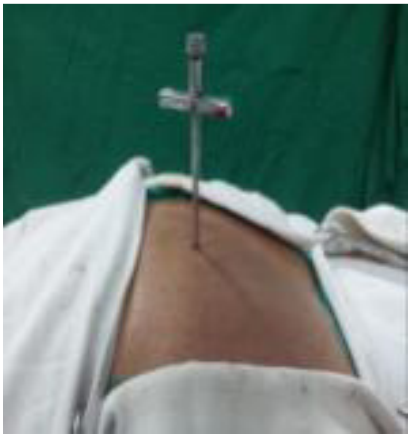
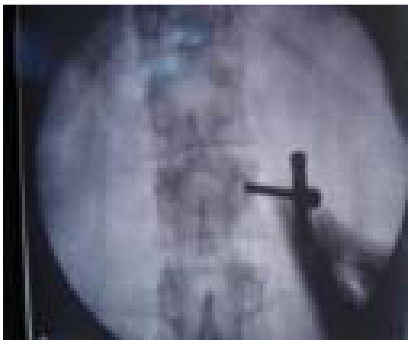
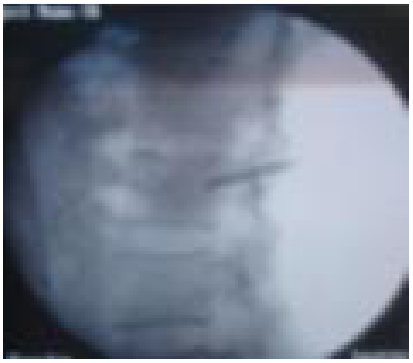


Picture demonstrating insertion of J-needle in prone position.





Antero-Posterior and lateral view showing J-needle position in L2 vertebra

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Figure showing core biopsy of vertebra with J-needle and its components

In planning the needle route, vital anatomical structures, e.g., major blood vessels, nerves, peritoneal cavity, and spinal canal and its contents were avoided. In the thoracic spine, care was taken to avoid the pleural cavity, thoracic aorta, and superior vena cava. In the lumbar spine, the abdominal aorta, inferior vena cava, renal vessels, nerve roots, and organs, such as, the kidneys should not be punctured. The lesion depth, entry point, and angle of the chosen needle route was estimated pre-procedure.

Level of biopsy was decided on the basis of the previous plain radiographs, MRI and CT scan images. Painting with povidone-iodine and draping of the region to be biopsied was done. Once the level was decided, Antero-posterior and Lateral views were taken with the help of a C-Arm and the level of biopsy was marked with the needle. The orientation of the C-arm beam is of critical importance. In AP images the spinous process should be in the midline of the vertebral body, equally placed between both pedicles. The superior and inferior endplate should be parallel, and the pedicles should be appropriately located at the caudal end of the ascending articular process. On the lateral view the superior endplate should appear as one line and the pedicles should overlap and thus appear as one. All the aseptic precautions were followed before performing the percutaneous transpedicular biopsy. Local anaesthesia (1ml 0.1% lidocaine) was administered at the entrance point. A 0.5 cm incision was then made with a No.15 blade 3-4cm lateral to the midline. Subsequently, 10ml bupivacaine was injected with an intravenous canula needle up to the pedicle.

Lumbar vertebrae were approached 5 to 7 cm laterally from the spinous process and with a vertical inclination of 60°. By changing the direction of the needle in a cephalad or caudal direction, tissue from two adjacent vertebrae

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and the intervertebral disk could be obtained. Thoracic vertebrae were approached 4 to 5 cm laterally from the spinous process with a vertical inclination of 30° to 40° over the superior border of the respective transverse process to the vertebral body. A right-sided approach routinely was used unless the lesion was located on the left side.

A Jamshidi needle, which has a trocar, cannula, obturator and a lock, was used to perform the biopsy.Jamshidi needle (8-gauge), which has a core cut of 3 mm was used for the biopsy. The needle was passed through the soft tissues upto the pedicle .An antero-posterior and lateral view was taken and level of biopsy confirmed. The lateral view gives a good view of the anterior trajectory. In AP view, tip of the needle should be either in the centre or lateral to it. Special care was taken not to damage the inferior and medial wall of the pedicle. This is to prevent any damage to the spinal cord by entering into the canal or damaging the nerve root. The trocar is locked in the cannula and entry into the pedicle was made with a gentle tap by a mallet and the needle was then passed into the pedicle, while taking serial antero-posterior and lateral fluoroscopic images. The trocar was removed once it was 0.5 cm away from the lesion and then the cannula was advanced with a screwing motion to perform the core biopsy. The material for culture is withdrawn by means of aspiration. Finally the cannula containing the core biopsy sample was withdrawn with slight rotation.To extract the specimen, a negative pressure was applied to the trephine with a 20-cc disposable syringe, and the specimen was expelled using the obturator. While advancing the needle patient was asked if he had any of the sensory or motor weakness and then needle was advanced and required sample was collected.

All the material obtained was sent for culture, sensitivity and histo-pathological examination.For histologic evaluation, core biopsy samples were fixed in formalin solution; and for microbiological examination, biopsy material was collected in sterile dry tubes. The average duration of procedure was 25-30 minutes.

After biopsy, the puncture site was looked for any signs of hemorrhage or hematoma formation. Single stitch was taken at entry point incision and was cleaned with spirit and dressing was given. Complications if any were managed accordingly. Strict bed rest was maintained throughout the recovery period. The patient was observed in recovery for 2–4 h, depending on the type of anesthesia that was used. Monitoring of the patient, including vital signs, was continued during the recovery period.When the patient was judged to be stable, either by the surgeon who performed the procedure or by the anesthesiologist who anaesthetized the patient, he or she is discharged from the recovery area: an outpatient goes home, an inpatient to a hospital room.

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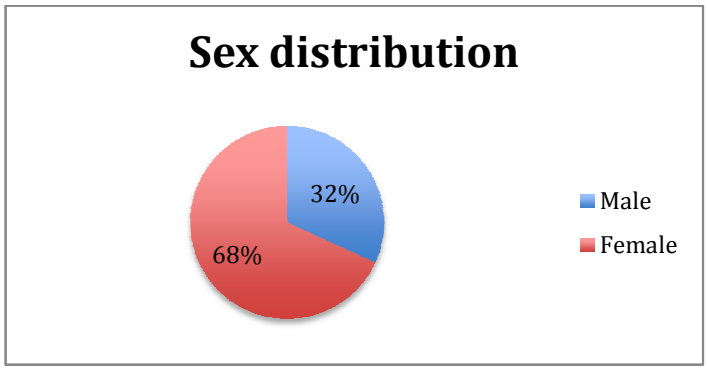
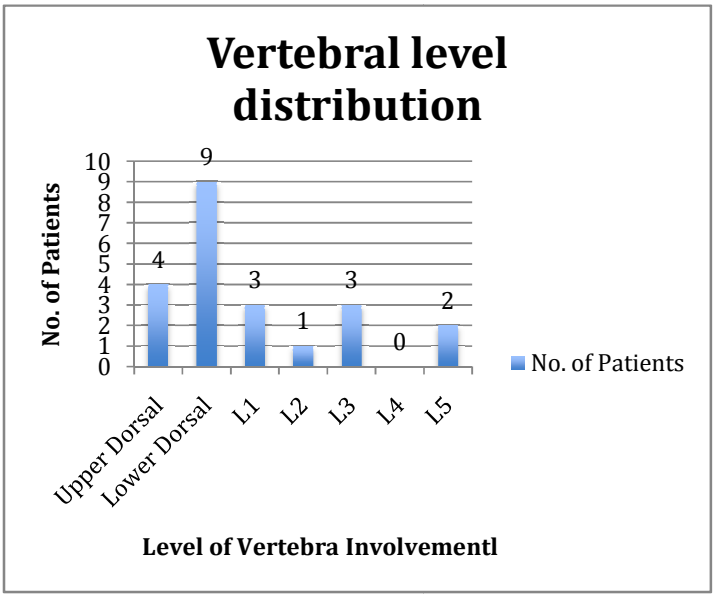
Statistical Analysis:

This was an observational study and no comparative control arm was present. Descriptive statistics was used to represent the data.

Results and Analysis: The fluoroscopic guided biopsies of 22 patients with spinal pathology were performed through posterior transpedicular approach percutaneously. Of the 22 patient's 15 were male(31.8%) and 7 were female(68.1%).

Only one biopsy was performed under general anaesthesia in a 12-year-old patient with a paraspinal swelling and dorsal spine involvement. Rest all the biopsies were performed under local anaesthesia. Vertebral involvement was observed to be more in the lower thoracic region (40.9%), followed by upper dorsal region (18.1%), L1(13.6%), L2(4.5%), L3(13.6%) and L5(9%).





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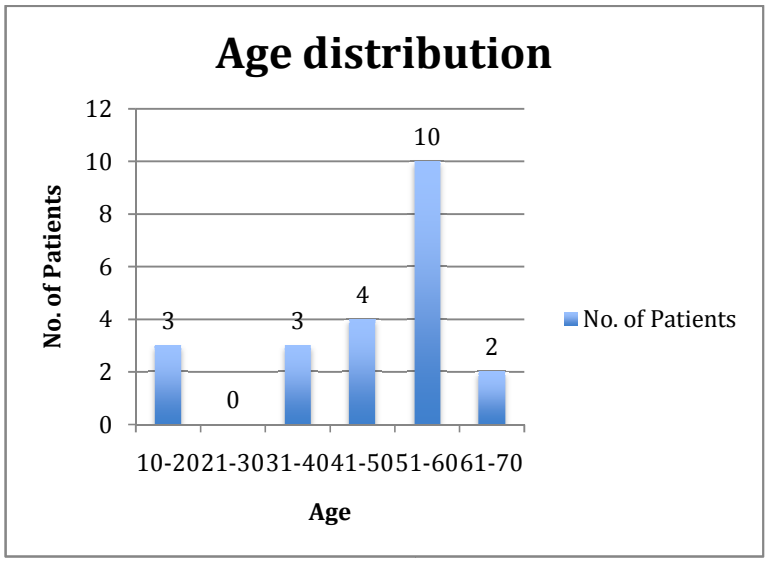
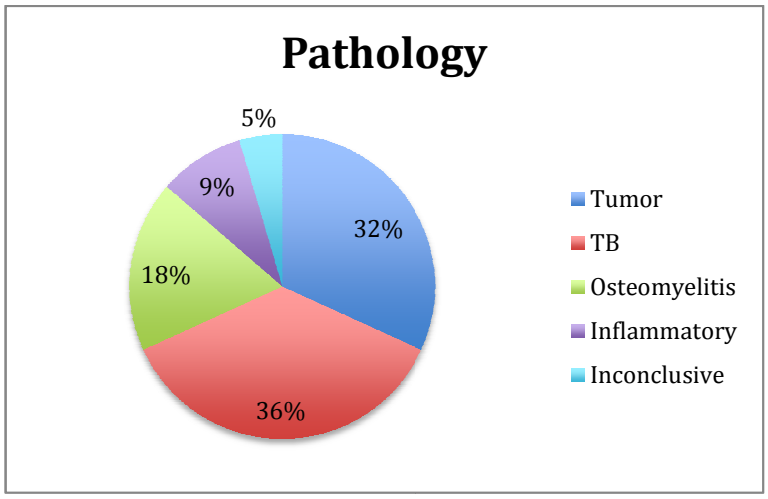


There were seven cases with tumor etiology (three metastasis, one malignant round cell tumor, multiple myeloma, and two lymphomas), eight tuberculosis, four osteomyelitis, two inflammatory and one isolated compression fractures. Four patients who were diagnosed with tuberculosis on histo-pathology had positive TB-MGIT culture & sensitivity pattern.



Two patients with evidence of inflammation but no positive culture had undergone a repeat biopsy that also was without malignant disease and with negative culture. All patients had post procedure localized pain, which got relieved on analgesic medication. Only one patient had complained of persistent pain at the biopsy site, which

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subsided on analgesic treatment. One patient had previously undergone a CT-guided biopsy and the report was inconclusive. On performing fluoroscopic percutaneous transpedicular biopsy in this patient a confirmed diagnosis was achieved. Complications in the form of bleeding, infection, neurologic deficit or internal organ damage were not seen. Patient outcomes were consistent with the histo-pathological diagnosis. We did not find evidence of needle tract contamination by infection or malignancy

Discussion:

Percutaneous needle biopsy of spinal lesions can be performed on an outpatient basis, with a low rate of complications such as bleeding, infection, and contamination of the biopsy tract. In addition, if indicated, it permits subsequent radiotherapy avoiding wound-related problems. The procedure can be performed under local anesthesia and conscious sedation. This provides monitoring of nerve root function during the procedure and helps minimize morbidity.

Percutaneous biopsies may be done under fluoroscopic guidance or CT guided biopsy may be done. Although CT-guided biopsy seems to offer accurate identification of the lesion, there are several disadvantages such as cost, radiation, continuous monitoring is not possible and real time positioning of needle is also not possible. C-arm image intensifier technique offers several advantages such as it can be done in the operating room under aseptic conditions, and in case of a major complication operative intervention may be undertaken immediately. Real-time positioning of the needle is possible and the amount of radiation is also low ascompared to CT guided biopsy.

The transpedicular approach vertebral lesions located immediately anterior to the pedicle and disc space both are accessible. Complications of this technique occur when the medial or inferior walls of the pedicle are violated, resulting in spinal cord damage or nerve root injury. Also, if the biopsy needle penetrates too deeply, it can puncture the aorta or inferior vena cava. The lateral route provides a wide field for needle insertion, allowing access to the lateral wall of two adjacent vertebral bodies and the intervertebral disk. The oblique direction of the needle is easy to maintain, and the needle is a safe distance away from the nerve roots, kidneys, renal pedicle, and large vessels. However, this approach should not be used if forward displacement of the abdominal contents is too small for a safe procedure.

Transpedicular biopsy of the spine is a relatively common approach for both biopsy and vertebroplasty. Potential pitfall of the transpedicular approach, which occurs when the pedicle is not involved by tumor, is the possibility of obtaining a false-negative biopsy result. The solution in such cases is to take deeper and multiple samples.

When aspiration biopsy is anticipated, it should be performed prior to obtaining any core specimens, since the core biopsy can create a hemorrhagic tract that prevents successful aspiration of the desired abnormal tissue. Successful aspiration biopsy requires a secure fit between the aspirating syringe and the needle hub to facilitate forceful suction. Full negative pressure is generated by using a 20-mL syringe while the needle is being advanced and retracted within the lesion. The distance of the needle excursions depends upon the lesion size; large lesions permit safer, longer excursions, and short excursions are required for small lesions adjacent to critical structures .The published accuracy of aspiration biopsy is series dependent and ranges from 23 to 97%. Specific instances do occur in which percutaneous biopsy may be unsuccessful, yielding either no specimen or one that proves to be nondiagnostic. The bony elements of the vertebrae consist of round, hard surfaces. Securing purchase on their normal hard cortex can be difficult when the target lesion lies deep into normal bone. In cases of heterogeneous lesions that are predominantly either cystic or necrotic, it may not be possible to harvest a satisfactory specimens despite multiple attempts. Several maneuvers can be attempted to obtain a specimen. Slight, gentle rocking of the needle may allow separation of the specimen from the parent bone. If the lesion is large enough and there is a margin of safety, then advancing the biopsy needle slightly may enable retention of the bone core within the chamber of the biopsy needle. Applying suction to the biopsy needle with a 20-mL syringe may also facilitate a successful biopsy. Some single-pass bone biopsy needles come with an inner cannula that is partially truncated near its tip to trap the bone core within the parent needle chamber. Alternatively, if the sample size remains unsatisfactory for diagnostic purposes, a larger gauge needle system can be used to obtain a specimen.

Other reasons for a nondiagnostic result include biopsies that are limited either by small lesion size or because too few passes were made with the biopsy needle. Hypervascular lesions can be difficult to sample, since the brisk bleeding that can potentially occur with the initial access to the lesion can terminate the procedure. The intraosseous blood that is often aspirated during bone biopsy is sometimes erroneously discarded. This osseous blood should be considered to be a biopsy specimen and should be submitted for pathological analysis, since it is possible to diagnose malignancy from this tissue .

Occasionally, a discrepancy in accounting for vertebral levels between different modalities causes the wrong vertebral levels to be sampled. Many spine lesions are identified on MRI, yet the percutaneous biopsy procedure is performed either with fluoroscopy or with CT. In certain situations, lesion conspicuity may be so much decreased with the latter modalities that optimal sampling is compromised. With respect to infectious spondylitis, the common reason for a nondiagnostic biopsy result is that patients are already being treated with antibiotics at the time of the

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procedure. Other reasons for a nondiagnostic biopsy result in spine infection include a failure to perform the correct microbiological testing (such as not performing an acid-fast bacillus stain or culture), dismissing as contaminants unusual microbes that may in fact be the causative agents, improper specimen handling or transport (e.g., not using anaerobic culture media when these organisms are suspected), or failing to follow specific cultures (e.g., Mycobacterium tuberculosis) for an extended period of observation.

There are two types of transpedicular failure that can be encountered:

1) if there is a lytic lesion distal to healthy or sclerotic bone and larger bore instruments like trocar instruments

2) if there is a sclerotic lesion distal to the pedicle.

The accuracy rate for lytic lesions is higher than those of sclerotic lesions. It has been recommended to biopsies from the least dense area in a sclerotic lesion and with larger bore instruments like trocar instruments . An experienced bone pathologist is an important factor for the diagnosis of spinal lesions and grading of tumors.

Posterolateral needle biopsy of vertebral lesions has been associated with complications such as nerve root injury, pneumothorax, hematoma, and bleeding from the trephine guide in up to 20% of cases, especially during biopsy of neoplastic lesions,

Careful preoperative assessment of the location of the lesion using CT and MRI is important in determining the site of the portal, thereby avoiding injury of vital structures.

Using a biopsy trocar with the appropriate diameter and collecting the tissue specimen with minimal artifacts are important for effective bone biopsy. Bone cores for histologic examination should be larger than 2 mm in diameter. On the other hand, larger needles may injure nerves or vessels and disseminate malignant tumor cells. Thus, the optimal diameter of the biopsy needle remains an important issue.

Conclusion:

Percutaneous Transpedicular biopsy of spinal vertebral lesions can be done safely under local anaesthesia with a high incidence of positivity, helping in clinching the diagnosis and can be performed as a day care procedure.

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