

## Preliminary results in paediatric percutaneous transthoracic procedures

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## Learning objectives

Report our experience with percutaneous transthoracic biopsies and hook wires positioning in paediatric patients and evaluate safety and efficacy of all procedures.

## Background

Percutaneous transthoracic procedures are commonly performed in adult patients with lung nodules or mediastinal masses. Needle biopsies permit to obtain an histological diagnosis which is fundamental to improve therapeutic planning and determine the prognosis of patients. Hook wire positioning is used to spare lung tissue when surgical resection of nodule is required.

Even different studies confirm their safety and feasibility in adults, there is little literature about transthoracic procedures in paediatric population.

Paediatric thoracic pathology is routinely detected using multidetector CT, which permits depiction also of small structures [1]. Focal lung paediatric pathology includes benign nodules such as hamartomas, chondromas, granulomas, IMTs (inflammatory myofibroblastic tumours) [2-4], while malign nodules are frequently metastases (10-30% of paediatric solid tumours) [5], especially from osteosarcoma, hepatoblastoma and Wilms tumour [6], but also primary malignancies like carcinoid tumours, adenocarcinoma and bronchoalveolar carcinomas [7].

Mediastinal space-occupying lesions in the anterior compartments in paediatric patients include lymphoma, bronchogenic or pericardial cysts, thymic diseases and germ cell tumours (GCTs 6-18% of paediatric mediastinal neoplasm) [8,9]. Thymoma incidence is higher between the 4<sup>th</sup> and 5<sup>th</sup> decade, but even if it is uncommon in children there are few cases reported [10].

CT technique is the most frequently chosen for transthoracic procedures because it offers high quality images and in case of needle biopsies it allows sparing of lung tissue and time in alternative to surgery. Nowadays patients' radiation exposure can be highly reduced using proper parameters of tube current and voltage [11].

Ultrasound is less specific in the determination of masses and nodules, but it uses non-ionizing radiations. Types of lesions most frequently detectable with US are subpleural lesions and huge mediastinal masses.

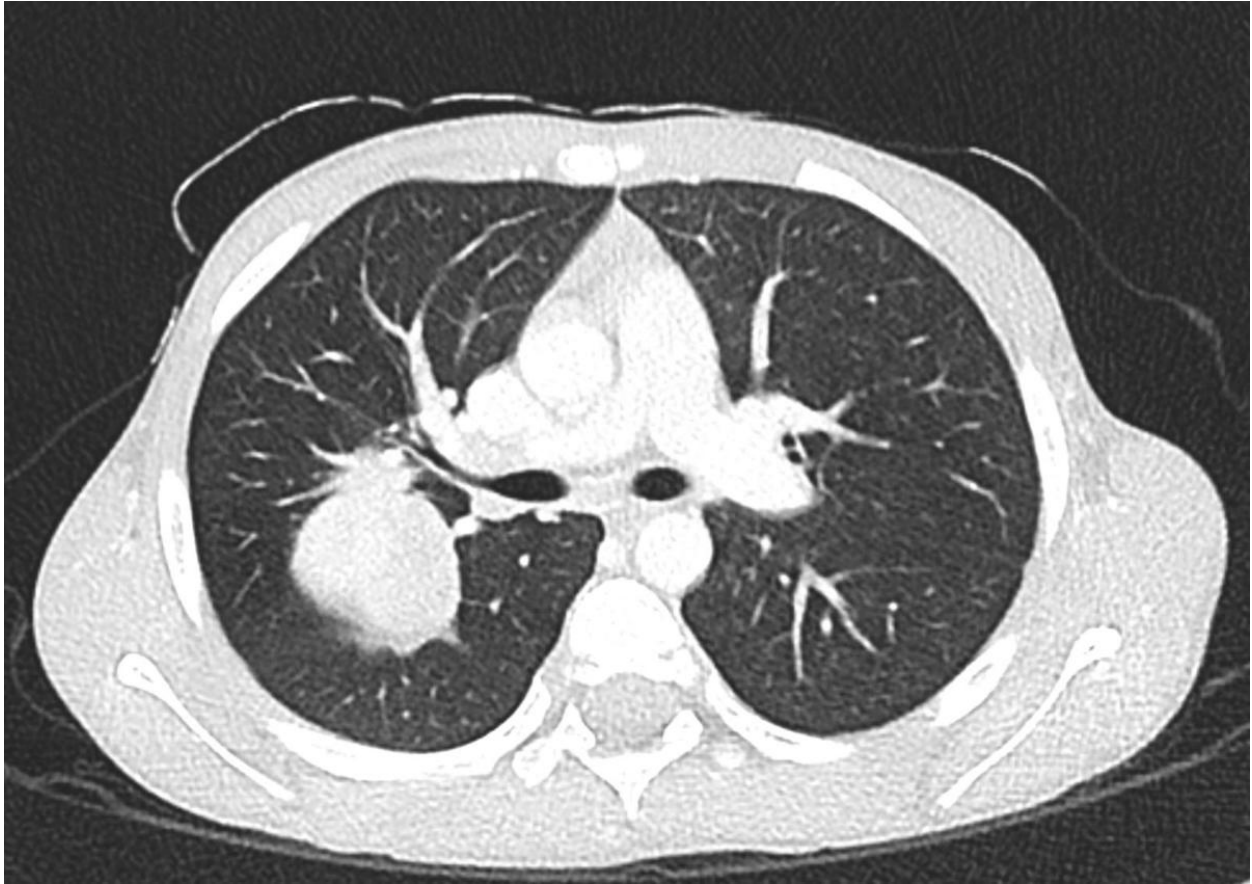
The most frequent complications reported for transthoracic biopsies are described for whole population (paediatric and adult patients) and are pneumothorax (5-64%), haemorrhage along the needle path or in perilesional lung tissue and haemoptysis (5-7%) [12-15]. Pneumothorax is more frequent if there is emphysema or the lesion is less than

2 cm deep from the pleura. It requires chest tube drainage in 2-17% of cases. It can be seen during the procedure, immediately after, or later at chest x-ray control. In our case patients underwent a control chest radiogram after 2 hours by the end of the procedure and remained under observation for 24 hours.

From April 2016 to August 2017 we performed percutaneous transthoracic procedures in 9 patients between 6 and 17 years, 5 males and 4 females; 4 patients underwent to CT-guided lung needle biopsies and 2 to mediastinal lesion biopsies. One patient underwent to US-guided mediastinal needle biopsy.

Two patients with lung nodules underwent to CT-guided pulmonary nodules hook wires localisation immediately before surgery [16,17].

Images for this section:



**Fig. 1:** 6 years old male with lung IMT (inflammatory myofibroblastic tumour)

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**Fig. 2:** 16 years old male with mediastinal germ cells tumour and multiple pulmonary metastases

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## Findings and procedure details

Before all procedures all patients were evaluated by a multidisciplinary team composed by radiologist, oncologic paediatrics, paediatric surgeon and anaesthesiologist. A thorax CT scan or PET-CT scan [18] was performed for each patient as previous imaging investigation. Informed consensus was obtained from parents and children were involved in the explication of the procedure. This was fundamental for the collaboration of little patients during procedures only under local anaesthesia. For each patient coagulation profile was checked (platelets # 25000 mm<sup>3</sup> and INR <1,5).

For CT-guided procedures we obtained low-radiation dose protocol using a 64-slice CT scanner. Patients' position was prone, supine or lateral decubitus, depending on the location of the lesion. A scan was obtained to calculate the needle point of entry and its path. We marked the entry point with a felt-tip pen using the laser grid of the gantry. In the case of lung nodules we always chose the shortest transthoracic distance from the target tissue and the pleura avoiding vital structures; we obtained sequential CT images after each manipulation of the needles (between 3 and 10 images). All biopsies were performed applying the coaxial technique to diminish the number passes through the visceral pleura, reduce the risk of pneumothorax and obtain a higher number of specimens. Coaxial technique has been used since 1990's [19] for biopsies of small pulmonary nodules in children and permitted to obtain adequate cores without significant morbidity. In our case, after injection of subcutaneous lidocaine, we inserted a puncture sheath (16 G) and a semiautomatic biopsy hand with quick release mechanism (18 G), obtaining almost three samples for each patient, soaked in jars of formalin and sent to laboratory investigation.

The localisation of lung nodule before surgery previewed the CT guided positioning of two 20 G hook wires for each nodule. The introducer needle was inserted through the skin, and after sequential CT images control to confirm the position of needle beyond the nodule, it was removed over the hook wire. A final image control was obtained to confirm the correct position of hook wires. Then the patient was transferred to surgery room.

In only one patient we performed US-guided to biopsy an anterior mediastinal mass; in this case we apply a needle bracket to the linear probe (9 MHz) and performed biopsy with coaxial technique.

In the majority of cases reported in literature thoracic biopsies required general anaesthesia [20], especially in patients younger than 15 years old. According to all multidisciplinary group, we preferred to perform procedures under sedation or local anaesthesia, depending on the compliance of patients. Anesthesiological evaluation

was obtained for all patients, but in our group only four biopsies required sedation; in the other biopsies, performed using only local anaesthesia, there was excellent compliance of patients. In any case during all procedures patients were monitored by the anaesthesiologist. Nodules localisation with hook-wire was performed immediately before surgery, using the same sedation for the intervention.

Adequate core biopsies were obtained in all patients; in one case histological examination showed false negative results and surgical evaluation was performed.

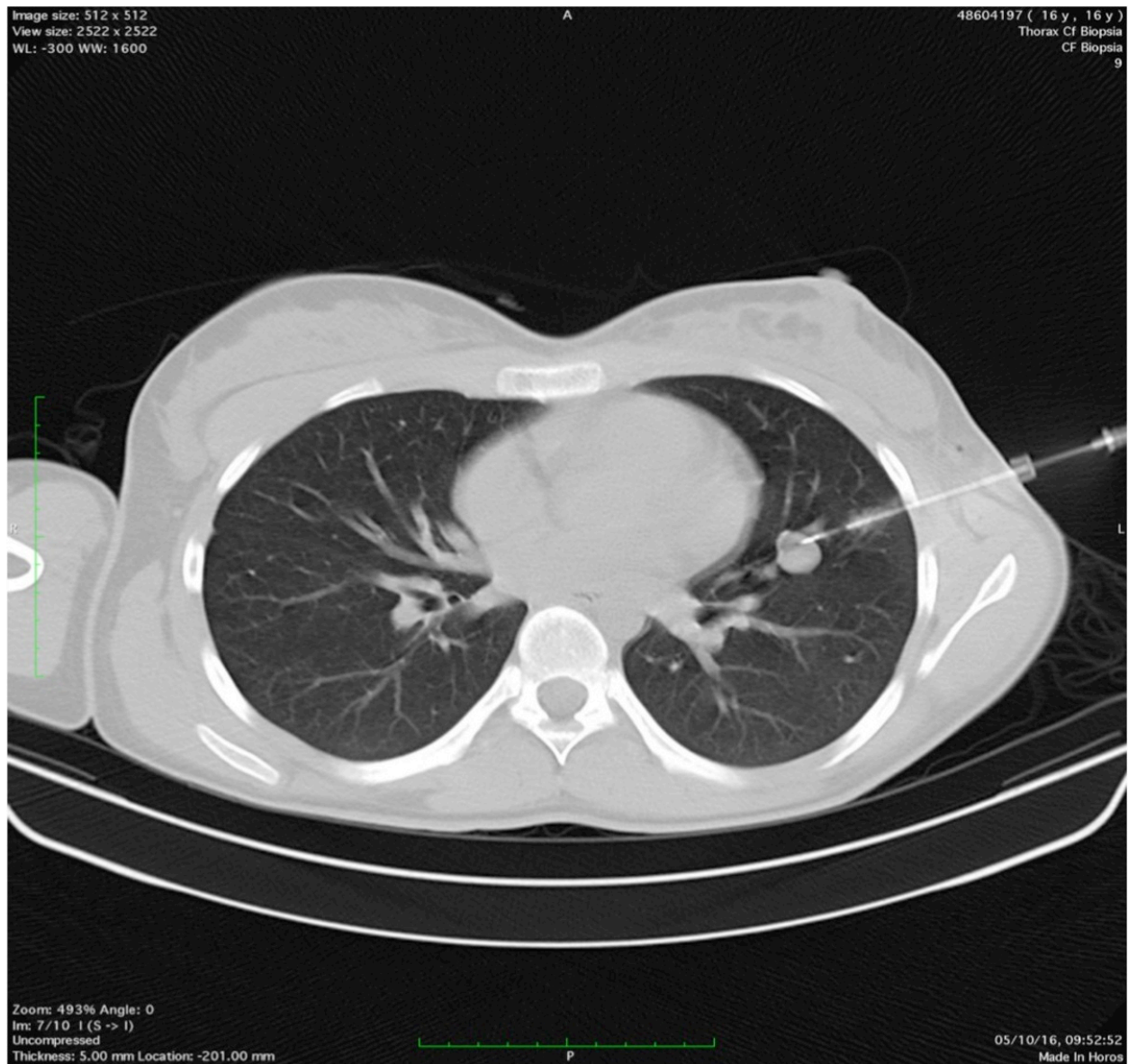
The hook wires were successfully positioned in all cases preventing more invasive intervention; their exact location was also confirmed by pathological examination Post procedure period was always normal; we observed two perilesional haemorrhages and one pneumothorax, but none of them required treatment.

All biopsied patients avoided other invasive investigations, except the non-diagnostic case who underwent to thoracotomy.

Both hook wires positioning were targeted and useful for lung lesions finding during the surgery.

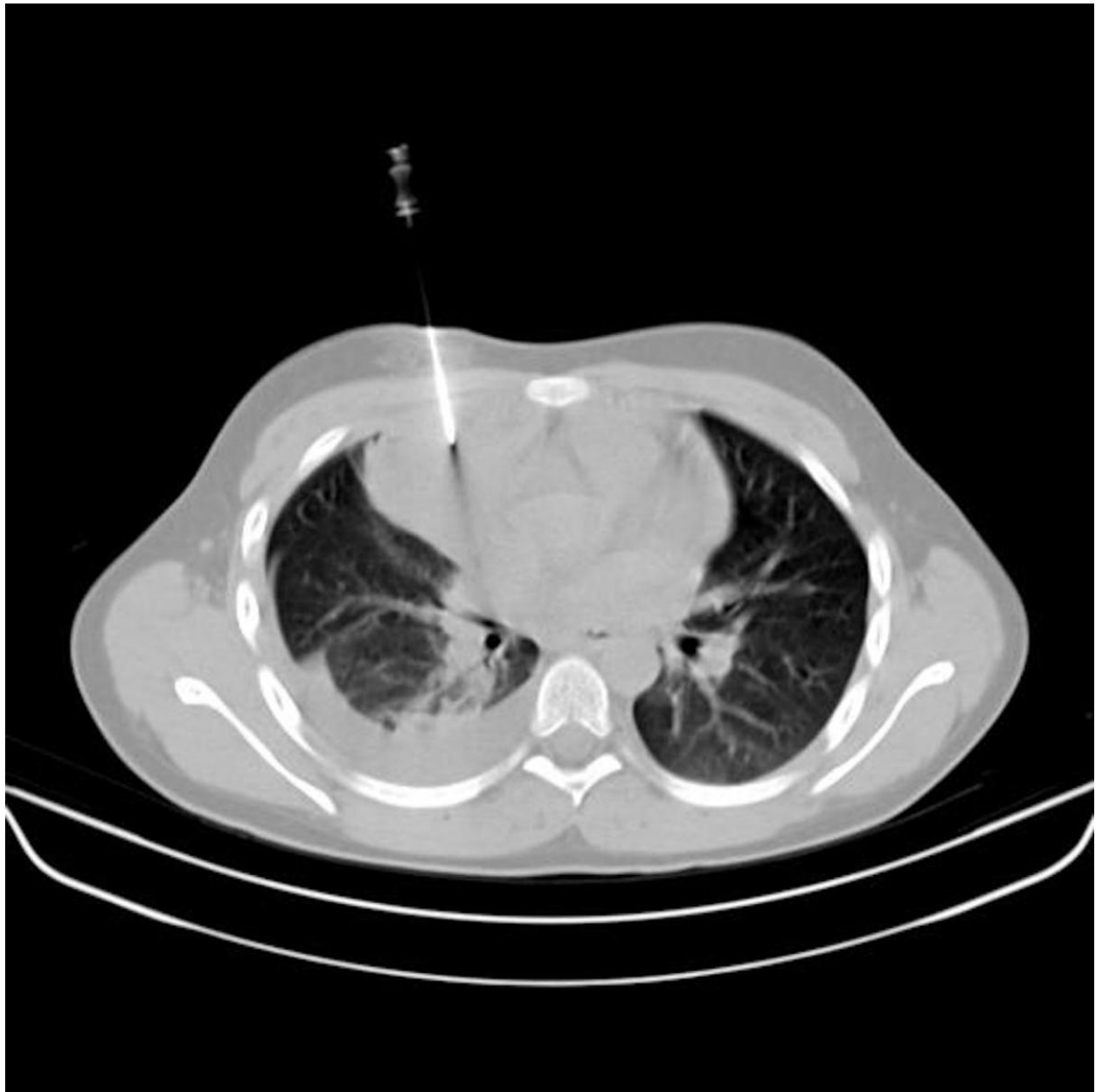


Images for this section:



**Fig. 3:** Lung biopsy of PET negative nodule in 16 years old female with GIST (Gastrointestinal Stromal Tumour)

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**Fig. 4:** Mediastinal biopsy in 17 years old male patient with germ cell tumour

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**Fig. 5:** Hook-wires positioning in 9 years old male patients with pulmonary metastases of hepatoblastoma.

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## Conclusion

In our experience, percutaneous transthoracic procedures are effective in paediatric patients, without significant complications.

Sedation is not always required for biopsies and the hook wired positioning can be performed using the same sedation for surgery; so, these procedures don't require necessary additional sedation if radiologists, anaesthetists and surgeons collaborate into a multidisciplinary management of patients.

For justified indications low dose radiation protocol can be safely used in paediatric population, adapting tube current and voltage selection and using iterative reconstruction algorithms, in according to the main principle in radiation exposure "as low as reasonably achievable".

Every case should be discussed in a multidisciplinary team and the use of US should be considered when possible.

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