Ultrasonically guided fine needle puncture of focal liver lesions Review and personal experience

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Abstract

Despite recent advances in diagnostic imaging of the liver, the management of a patient with focal liver lesions often depends on obtaining tissue for histological diagnosis. Ultrasound guided fine needle biopsy is recommended as a safe and reliable method for cyto-histological confirmation of suspected hepatic malignancy. A fine needle is conventionally defined as having an outer diameter $\leq$ 0.9 mm or $\geq$ 19 G. Ultrasound guided fine needle aspiration cytology is found reliable for diagnosing malignancy. Limitations of this method are inadequate sampling and limited value in diagnosis of well-differentiated malignant tumours and benign tumours. Ultrasound guided fine needle cutting biopsy allows to obtain tissue for histological examination according to the Menghini technique. Both methods have high sensitivity, specificity and accuracy in detecting malignancy. In a personal series of 50 fine needle aspiration cytologies, a sensitivity for malignancy of 87% was obtained, with a specificity of 100%. The insufficient sampling rate, however, was 10%. Ultrasound guided fine needle trucut biopsy combines the advantages of a fine needle and a better sampling quality ; a lower insufficient sampling rate can be expected without increase in complication rate. Despite the availability of numerous manually operated or (semi-) automated devices, little data have been published up to now on liver lesions. In our hands, it has proven to be a safe and reliable method, with low insufficient sampling rate, allowing correct identification of primary liver malignancies, correct suggestion of the primary source of the majority of metastases and correct identification of most benign liver lesions. Therefore it is considered as the method of choice when focal noncystic liver lesions are to be biopsied. (Acta gastroenterol. belg., **1998**, 61, **158-163**).

Key words : liver lesions, ultrasound guidance, fine needle aspiration biopsy, fine needle trucut biopsy.

1. Introduction

Improved imaging techniques in medicine have led to a more frequent detection of sometimes small focal liver lesions. A typical simple cyst presents on ultrasound as a round, sharply demarcated echofree area with distal acoustic enhancement (Fig. 1). A typical haemangioma presents as a small, sharply demarcated hyperechoic lesion, mostly in close contact with a branch of a hepatic vein (Fig. 2). However, focal liver lesions may present atypically. Haemangiomas may have an echopoor aspect or show heterogeneity especially when they are large. The echopattern of metastases may vary from echorich to almost echofree, without consistent correlation to tumour type. Also other imaging techniques do not always allow to characterize the lesions. There is a need for a precise invasive procedure allowing tissue sampling for cytological or histological examination. In comparison with computed tomography, ultrasound (US) guidance al-

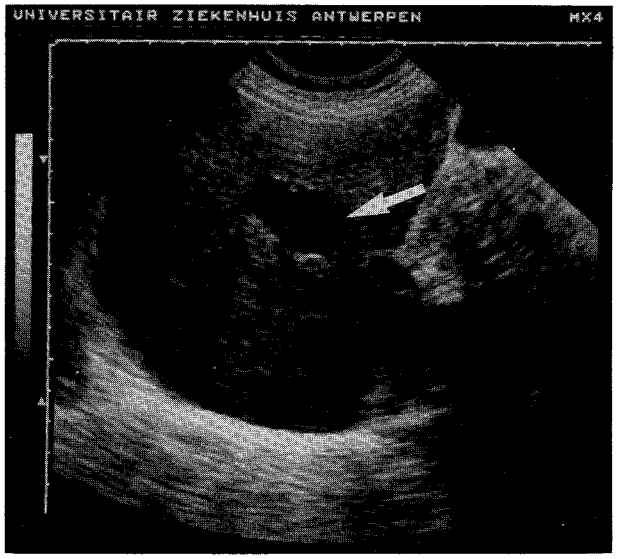

Fig. 1. — Subcostal section through the right liver showing a typical liver cyst (arrow) with distal acoustic enhancement.

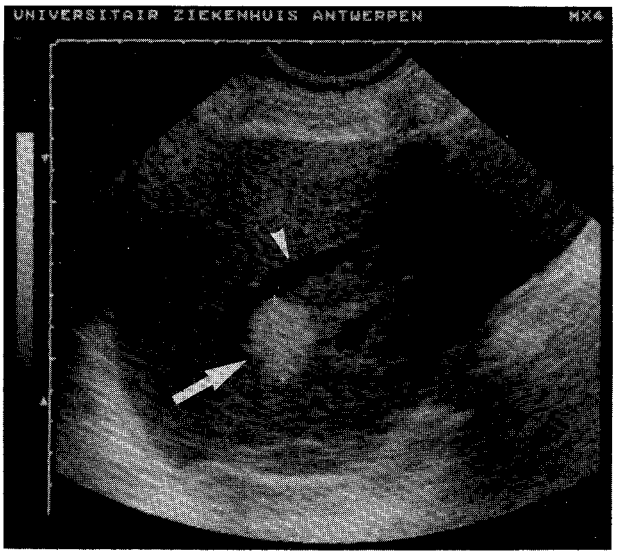

Fig. 2. — Longitudinal section through the right liver showing a typical haemangioma (arrow) in contact with a hepatic vein (arrowpoint).

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lows a quick, safe and relatively inexpensive means of percutaneous puncture of space-occupying liver lesions. It can be performed bed-side and does not expose to radiation.

2. Indications to perform biopsy of focal liver lesions

US guided liver biopsy is carried out for following three main indications (2).

1. To verify the presence of liver metastases in patients with known malignant disease in order to assess the correct stage of the disease, and thus defining the oncological management.
2. To determine the nature of the primary tumour in patients with liver metastases and occult malignant disease.
3. To obtain the cytological or histological background of focal liver lesions, suspect but not certain, for malignancy.

3. Percutaneous liver biopsy techniques

Liver biopsy is being performed since the end of the 19th century. Two types of needles are used. The Menghini needle obtains a specimen by aspiration (3). The Trucut needle is sheathed with an outer cannula and an inner cutting needle (4). For diagnosis of diffuse liver disease large bore needles are used, mostly with an outer diameter of 14 G (2.1 mm) or 16 G (1.65 mm). The amount of liver tissue obtained with a 14 G needle is approximately 50 mg (5). For the diagnosis of liver tumours, fine needle guided biopsy is particularly useful. A fine needle has an outer diameter equal to or less than 0.9 mm (19 G) (2). The amount of liver tissue obtained with a 22 G (0.7 mm) needle is only 4-5 mg, which makes this approach unsuitable for diagnosing diffuse liver disease (5). The complication rate, however, depends on the calibre of the needle.

In the seventies, Holm *et al.* constructed special ultrasound probes to guide the puncture of focal lesions (6). US guided fine needle biopsy is now generally accepted as a reliable and safe technique to examine focal liver lesions. Three different types of fine needles can be used (Fig. 3).

— Fine needle aspiration biopsy (FNAB) with a spinal needle having a bevel of varying angulation but no cutting edge is suitable to obtain small tissue samples for **cytological** examination. During biopsy negative pressure is applied with a syringe. A fine needle mounted on a syringe in an aspiration handle is ideal for one-handed manipulation, because one hand is engaged in holding the transducer.

— Fine needle cutting biopsy (FNCB) is performed with a needle having a cutting tip with or without a bevel, which enables to obtain tissue for histology.

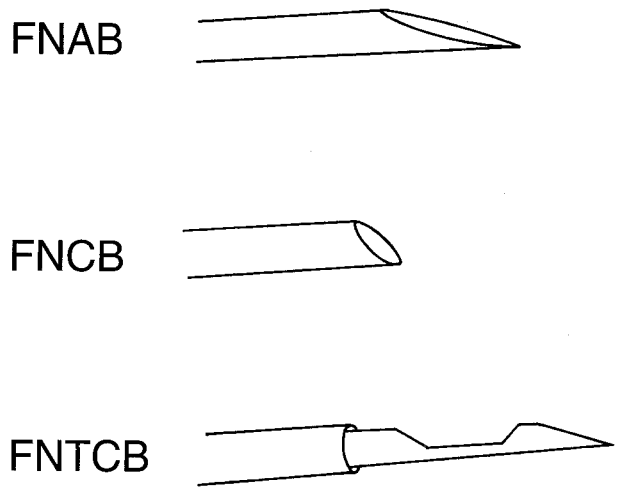

Fig. 3. — Needle tips. a) FNAB using a needle without cutting edge ; b) FNCB with a short bevel and a cutting tip ; c) FNTCB with an inner stylet with a notch and a cutting sheath.

Histological biopsy requires the presence of a stylet, preventing the biopsy from being fragmented or distorted by violent aspiration into the syringe. The Surecut® needle is a modified Menghini needle uniting needle, stylet and syringe. The stylet is attached to the plunger of the syringe. As the plunger is retracted and negative pressure applied, the stylet moves with it, revealing the cutting tip of the needle. This device can be manipulated with one hand.

— Fine needle trucut biopsy (FNTCB) combines a fine needle with a trucut technique. This needle has an inner stylet with a side notch and a cutting sheath. Numerous manually operated and automated devices are available.

4. Cytology or histology

Aspiration cytology is a reliable method of diagnosing malignancy in most tissues. False negatives occur, because of faulty guidance and sampling error due to small tumour size, inexperience, or a particularly deep and inaccessible site. A major cause of failure is inadequate sampling because of inappropriate or too few cells being harvested : fibrotic lesions, necrotic tumours, vascular tumours such as haemangiomas. Furthermore, cytology in its own is inadequate in some patients with well-differentiated tumours such as cholangiocarcinomas, hepatocellular carcinomas or lymphomas, and benign tumours.

Specimens for *histological evaluation* have many advantages. The specimen can be oriented in relation to the tumour mass and surrounding tissues, numerous sections can be taken and hence a number of different staining techniques can be used. In contrast with cytology, where isolated cells or cell groups are studied, histological specimens allow to evaluate the cells in their mutual relationship.

Fine needle histology has been found to be superior to cytology in the diagnosis of benign liver lesions, hepatocellular carcinomas and lymphomas (5,7,8).

5. Principles of ultrasonically guided biopsy

In its simplest way an US guided biopsy is performed free-handed. The needle is introduced close to the transducer and visualized as it enters the soundfield. The needle, however, will not be visualized when it takes a wrong direction and leaves the soundfield, that is only a few millimetres in width. This procedure is therefore only suited for superficial and large structures. Guiding mechanisms ensure that the needle follows a predetermined path in the soundfield and make accurate needle placement possible. A special linear array puncture transducer contains a needle canal. A crystal is missing where the needle penetrates the face of the transducer causing a vertical defect in the ultrasound image (Fig. 4). Any transducer can be mounted with a steering attachment guiding the needle into the soundfield from the side.

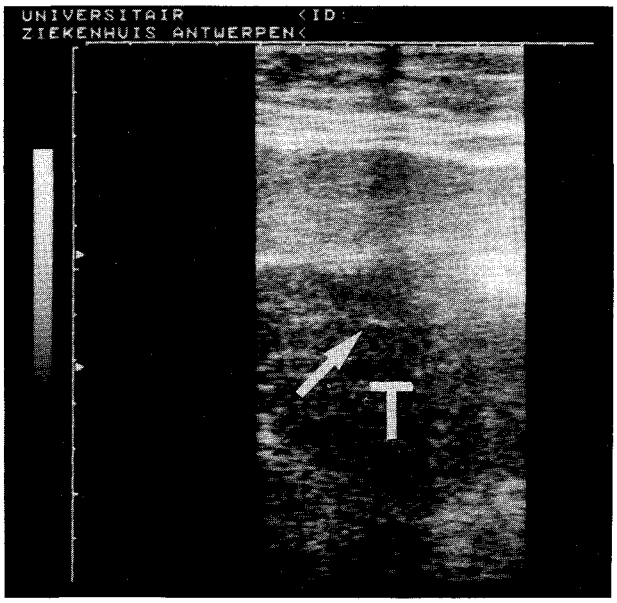

Fig. 4. — Ultrasound image with the linear array puncture transducer showing the needle tip (arrow) in a liver tumour (T).

6. Results of different US guided fine needle techniques for biopsy of focal liver lesions

The primary objective of fine needle biopsy of focal liver lesions is to differentiate between malignant and nonmalignant space-occupying lesions. The results in most series are evaluated by different indices (Table I). Sensitivity (true positive results) is the percentage of biopsy specimens read as abnormal in the group of patients with proven malignant disease. Specificity (true negative results) is the percentage of biopsy specimens read as normal in all patients free of malignant disease. Overall accuracy is defined as the percentage of the correct abnormal and normal readings in all patients. The predictive value of positive or negative result is defined as the percentage of normal or abnormal readings proven to be correct.

Other objectives of fine needle biopsy of focal liver lesions could be the correct differentiation of primary malignant liver lesions, the correct prediction of the primary tumour of liver metastases, and the correct identification of focal benign lesions. Another interesting aspect of comparison of different methods is the rate of insufficient sampling, which often is not taken into account when calculating diagnostic indices.

A summary of literature data on US guided FNAB and FNCB of liver lesions is given in Table II (8-15).

Table I. — **Diagnostic indices used to evaluate the results of fine needle biopsies**

— Sensitivity : TP / (TP + FN) × 100%
— Specificity : TN / (FP + TN) × 100%
— Accuracy : (TP + TN) / (TP + FP + TN + FN) × 100%
— Predictive value + test : TP / (TP + FP) × 100%
— Predictive value - test : TN / (FN + TN) × 100%

TP : true positives ; TN : true negatives ; FP : false positives ; FN : false negatives.

Table II. — **Literature data on FNAB/FNCB of liver lesions**

Author (year)	Reference	Type of needle	Number of biopsies	Sensitivity (%)	Specificity (%)	Accuracy (%)	Predictive value neg. test (%)	Insufficient sampling rate (%)
Montali ('82)	9	FNAB	126	92	100	94	72	4.8
Holm ('85)	2	FNAB	247	91	100	92	60	0
Holm ('85)	2	FNCB	75	94	100	96	88	1.3
Sautereau ('87)	10	FNAB	97	83	93	86	83	6.2
Limberg ('87)	8	FNCB	84	88	100	93	84	?
Solmi ('89)	17	FNCB	85	91.5	100	91.5	NA	29.5
Dumas ('90)	11	FNAB	199	92	100	92	90	5
Fornari ('90)	12	FNAB	481	93	100	95	84	0
Buscarini ('90)	13	FNAB	972	91	99	93	81	?
Buscarini ('90)	13	FNAB	484	93	100	95	84	?
Buscarini ('90)	13	FNAB+CB	493	97	100	98	91	?
Fornari ('94)	14	FNAB/CB	395	86	100	90	73	1.3
Borzio ('94)	15	FNAB	93	78	71	76	48	7.5
Borzio ('94)	15	FNCB	97	81	86	81	58	3.1
Michielsen	(this paper)	FNAB	50	87	100	89	58	10

Table III. — **Literature data on (F)NTCB of liver lesions**

Author (year)	Reference	Type of size	Number of biopsies	Sensitivity (%)	Specificity (%)	Accuracy (%)	Predictive value neg. test (%)	Insufficient sampling rate (%)
Jennings ('89)	16	18 G	84	94	100	95	83	0
Solmi ('89)	17	21 G	85	91	100	91	NA	4.7
Tikhakoshi ('93)	18	18 or 20 G	89	94	100	99	98	6.7
Duysburgh ('97)	27	21 G	68	90	100	92	81	1.5

NA : not available

It is obvious that sensitivity and specificity in detecting malignancy are high. The predictive value of a negative test (nonmalignancy), however, often is low. This means that a nonmalignant result is not that certain. The rate of insufficient sampling can be high, and is not always mentioned in the results.

From FNTCB a better sample quality for histological examination and a lower insufficient sampling rate can be expected without an increase in the complication rate. Despite the increasing popularity of automated biopsy guns, little data are available in the literature (Table III). Jennings *et al.* (16) report on US guided trucut biopsies in 84 focal liver lesions with a 18 G (1.2 mm) spring-loaded device, describing no insufficient sampling. Solmi *et al.* (17) performed US guided FNTCB with a 21 G (0.8 mm) Urocut® needle in 85 patients with focal liver malignancy and reported an insufficient sampling rate of only 5%. The Urocut® needle is a fully manually operated trucut device. As only malignant lesions were examined, the predictive value of a negative test was not evaluable. Tikhakoski *et al.* (18) report on 83 focal liver lesions punctured with a 18 or 20 G cutting needle, not entirely fitting with the definition of a fine needle.

7. Complications

The complication rate of percutaneous liver biopsy is well known. A multicentre retrospective study of 68,276 liver biopsies by Italian investigators yielded a mortality rate of 0.009% and an overall complication rate of 2.2%, the risk being less with the use of the Menghini needle as compared to the Trucut technique (19). In a more recent series of 9,212 biopsies, there was a 0.11% fatality rate (20). The complication rate clearly depends on the calibre of the needle used. The risk of fine needle biopsy is low. About 0.5% minor complications, 0.05% major complications requiring surgery or having other sequelae, and 0.008% mortality rate are reported (21-23). Patients with bleeding tendency or with prothrombin time $< 50\%$ and platelet count $< 70\text{-}100 \times 10^9/l$ are mostly excluded. Even the possible angiomatous nature of hepatic lesions should not be considered an absolute contraindication to biopsy (24,25). To minimize the risk, a route traversing normal liver when performing such biopsies is recommended (26). Cutting fine needles do not cause more complications than aspiration fine needles (22). Subcutaneous seeding after percutaneous US guided fine needle aspiration of liver tumours is a rare complication and only a few cases have been reported (27). It is estimated between 1/10,000 and 1/30,000 punctures. It increases with the diameter of the needle, the number of passages through the lesion and the amount of normal parenchyma around the lesion to be traversed by the needle. It is therefore recommended to have a minimum of 1 cm of normal parenchyma surrounding the mass (27).

8. Personal results

We have been performing US guided fine needle biopsies on focal liver lesions since 1981. Prior to 1990, FNAB was performed on focal solid liver lesions. A series of 50 FNAB biopsies in 50 consecutive patients was analyzed. The patients were 29 males, 21 females, mean age 62 years, range from 24 to 84 years. The FNAB was performed with a 22 G (0.7 mm) needle of 10 cm, for the aspiration we used a disposible syringe of 20 ml fitted in a holder. The lesions were localized by means of a real-time puncture transducer (Toshiba), 4 or 5 MHz. The aspirate was smeared out on glass slides, fixed for 15 minutes in p.a. methanol and stained for May-Grünwald Giemsa, or treated with a spray fixative (Merckofix or Scires) and stained according to Papanicolaou. The final diagnoses, established by histology of material obtained by surgery, endoscopy or autopsy, or by a clinical course consistent with the diagnosis, were : 8 benign liver lesions (among them 5 haemangiomas), 42 malignant lesions (among them 2 hepatomas and 1 cholangiocarcinoma). The results are given in Tables II and IV. In 5 patients (10%) insufficient material was obtained for cytologic diagnosis (peripheral blood or only necrotic cells). Out of 38 malignant tumours, 33 were correctly diagnosed (sensitivity for malignancy 87%). Among the 5 false negatives was 1 hepatoma. There were no false positives (specificity for malignancy 100%). The predictive value for a nonmalignant result was only 58%. The benign lesions could not be specified. There were no complications following the procedure, not even when puncturing haemangiomatous lesions.

From 1990 on we use US guided FNTCB (Temno Biopsy Gun®, Bauer), 21 G (0.8 mm), 15 cm long, to puncture solid focal liver lesions. This is a semi-automated device. After needle placement with the tip

Table IV. — **Fine needle aspiration cytology of focal liver lesions, correlation between cytological diagnosis and final diagnosis**

	Cytological diagnosis			
Final diagnosis	Malignant cells	Normal liver cells	Insufficient material	Total
Malignant	33	5	4	42
Benign	0	7	1	8
Total	33	12	5	50

just in front of the lesion, the central stylet is advanced manually by means of a plunger on the end of the handle to expose the side notch. After the plunger is advanced into the lesion, the outer cannula is thrusted forward by triggering a spring loaded device, thus trapping the specimen in the exposed side notch (Fig. 5). This device allows accurate manual positioning of the central stylet into the lesion. Furthermore, the biopsy gun can be operated by one hand, thus leaving one hand free to manipulate the echotransducer, used to guide the biopsy. An illustration of the tissue core obtained with the Biopty gun is given in Fig. 6. The results of a preliminary series of 68 evaluable fine needle trucut biopsies are published in detail elsewhere (28) and are summarized in Table III. There was only 1 insufficient sample (2%). All primary liver malignancies (11/11) and 87% (35/40) of the secondary malignancies were correctly diagnosed, in 57% of the latter a correct primary tumour was suggested. Also 12/17 benign liver lesions were correctly diagnosed. There was only 1 complication, an intraperitoneal bleeding necessitating transfusion.

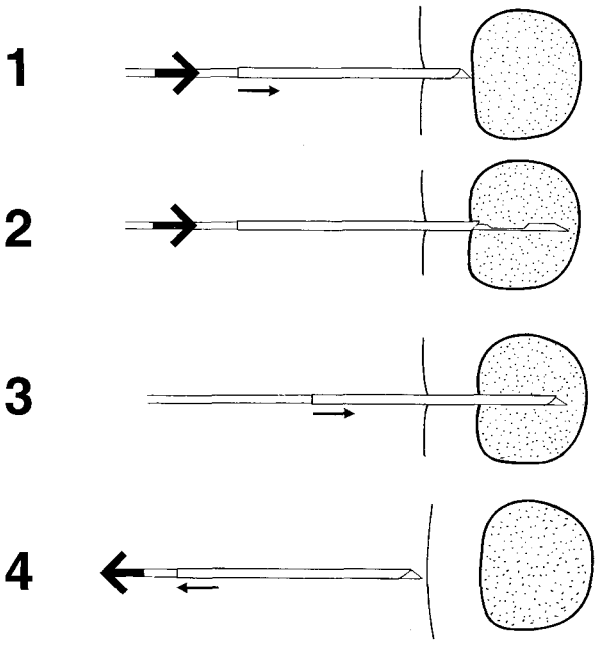

Fig. 5. — Four steps in fine needle trucut biopsy with a Temno® Biopsy Gun :
1. Introduction of the needle into the liver until the needle tip is just in front of the lesion.
2. Advancement of the central stylet into the lesion in order to expose the side notch (manually).
3. Protrusion of the cutting cylinder over the stylet (automated).
4. Retraction of the fired biopsy needle.

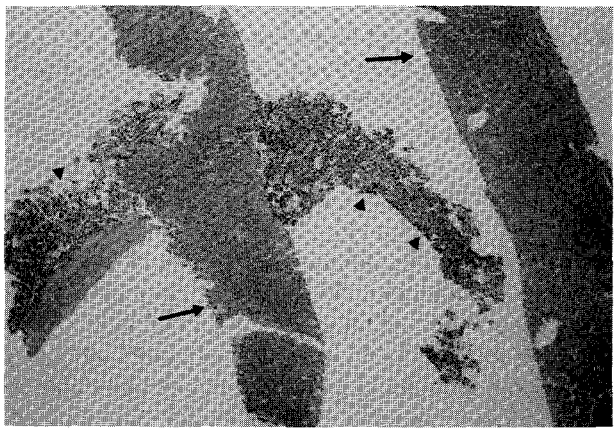

Fig. 6. — Haematoxylin-eosin stained paraffin section of a fragmented tissue core obtained with the Biopty gun, composed of normal liver (arrows) and metastasis of a pancreatic neuro-endocrine tumour (arrowheads) (magnification × 50).

The FNAB and FNTCB were statistically compared. There was no significant difference in age (Student's t-test for unpaired observations) or gender (chi-square test) distribution. The sensitivity for malignancy and predictive value of a nonmalignant result were not significantly different (chi-square test). The insufficient sampling rate tended to be lower in the FNTCB series, but the difference did not reach statistical difference ($p = 0.084$, chi-square test).

Although sensitivity, specificity and accuracy in the two series are similar, the latter method is now preferred on solid lesions because of improved detection of primary liver malignancies, possible identification of the origin of metastases and the possibility to identify benign lesions. Also the rate of insufficient sampling tends to be lower. We now reserve FNAB for cystic lesions to be punctured. For the aspiration of pus US guided 18 G (1.2 mm) needles are used.

9. Conclusions

US guided fine needle biopsy of focal liver lesions is a safe and highly accurate technique to diagnose malignancy. FNTCB combines the safety of a fine

needle with the possibility to obtain a more accurate histologic diagnosis of primary liver malignancies, correct identification of the nature and possible origin of secondary liver malignancies and correct identification of benign liver lesions, together with a low rate of insufficient sampling.

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