EPITOME
PHARMACEUTICALS

## Risk of complications and size of cutting needles: a literature review.

Core needle biopsy is a safe procedure, with very few severe complications. The doctor administering the biopsy has to balance sample adequacy versus the complication rate when choosing which needle size to use. Larger needles produce better samples with fewer passes. However, larger needles also produce more bleeding in blood rich organs such as kidney or liver. We undertook this study because the Twin Sample biopsy needle is 16G in size to produce two samples comparable to an 18G biopsy needle. In discussion with interventional radiologists, they expressed concern that the larger gauge would lead to greater complication rates.

What is the evidence? We gathered all the papers available through Pub Med on complication rates in relation to the size of the biopsy needle. We also perused the bibliographies of those references and found 45 references covering a 30 year period. Most of these papers found no evidence for increased rate of complications based on needle size, especially when multivariate analysis was used to establish the correlation. The quality of evidence was relatively low, as most reports are retrospective reviews of patient series, where the choice of needle size was the prerogative of the interventional radiologist. Naturally they chose smaller needles for deep biopsies of smaller lesions.

The one well-done animal study demonstrates the balance of complication rate to sample adequacy. They performed 100 biopsies in livers of living pigs, balanced between 14, 18 and 20G cutting needles, and measured both sample size and bleeding at the puncture. The ratio of blood loss to sample size was constant across needle sizes; because the variance in all measurements was on the order of the measurement, there were no significant differences (Plecha, 1997). A previous study in pig liver with 14 – 22G Chiba needles found the same increases in blood loss with larger needles, but did not analyze sample size (Gazelle 1992).

Across the literature there are well-known characteristic complications of biopsy in that organ. In the lung these are pneumothorax and needle tract bleeding. In the kidney and liver, bleeding is typical. The literature reports bleeding rates from 1 – 5%, and major bleeds as <0.5%. Even severe bleeds are handled in the hospital setting without consequences. **Life-threatening complications are extremely rare and not associated with needle size.**

There were four randomized clinical trials of larger gauge needles: three in prostate biopsy and one in kidney. All three prostate trials demonstrated that a 16G needle provides a better sample without increasing pain, bleeding or infection; there was also no increase in cancer detection, which is a sampling problem in the prostate (Giovanni 2009; Inal 2008; McCormack 2012). In the kidney trial, 100 patients with allograft kidneys were randomized to biopsy with a 14, 16 or 18G cutting needle. The 14G needle produced significantly more adequate samples, with at least seven glomeruli in the sample, $P < 0.01$ versus 18G. The only difference in complication rates was pain scores by VAS, with the 14G needle producing more pain than the other two, $P < 0.05$. Minor bleeding was noted in eight patients (8%); the complication rates were not significantly


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different between needles (Nicholson, 2000). As a randomized trial, this is the highest level of evidence available, and it demonstrates the overall picture we have found: larger samples are better for diagnostic purposes; complications due to the larger needle, due to the larger wound, are typically minor.

Complication rates for biopsy in all organs are low, especially for serious life-threatening complications. The few deaths reported are often related to the disease state of the patient. In general, complications resolve spontaneously or with minimal treatment such as chest tube placement during pneumothorax. The real risk is performing an inadequate biopsy. There are repeated examples in the literature where the biopsy was technically successful, but the sample was inadequate to provide a definitive diagnosis. Getting an adequate sample with a larger needle or making more passes with a smaller needle to obtain enough tissue appear roughly equivalent risks. In the dawning age of molecular medicine, more tissue is required for molecular assays and this will place additional demands on the biopsy.

Adequacy standards for biopsy tissue are not common. For monitoring transplanted kidneys, adequacy is defined as at least seven glomeruli in the sample. In the randomized controlled trial discussed above, the 14, 16 or 18G cutting needles delivered an adequate sample in 85%, 76% and 53% of biopsies respectively, $P < 0.01$ relative to 18G (Nicholson, 2000). In another example, in lymphoma a large tissue sample is needed for typing to plan treatment; tissue adequacy of the biopsy is lowest in the reports on lymphoma biopsy. Lung carcinoma can often be diagnosed pathologically with only a small sample, but whether the sample is sufficient at the time of biopsy is requires a cytologist to be present; a large retrospective series showed the rate of false negative findings, i.e. inadequate sample, increased significantly when the needle size was reduced from 18G to 19G, $P < 0.02$ (Geraghty, 2003). Characterizing the tumor genomically requires more tissue; enrollment in the BATTLE trial required characterizing 11 biomarkers on slides, and biopsy using a 20G cutting needle provided an adequate sample in only 83% of NSCLC lung tumors (Tam, 2013). Personalized medicine will require larger biopsies; one company reported 30% of patient samples, delivered as remaining blocks of 18G prostate biopsies, were inadequate for mRNA recovery (Personal communication, B. Denes, 2014) So more tissue is needed, even at the cost of minor complications, to serve the needs of diagnosis and spare the patient a second procedure.

## Lung biopsies and pneumothorax:

Lung biopsy has the highest complication rate, as pneumothorax (PTX) is a common result; most are detected immediately, treated by aspiration or a chest tube and resolve within a day. The Twin Sample biopsy needle, at 16G, is probably too large for deep lung biopsies, since a 15G introducer needle in the aerated lung would almost certainly lead increased rates of PTX. Even so, there is only one study which reported an effect of needle size on PTX rate in multivariate analysis; in a retrospective series of 846 lung patients, the PTX rate for the 18G needle in 324 patients was double that of the 19G needle in 522 patients (Geraghty 2003). There was only one death, in an inpatient with a large mass in the lung; all other cases of PTX, even with chest tube placement, resolved without further consequences. The paper was criticized because the biopsy adequacy rate fell from 96% for 18G needles to 92% for 19G needles (van Rijn, 2004).

**No other large patient series on lung biopsy shows any effect of needle size on complication rate.** A multivariate analysis done retrospectively on 660 lung biopsies showed no effect of needle size, ranging from 16G to 20G, on PTX or bleeding (Yeow, 2004). A similar analysis of 453 lung biopsies using 18, 20 and 22G needles showed no correlation of PTX rate with needle gauge, $P > 0.05$ (Covey, 2004). Two reports from another group on factors related to PTX found no relation between procedural factors, including needle size, number of passes and operator experience, all $P > 0.05$. They used primarily 18 and 20G needles. (Topal, 2003, 2005). A study of 346 lung biopsies, there was no correlation of needle size (not specified) with PTX rate; since they used FNA, the needles were probably 20G or smaller. (Cox 1999). 47 lung biopsies for EGFR determination compared 18G with 20G; there was no difference in complication rates and the 18G returned a larger sample (Cheung, 2010). In 91 lung biopsies comparing 18 and 20G and testing PTX rates, there was no association of PTX rate with needle size, $P = 0.24$, and no difference in diagnostic accuracy by needle size (Kakizawa, 2010). Other studies report using larger gauge needles for biopsy of lesions on the pleural wall or mediastina without high complication rates (Chojniak 2006; Heilo 1993;Schubert 2005; Haramati 2005) Until PTX are recognized as predictable and manageable consequences of lung biopsy. Clinicians will continue to use skinny needles in the aerated lung, despite the extensive evidence that needle size is not related to complication rate and PTX largely is a result of patient factors, not technique.

## Complications in other organs:

All other soft tissue biopsies have very low rates of minor complication, usually <5%, and these minor complications resolve by them selves, (or they are called major complications). There is a random factor involved; hitting a minor artery can lead to extensive bleeding, but when this occurs it is not the fault of the operator since they cannot see smaller vessels. A prospective review of 1000 patients across all organ types using 14G to 21G needles, predominantly 16, 18, 19 and 21G, reported eleven minor complications (1.1%), and only one serious complication (0.1%); complications were unrelated to needle size (Welch, 1989). An early retrospective review of 1,100 kidney biopsies with a 14G needle, done without radiological guidance, found 32 complications (2.8%) and a 92% adequacy rate; there were no deaths. Serious complications took place mostly due to a failing transplant, as opposed to a healthy kidney (Wilczek, 1990). A multivariate analysis done retrospectively on 771 biopsies using 18G versus 20G needles in the liver showed higher odds of obtaining an adequate sample in one or two passes, OR 3.7 [95% Confidence Interval 1.93 – 6.95] with the larger needle and no difference in the complication rates, $P = 0.34$ (Vijayaraghavan, 2014).

In the few randomized prospective trials, there was no difference in the complication rates, but better sample quality for larger needles. In the trial in kidneys discussed above, sample adequacy was significantly better for the 14G versus the 16G and a 16G versus the 18G needles; would the patient be willing to endure moderate pain in return for a better biopsy? (Nicholson, 2000) In the three randomized, prospective trials of 16G versus 18G needles in prostate biopsy, there were no differences in complication rates of pain, bleeding and infection, but all three trials reported better quality and larger samples (Giovanni, 2009; Inal, 2008; McCormack, 2012) Other reports of complication rates,

yields and various needle sizes paint a similar picture in many organs. In a retrospective review of 1,300 biopsies, 770 were not in the lung and had a major complication rate of 0.4%. The 16 or 18G cutting needles had a lower failure rate than FNA (Chojniak, 2006). The complication rate is so low and the ability to detect and monitor complications so advance that **the only consideration in soft tissue biopsies is sample adequacy.** Otherwise one may have to repeat the procedure in the patient, and most would accept a small increase in risk compared to a failed biopsy.

## Liver:

In a group comparison of 226 liver biopsies done either by the gastroenterology section on an outpatient basis or interventional radiologists for mostly inpatients, where the GI group used a 16G Menghini needle and the IR group an 18G Menghini needle, there were no serious complications either group. The minor complication rate was not significantly different, but sample adequacy was 96% for 16G and 92% for the 18G, i.e. twice the failure rate. For 272 biopsies in the liver comparing 14G and 18G needles, differences in accuracy and complication rates were not significant (Haage, 1999).

## Kidney

The randomized trial showed better samples with slightly more pain in 100 kidney biopsies (Nicholson, 2000) A retrospective review of 161 CT-guided biopsies compared 14G to 18G cutting needles and found no significant differences in yield or complication rate (Song, 1998). This paper also summarized the previous literature. For the 14G needle, a total of 605 biopsies showed an average tissue recovery rate of 97.9% (± 0.5 SE) and a major complication rate of 0.5%; for the 18G needle, 768 reported biopsies averaged a recovery rate of 97.4% (± 0.6 SE) and a major complication rate of 1.3%.

## Other organs

A retrospective review of 269 pancreas biopsies with 16G to 22G needles guided by US found a higher accuracy of 92% for 16 – 19G, versus 85% for 20 – 22G needles. The major complication rate was low, 3 cases or 1.1%, with 19, 21 and 22G needles involved (Brandt, 1993). Another study with 57 biopsies in the pancreas under CT guidance used predominantly 16G needles, with some 14G and 18G needles, and had one serious complication, 1.5% (Zech, 2002). In 53 biopsies of the parotid gland, 14, 16 and 18G needles showed no differences; there was only one complication (Wan, 2004). For 151 musculoskeletal biopsies using 14, 16, 18 and 19G needles, the complication rate was 0.7%. For 209 biopsies of the thyroid gland, 16 and 18G needles were used, with a major complication rate of 2% (Screaton, 2002). Three studies of biopsy of suspected lymphomas, totaling 574 biopsies, used mainly 16G or 18G needles and showed adequacy rates from 72% to 95% with no major complications. In one series they have been increasing the size of needle used over the years based on these findings (de Kerviler, 2000; Screaton, 2003; Silverman, 1994).

## Conclusions:

Tissue biopsy using cutting needles is remarkably safe. The very few serious complications and deaths occur mainly in relation to the patient's disease and weakened state. There is no evidence that larger needles produce more serious complications, or stated another way, the preponderance of the evidence supports the finding that needle size is only correlated to the minor complication rate in a logical sense, in that larger needles obtain larger samples, as well as more noticeable instances of minor bleeding. Studies directed at the question of sample adequacy consistently find better results with larger needles. Considering the risk-reward question, the risk of redoing an inadequate biopsy predominates.

The papers cited and others are summarized below. On the last page there is a table of data abstracted from the studies.

This review was written by Paul T. Wegener, Epitome Pharmaceuticals Limited, who takes full and sole responsibility for its contents. I welcome comments and criticism; please contact me at pwegener@epitomepharm.com

Respectfully submitted, 28 February 2015

## *Bibliography Needle gauge review, references with comments*

Anania G, Gigante E, Piciucchi M, Pilozzi E, Pucci E, Pellicelli AMet al. Liver biopsy: Analysis of results of two specialist teams. World J Gastrointest Pathophysiol 2014;5(2):114-9.
PM:24891983

Analyzed medical records of consecutive patients evaluated at our GI unit from 01/01/2004 to 31/12/2010 for whom liver biopsy (LB) was considered necessary… Patients were divided into two groups: one undergoing an ultrasonography (US)-assisted procedure by the G team and one undergoing US-guided biopsy by the IR team. For the first group, an intercostal approach (US-assisted) and a Menghini modified type needle 16 G (length 90 mm) were used. The IR team used a subcostal approach (US-guided) and a semiautomatic modified Menghini type needle 18 G (length 150 mm). All the biopsies were evaluated for appropriateness according to the current guidelines. The number of portal tracts present in each biopsy was assessed by a revision performed by a single pathologist unaware of the previous pathology report. Clinical, laboratory and demographic patient characteristics, the adverse events rate and the diagnostic adequacy of LB were analyzed.
RESULTS: During the study period, 226 patients underwent LB: 167 (74%) were carried out by the G team, whereas 59 (26%) by the IR team. LB was mostly performed in a day hospital setting by the G team, while IR completed more procedures on inpatients (P < 0.0001)….Complications occurred in 26 patients (16 G team vs 10 IR team, P = 0.15). Most gross samples obtained were considered suitable for basal histological evaluation, with no difference among the two teams (96.4% G team vs 91.5% IR, P = 0.16). However, the samples obtained by the G team had a higher mean number of portal tracts (G team 9.5 +/- 4.8; range 1-29 vs IR team 7.8 +/- 4.1; range 1-20) (P = 0.0192) and a longer mean length (G team 22 mm +/- 8.8 vs IR team 15 +/- 6.5 mm) (P = 0.0001). CONCLUSION: LB can be performed with similar outcomes both by G and IR. Use of larger dimension needles allows obtaining better samples, with a similar rate of adverse events

Brandt KR, Charboneau JW, Stephens DH, Welch TJ, Goellner JR. CT- and US-guided biopsy of the pancreas. Radiology 1993;187(1):99-104.
PM:8451443

Retrospective review of 269 biopsy procedures of pancreas using tru-cut needles from 16G to 22G, including passes through intestines. 1% major complication rate unrelated to needle gauge. Larger needles gave better samples, 92% vs 85% for 20 – 22G needles. Both US and CT.

Cheung YC, Chang JW, Hsieh JJ, Lin G, Tsai YH. Adequacy and complications of computed tomography-guided core needle biopsy on non-small cell lung cancers for epidermal growth factor receptor mutations demonstration: 18-gauge or 20-gauge biopsy needle. Lung Cancer 2010;67(2):166-9.
PM:19450892

Compared 18G and 20G cutting needles for lung tumor sampling. Coaxial technique and both groups balanced. No difference in complication rate; 18G produced larger samples.

Chojniak R, Isberner RK, Viana LM, Yu LS, Aita AA, Soares FA. Computed tomography guided needle biopsy: experience from 1,300 procedures. Sao Paulo Med J 2006;124(1):10-4.
PM:16612456

Large retrospective study comparing 16 and 18G cutting needles with 22G FNA. Diagnostic accuracy was significantly higher for cutting needles. A specific diagnosis was reached far more often with cutting needles, $P < 0.001$ for all organs. Complication rates of 1.3% were too low for analysis in all organs except the lung; they occurred for both cutting and FNA. For the lung and thorax, PTX rate was 6%, all minor, for cutting needles; the rate was higher for FNA. This is probably due to the use of the smaller FNA needle for aerated lung. No data on differences between 16G and 18G cutting needles.

Cicione A, Cantiello F, De NC, Tubaro A, Damiano R. Prostate biopsy quality is independent of needle size: a randomized single-center prospective study. Urol Int 2012;89(1):57-60.
PM:22738882

Patients undergoing TRUS PBx were consecutively randomized with a 1:1 ratio into two study arms: group A (16-gauge needle) and group B (18-gauge needle). Core fragmentation and small specimen length (<10 mm) rate were the sample quality criteria. Three consecutive visual analog scale tests for pain and the Clavien surgical classification complications grading for rectal bleeding were used to evaluate TRUS PBx morbidity. RESULTS: Overall, 250 patients were evaluated. No statistically significant difference between 16- and 18-gauge biopsy needles was recorded for cancer detection rate (29.6 vs. 30.4%, $p = 0.890$), core fragmentation rate (5 vs. 7%, $p = 0.425$) and shorter specimen (2 vs. 2%, $p = 0.309$). Pain control was similar in the two groups during the biopsy, 30 min after biopsy and the evening of the same day. Very small or absent bleeding was the more frequent complication observed in each group. CONCLUSION: Prostate detection rate and sample quality were not influenced by needle size. A 16-gauge needle biopsy does not increase TRUS PBx morbidity

Covey AM, Gandhi R, Brody LA, Getrajdman G, Thaler HT, Brown KT. Factors associated with pneumothorax and pneumothorax requiring treatment after percutaneous lung biopsy in 443 consecutive patients. J Vasc Interv Radiol 2004;15(5):479-83.
PM:15126658

PURPOSE: To describe patient- and procedure-related factors associated with post-biopsy pneumothorax and those that require intervention. MATERIALS AND METHODS: Patient and procedure data from all lung biopsies performed at a single center between January 2000 and July 2001 were recorded prospectively. Data included patient demographics, lesion size, lesion depth from skin, **needle size**, **number of passes**, patient position during biopsy, imaging method used (computed tomography/fluoroscopy), if sedation was used, occurrence of pneumothorax and whether the pneumothorax required treatment.… Univariate and multivariate analysis was performed, and $P < .05$ was considered significant.
RESULTS: Four-hundred fifty-three biopsies were performed on 443 patients. One-

hundred six patients (23.4%) had post-biopsy pneumothorax and 31 patients (6.8% overall, 29.2% of pneumothorax group) required intervention. By univariate analysis, increased patient age, smaller lesion size, increased depth from skin, supine position, and no history of surgery were significant predictors of biopsy-related pneumothorax. However, only increased patient age, supine position, no history of ipsilateral surgery, and history of smoking were associated with pneumothorax that required intervention. By multivariate analysis, increased patient age, smaller lesion size, and no history of surgery predicted pneumothorax; supine position, history of smoking, and no history of ipsilateral surgery predicted which patients with pneumothorax would require treatment. CONCLUSION: Independent risk factors for pneumothorax include increased patient age, smaller lesion size, and no history of surgery. Previous surgery and prone positioning during biopsy appear to provide a "protective effect" against clinically significant post-biopsy pneumothorax.

**Comment: No relation of PTX to needle size found in analysis; therefore it must not be significant. Used 394 22G, 41 20G and 18 <20G needles, probably FNA, since cytopathologist reviewed sample adequacy immediately.**

Cox JE, Chiles C, McManus CM, Aquino SL, Choplin RH. Transthoracic needle aspiration biopsy: variables that affect risk of pneumothorax. Radiology 1999;212(1):165-8.
PM:10405737

PURPOSE: To analyze the influence of multiple variables on the rate of pneumothorax and chest tube placement associated with transthoracic needle aspiration biopsy of the lung. MATERIALS AND METHODS: In 346 patients, 331 CT-guided and 24 fluoroscopically-guided lung biopsies were performed. Variables analyzed were lesion size, depth, and location; number of pleural passes; needle size; presence of emphysema; and training level of the person who performed the biopsy. RESULTS: Pneumothorax occurred at 144 (40.4%) of 356 biopsies, including 139 (42.0%) CT-guided and five (21%) fluoroscopically guided biopsies. Chest tube placement was needed in 25 (17.4%) of 144 cases of pneumothorax (7% of all biopsies). An increased rate of pneumothorax was correlated with smaller lesion size (P = .001) and presence of emphysema (P = .01). Patients with emphysema were three times as likely to require chest tube placement. The pneumothorax rate was 15% (16 of 105) if no aerated lung was traversed and approximately 50% if aerated lung was penetrated. Lesion location, **needle size, number of pleural passes,** and level of training **were not correlated with pneumothorax rate**. CONCLUSION: Smaller lesion size and emphysema are strongly correlated with occurrence of pneumothorax. Pneumothorax was more than three times less frequent if no aerated lung was traversed. After pneumothorax, chest tube placements were related to the presence of emphysema.

de Kerviler E, Guermazi A, Zagdanski AM, Meignin V, Gossot D, Oksenhendler Eet al. Image-guided core-needle biopsy in patients with suspected or recurrent lymphomas. Cancer 2000;89(3):647-52.
PM:10931465

Retrospective analysis of 212 PNB in 194 patients with lymphomas over 5 years. "…The overall complication rate was 7.5%. Perilesional or parietal hematomas occurred in 13 patients. None required blood transfusion or intervention. A small pneumothorax

occurred in 2 of the 13 patients biopsied in the lung. Pneumothoraces remained asymptomatic and did not require chest tube placement…"
"…The progressive increase in the size of our biopsy systems over time, from a mean diameter of 18 gauge in 1995 to 16.2 gauge in 1999, has not been followed by an increase in the number of complications in our series. This may be partly due to technical progress, such as the compression system that we developed for abdominal procedures and improvement of the skill of our radiologic staff…"
"…the main risk is … to sample insufficient biopsy material regarding the level of precision required to plan a treatment protocol…"

Gazelle GS, Haaga JR, Rowland DY. Effect of needle gauge, level of anticoagulation, and target organ on bleeding associated with aspiration biopsy. Work in progress. Radiology 1992;183(2):509-13.
PM:1561359

This study was performed to evaluate the effect of needle size, coagulation impairment, or biopsy of different organs on risk of bleeding during the procedure. Multiple biopsy procedures were performed on the livers and kidneys of anesthetized pigs with 14-22-gauge Chiba-type needles. The procedures were performed under direct vision at laparotomy, and blood loss was measured. While larger needles generally produced more bleeding, the differences were statistically significant only when comparing 14- with 16-gauge needles and 16-gauge needles with the group of 18-, 20-, and 22-gauge needles in the liver. In the kidney, no significant difference was noted between 18-, 20-, and 22-gauge needles. Anticoagulation did not produce significantly greater blood loss but did allow separation of the group of 18- and 20-gauge needles from 22-gauge needles in the kidney. Renal biopsy resulted in greater overall blood loss than did liver biopsy.

Comment: An old study using Chiba-style needles. Plecha (1997) did a similar study and agreed that blood loss was higher with larger needles, but not when normalized for recovered DNA.

Geraghty PR, Kee ST, McFarlane G, Razavi MK, Sze DY, Dake MD. CT-guided transthoracic needle aspiration biopsy of pulmonary nodules: needle size and pneumothorax rate. Radiology 2003;229(2):475-81.
PM:14595149

PURPOSE: To evaluate the effect of coaxial needle size on pneumothorax rate and the diagnostic accuracy of computed tomography (CT)-guided transthoracic needle aspiration biopsy (TNAB) of pulmonary nodules. MATERIALS AND METHODS: Retrospective review of 846 consecutive CT-guided TNAB procedures was performed. A coaxial approach was implemented in all patients by using an 18- or 19-gauge outer stabilizing needle through which a smaller aspiration needle or automated biopsy gun was inserted for tissue sampling. Univariate and multivariate regression analyses were used to analyze coaxial needle size, age, sex, smoking history, lesion size, use of an automated core biopsy gun, number of needle passes, and frequency of chest tube placement. Sensitivity, specificity, and diagnostic accuracy were calculated for 676 patients with at least 18 months of clinical follow-up. RESULTS: Pneumothorax occurred in 226 of 846 patients. Coaxial needle size and patient age had a significant effect on pneumothorax rate. Pneumothorax occurred in 124 (38%) of 324 patients who underwent procedures with 18-gauge needles and in 121 (23%) of 522 patients who underwent procedures with 19-

gauge needles (P <.001). The overall diagnostic accuracy was 96% for procedures performed with 18-gauge needles and 92% for procedures performed with 19-gauge needles, with a sensitivity of 95% and 89% and a specificity of 100% and 99%, respectively. Pneumothorax occurred in 153 patients older than 60 years, in 99 patients 60 years and younger (P <.02), in 90 patients older than 70 years, and in 162 patients younger than 70 years (P <.01). The relationship between pneumothorax rate and age as a continuous distribution was not significant (P <.07), nor were the 50- or 75-year age cutoffs (P <.06 and P <.9, respectively). CONCLUSION: Use of a smaller coaxial stabilizing needle produces a substantially decreased risk of pneumothorax with comparable diagnostic accuracy, sensitivity, and specificity for histopathologic diagnosis of pulmonary nodules.
Comment: This study is quoted most often as evidence for higher PTX rate with larger needle, 18G vs. 19G introducer. However, they used the 18G introducer exclusively in the first 324 patients, and then they converted to a 19G introducer for the following 522 patients. Four staff interventional radiologists (or radiologists in training with staff supervision) performed all biopsies. The first 324 patients represent 81 or less biopsies per staff radiologist; the higher PTX rate could simply be due to more experience before the second cohort. This paper was criticized for the statistical analysis (van Rijn, 2004).

Giovanni S, Sighinolfi MC, Fidanza F, De SS, Micali S, Maurizio Pet al. Does needle calibre affect pain and complication rates in patients undergoing transperineal prostate biopsy? A prospective, randomized trial. Asian J Androl 2009;11(6):678-82.
PM:19767761

A prospective, randomized trial comparing prostate biopsy samples obtained using an 18 G-needle to those obtained using a 16 G needle. The aim of this preliminary study was to evaluate pain and complication rates in both groups. 187 patients undergoing transperineal prostate biopsy were prospectively evaluated and divided into two groups. The first group (94 patients, Group A) received a transperineal prostate biopsy using a 16 G-needle and the second group (93 patients, Group B) underwent transperineal prostate biopsy with an 18 G-needle. A visual analogue scale (VAS) and facial expression scale (FES) were used to assess pain during multiple steps of the procedure in each group. A detailed questionnaire was used to obtain information about drug use because it could potentially influence the pain and complications that patients experienced. Two weeks after the procedure, early and late complications were evaluated. Pain during prostate biopsy, which was measured with both the VAS and FES instruments, did not differ significantly between the 18- and 16 G-needle groups, and no significant differences were found in early or late complication rates between the groups. Transperineal prostate biopsy with a 16 G-needle is a feasible procedure in terms of pain and complication rates. Further studies with larger patient populations are required to assess whether or not this procedure can improve prostate cancer detection rates.

Gohari A, Haramati LB. Complications of CT scan-guided lung biopsy: lesion size and depth matter. Chest 2004;126(3):666-8.
PM:15364737

Editorial on Yeow *et al*, same issue. Relevant quotes: Yeow et al analyzed the risk factors for pneumothorax and bleeding for 660 consecutive CT scan-guided percutaneous coaxial cutting needle biopsies. They consistently performed coaxial cutting needle biopsies

because an on-site cytopathologist was not available. The diagnostic accuracy of these biopsies has been previously reported.12 Multiple variables related to the patient, the lesion, the biopsy needle, and the radiologist were assessed using univariate and multivariate analysis to determine the influence of each specific variable on the rate of pneumothorax and bleeding. The analyzed variables included the presence of emphysema, chest wall thickness, lesion size and depth, lesion necrosis or cavitation, needle size, number of specimens obtained, needle-pleural angle, and the experience of the radiologist performing the biopsies.
Negative findings in a large series are an important component of the results. Yeow et al showed no increase in the risk of pneumothorax for factors that intuitively, and in other series, have been suggested to increase the risk of pneumothorax. Emphysema, cavitation of the lesion, **needle size**, number of specimens, and postbiopsy patient positioning all **showed no association** with an increased risk of pneumothorax.

Gupta S, Wallace MJ, Cardella JF, Kundu S, Miller DL, Rose SC. Quality improvement guidelines for percutaneous needle biopsy. J Vasc Interv Radiol 2010;21(7):969-75.
PM:20304676

An update of previous guidelines of the principles for performing PNB. They are intended for use in quality improvement programs to assess PNB procedures. Outcome measures are suggested. Concerning complication rates, they write: “Clinically significant bleeding is infrequent, although relative bleeding risks increase with increasing needle size, use of cutting needles, and vascularity of the organ/lesion in which biopsy is performed (i.e. renal and liver biopsies, hypervascular lesions) (18, 41).” These refer to Geraghty 2003 and Schubert 2005, shown here, and neither reference refers to bleeding, and Schubert had no complications using a 14G cutting needle. The article has no other comments on needle size.

Haage P, Piroth W, Staatz G, Adam G, Gunther RW. [CT-guided percutaneous biopsies for the classification of focal liver lesions: a comparison between 14 G and 18 G puncture biopsy needles]. Rofo 1999;171(1):44-8.
PM:10464504

272 CT-guided biopsies in 268 patients were evaluated retrospectively with regard to sensitivity, specificity and complication rate of the chosen needle caliber in differentiating between benign and malignant disease as well as in the ability to determine specific cell types in the various disorders. A 14G needle was used in 101 (37.1%) cases, an 18G needle biopsy was performed in 171 (62.9%) cases. The Fisher exact test was employed for statistical analysis…The sensitivity, specificity and rate of **complications** were 94.8%, 92.0%, **3.0% for the 14G needle** and 92.7%, 97.6%, **0.6% for the 18G** needle, respectively. There were **no statistically significant differences** with regard to the needle size.

Haramati LB. CT-guided automated needle biopsy of the chest. AJR Am J Roentgenol 1995;165(1):53-5.
PM:7785631

33 needle biopsies of the lungs (n = 31) and mediastinal (n = 2) done with 18G (n = 28) or 20G (n = 5) cutting needle under CT guidance, using a freehand technique. There were

3 minor PTX and no other complications. No mention of a difference in complication rates between needle sizes.

Heilo A. Tumors in the mediastinum: US-guided histologic core-needle biopsy. Radiology 1993;189(1):143-6.
PM:8372184

Retrospective analysis of 62 US-guided biopsies of mediastinum using 14G or 18G cutting needles with a freehand technique. Average of 2.4 punctures per session. Obtained adequate tissue in 84% of biopsies. No serious complications.

Inal GH, Oztekin VC, Ugurlu O, Kosan M, Akdemir O, Cetinkaya M. 16G needles improve specimen quality but not cancer detection rate in transrectal ultrasound-guided 10-core prostate biopsies. Prostate Cancer Prostatic Dis 2008;11(3):270-3.
PM:18521101

Performance of 16G (n=103) and 18G (n=101) biopsy needles in transrectal ultrasound (TRUS)-guided 10-core prostate biopsies were compared in terms of cancer detection and pre-defined specimen quality criteria in this **prospective randomized study**. Cancer detection rates of the two groups were similar, although the mean core volume of 16 g needles was almost twice that of 18 g needles. On the other hand, using 16 g needles significantly improved specimen quality by acquiring less empty cores, small cores and fragmented cores. There were no significant differences among the complication rates and VAS pain scores of the two groups. Sixteen gauge needles can safely be used in TRUS-guided prostate biopsies, as they improve specimen quality without increasing morbidity and patient discomfort.

Kakizawa H, Toyota N, Hieda M, Hirai N, Tachikake T, Matsuura Net al. Risk factors for severity of pneumothorax after CT-guided percutaneous lung biopsy using the single-needle method. Hiroshima J Med Sci 2010;59(3):43-50.
PM:21265263

We reviewed 91 biopsy procedures for 90 intrapulmonary lesions in 89 patients. Patient factors were age, sex, history of ipsilateral lung surgery and grade of emphysema. Lesion factors were size, location and pleural contact. Procedure factors were position, needle type, needle size, number of pleural punctures, pleural angle, length of needle passes in the aerated lung and number of harvesting samples. The severity of pneumothorax after biopsy was classified into 4 groups: "none", "mild", "moderate" and "severe". The risk factors for the severity of pneumothorax were determined by multivariate analyzing of the factors derived from univariate analysis. Pneumothorax occurred in 39 (43%) of the 91 procedures. Mild, moderate, and severe pneumothorax occurred in 24 (26%), 8 (9%) and 7 (8%) of all procedures, respectively. Multivariate analysis showed that location, pleural contact, number of pleural punctures and number of harvesting samples were significantly associated with the severity of pneumothorax ($p < 0.05$). In conclusion, lower locations and non-pleural contact lesions, increased number of pleural punctures and increased number of harvesting samples presented a higher severity of pneumothorax.
Comments: Used 20 – 21G or 18-19G, both cutting (n = 78) and aspiration (n = 8). In multivariate analysis there was no difference in PTX rate (P = 0.24)

McCormack M, Duclos A, Latour M, McCormack MH, Liberman D, Djahangirian Oet al. Effect of needle size on cancer detection, pain, bleeding and infection in TRUS-guided prostate biopsies: A prospective trial. Can Urol Assoc J 2012;6(2):97-101. PM:22511415

Prospective trial in 105 patients of combining 16G and 18G cutting needles in 12-core prostate biopsy, vs. assigned control group of 100 patients. No difference in cancer detection rates (P = 0.33) or complications of pain (P = 0.38), bleeding (P = 0.35) or infection rates (4% in both groups).

Nicholson ML, Wheatley TJ, Doughman TM, White SA, Morgan JD, Veitch PSet al. A **prospective randomized trial** of three different sizes of core-cutting needle for renal transplant biopsy. Kidney Int 2000;58(1):390-5. PM:10886586

100 patients assigned to 14, 16 or 18G cutting biopsy needle to assess failing kidney transplants. The 14G needle produced a significantly better sample than the 18G (P < 0.01); the results from the 16G were intermediate. The pain scores were highest for the 14G needle, with 6 patients reporting moderate pain, versus 2 for the 16G and 1 for the 18G. The VAS pain score was significantly higher for the 14G (P < 0.05). Bleeding rates were low, 12% for the 14G and 6% for the 16 and 18G needles; all bleeding episodes resolved within a day.

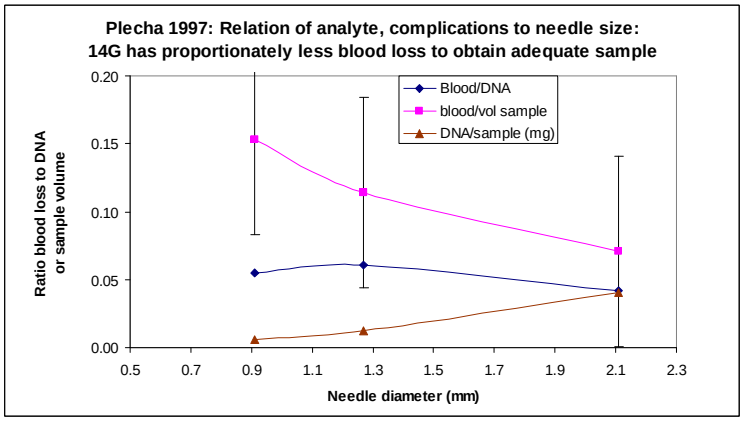
Pedersen OM, Aarstad HJ, Lokeland T, Bostad L. Diagnostic yield of biopsies of cervical lymph nodes using a large (14G) core biopsy needle. APMIS 2013;121(12):1119-30. PM:23489251

During a 10-year period ultrasound (US)-guided CNB, using a 14G Tru-Cut needle (non-advancing), was performed in 140 consecutive cases (135 patients, aged 8-88 years) when a detailed histological diagnosis was required to guide therapy ... One patient experienced pain in an arm lasting 3-4 days. No other immediate or delayed complications were diagnosed. A 14-gauge may be used safely as the sole needle bore in US-guided CNB of cervical lymph nodes, rendering samples sufficient for full subtyping in lymphoma, even in the smallest nodes

Plecha DM, Goodwin DW, Rowland DY, Varnes ME, Haaga JR. Liver biopsy: effects of biopsy needle caliber on bleeding and tissue recovery. Radiology 1997;204(1):101-4. PM:9205229

PURPOSE: To evaluate different-caliber biopsy cutting needles in terms of the benefits and potential risk of bleeding in a swine model.
MATERIALS AND METHODS: A total of 190 sequential liver biopsy specimens were obtained in 11 Yorkshire pigs (weight, 50-70 lb [22.5-31.5 kg]) by using 14-, 18-, and 20-gauge cutting needles. For each biopsy procedure, blood loss was determined by weighing sponges used to absorb bleeding, and sample-tissue DNA content was measured with spectrofluorometry. Analysis of variance was used to compare results.
RESULTS: The larger the caliber of needle, the greater the absolute blood loss (for 14-gauge, 1.69 g; for 18-gauge, 0.74 g; for 20-gauge, 0.32 g) and DNA content per sample (for 14 gauge, 40.38 microg; for 18-gauge, 12.18 microg; for 20-gauge, 5.86 microg). The ratio of blood loss to amount of DNA recovered did not differ among the different-caliber needles. To obtain the same amount of diagnostic tissue, more passes were needed

with the smaller-caliber needles. CONCLUSION: Use of larger-caliber needles is more efficient despite the greater amount of blood loss, because more tissue can be recovered and because fewer passes are necessary, which reduces the chances of complications Comments: Although the variance is high, the mean values clearly show less blood loss for a given sample requirement. The results are shown on the graph.




Preda A, Van Dijk LC, Van Oostaijen JA, Pattynama PM. Complication rate and diagnostic yield of 515 consecutive ultrasound-guided biopsies of renal allografts and native kidneys using a 14-gauge Biopty gun. Eur Radiol 2003;13(3):527-30. PM:12594555

Our objective was to evaluate the safety and diagnostic efficacy of the ultrasound-guided renal biopsy procedure using an automated biopsy device (Biopty gun) with a 14-gauge needle. 515 consecutive ultrasound-guided renal biopsies performed in two large university hospitals were retrospectively reviewed. 345 biopsies were performed on renal allografts and 170 on native kidneys. The tissue specimen was adequate for histological evaluation in 95.3% of the cases (94.8% in the transplanted kidney group, 96.5% in the native kidney group). The overall complication rate was 12.2% and was significantly higher in the native kidney group (19.4%) than in the renal allograft group (8.7%). Major complications occurred in 2.7% of the cases (2.9% of the renal allografts and 2.4% of the native kidney biopsies), including one procedure-related death and the loss of the renal allograft in two other patients. Minor complications were noted in 9.5% of the biopsies and there were significantly more in the group of the native kidneys (17.1%) than in the group of the transplanted kidneys (5.8%). Renal biopsy with an automated device using a 14-gauge needle has a high tissue recovery rate, but it is associated with a small risk of serious complications.

Schlolaut KH, Lackner K, von Uexkull-Guldenband V, Nicolas V, Vogel J. [Results and complications of CT-guided puncture biopsies with a wide-lumen puncture needle]. Rofo 1987;147(1):25-32. PM:3039596

High success rate and few complications.

Schubert P, Wright CA, Louw M, Brundyn K, Theron J, Bolliger CTet al. Ultrasound-assisted transthoracic biopsy: cells or sections? Diagn Cytopathol 2005;33(4):233-7. PM:16138366

We recruited 97 consecutive patients, and of these, 85 underwent both (14G) cutting-needle biopsy and FNAB. These were adequate for diagnosis in 81.2% and 80% of cases, respectively, with a combined yield of 90%. Measured with a novel semiquantitative score, FNAB allowed a diagnosis with fewer special investigations than cutting biopsy. Comments: No complications occurred at all. US guidance was used at the bedside, so only pleural peripheral lung lesions were available for biopsy, as well as anterior mediastinum and other thoracic lesions.

Screaton NJ, Berman LH, Grant JW. Head and neck lymphadenopathy: evaluation with US-guided cutting-needle biopsy. Radiology 2002;224(1):75-81.
PM:12091664

260 biopsies in 247 patients with cervicofacial lympadenopathy with US guidance. 16G needles were used for large, accessible nodes and all suspected lymphoma patients; 18G needles were used for small and relatively inaccessible lesions. Numbers of each not reported. Only 3 patients had minor post-biopsy hematomas that resolved spontaneously (1%) No relation to needle gauge reported.

Screaton NJ, Berman LH, Grant JW. US-guided core-needle biopsy of the thyroid gland. Radiology 2003;226(3):827-32.
PM:12601219

There was no correlation between lesion size or consistency, biopsy needle gauge, or operator experience (staff radiologist or fellow) with the adequacy of the sample….Reluctance of clinicians to use core needle biopsy of the thyroid gland, in part, relates to the perceived risks associated with core-needle biopsy of the thyroid gland, in particular the risk of hemorrhagic complications. Although complications such as tumor implantation along the biopsy track, hemorrhage, and recurrent laryngeal nerve injury with non–image-guided large-needle biopsy have been described in the early literature, complications with single-action core needles with US guidance are rare.
Comments: Of 209 biopsies, 138 done with 16G, 36 with 18G and 35 with both. The complications were minor and rare (2%) and not related to biopsy needle size.

Silverman SG, Lee BY, Mueller PR, Cibas ES, Seltzer SE. Impact of positive findings at image-guided biopsy of lymphoma on patient care: evaluation of clinical history, needle size, and pathologic findings on biopsy performance. Radiology 1994;190(3):759-64.
PM:8115624

Biopsy of 102 patients with abdominal lymphoma using FNA (32 of 20 or 22G aspiration needles) or cutting needles or both (67 procedures with 14 – 19G cutting needles). There were two minor complications (2%) and the needle type used was not reported.

Sklair-Levy M, Lebensart PD, Applbaum YH, Ramu N, Freeman A, Gozal Det al. Percutaneous image-guided needle biopsy in children--summary of our experience with 57 children. Pediatr Radiol 2001;31(10):732-6.
PM:11685444

69 percutaneous image-guided needle biopsies were performed in 57 children. The age of the children ranged from 4 days to 14 years (mean 5.6 years). We used 16- to-20-gauge cutting-edge needles. Sixty-two biopsies were core-needle biopsies and 7 fine-needle aspiration biopsies. RESULTS: There were 50 malignant lesions, 10 benign lesions and 2 infectious lesions. Core-needle biopsy was diagnostic in 47 of 50 (94 %) of the malignant

solid tumors. All the biopsies were performed **without complications**. CONCLUSION: Percutaneous image-guided needle biopsy is a simple, minimally invasive, safe and accurate method for the evaluation of children with suspicious masses.

Song JH, Cronan JJ. Percutaneous biopsy in diffuse renal disease: comparison of 18- and 14-gauge automated biopsy devices. J Vasc Interv Radiol 1998;9(4):651-5.
PM:9684839

161 CT-guided biopsies for diffuse renal disease were retrospectively reviewed. An automated biopsy gun with an 18G needle was used in 74 procedures, and a 14G needle was used in 87 cases. RESULTS: Adequate tissue for histologic diagnosis was obtained in 96% (71 of 74) of cases with use of the 18-gauge needle, compared with 99% (86 of 87) in the 14-gauge group. The mean glomeruli per specimen were 10.7 and 13.7, respectively. Major hemorrhagic complications occurred in two cases (2.7%) of the 18-gauge group and in three cases (3.4%) of the 14-gauge group, no statistically significant difference from the 14-gauge needles (P = .80)
This article has **a tabular summary of 15 early studies** of either 14G or 18G needle biopsies of kidneys in 15 reports. The weighted average results for tissue recovery rate and major complication rate are 97.9 ± 0.5 SE and 0.5 ± 0.1 SE respectively for the 14G needle, compared to 97.4 ± 0.6 SE and 1.3 ± 1.3 SE for the 18G needle.

Stattaus J, Kuhl H, Hauth EA, Kalkmann J, Baba HA, Forsting M. [Liver biopsy under guidance of multislice computed tomography: comparison of 16G and 18G biopsy needles]. Radiologe 2007;47(5):430-8.
PM:16440187

A 16G biopsy needle was used in 121 cases and an 18G needle in 42 cases. The sensitivity, specificity, and accuracy were 97.2, 100.0, and 97.5% for the 16G needle and 78.6, 100.0, and 85.7% for the 18G needle, respectively. A definite histological diagnosis could be obtained in 90.0% of the cases (16G 94.0%, 18G 75.8%). These differences were statistically highly significant. Bleeding complications were recognized in seven biopsies (4.3%), with minor complication rates of 4.1% for 16G and 2% for 18G. In one patient a fatal bleeding occurred after the biopsy with a 16G needle. For an accurate diagnosis of liver lesions a 16G needle is recommended, provided patients are carefully monitored afterwards.

Steil S, Zerwas S, Moos G, Bittinger F, Hansen T, Mergenthaler Uet al. CT-guided percutaneous core needle biopsy in oncology outpatients: sensitivity, specificity, complications. Onkologie 2009;32(5):254-8.
PM:19420971

We retrospectively analyzed data of all oncology outpatients who received CT-guided core needle biopsies between August 2001 and March 2005; 432 outpatients received 465 CT-guided core needle biopsies using a 14-, 16-, or 18-gauge coaxial cutting needle. Sensitivity was 94%, specificity 92%, and effective accuracy 92%. Complications occurred after 23 biopsies (4.9%), including pneumothorax after 17 thorax biopsies (13%). Only 7 patients (1.5%) had to be hospitalized after the biopsy and no patient died due to the procedure. CT-guided core needle biopsies in oncology outpatients show a high diagnostic sensitivity and specificity with a low complication rate in routine care.

The distribution of needle sizes was not reported; the larger needles must not have a markedly higher complication rate in this series.

Tam AL, Kim ES, Lee JJ, Ensor JE, Hicks ME, Tang Xet al. Feasibility of image-guided transthoracic core-needle biopsy in the BATTLE lung trial. J Thorac Oncol 2013;8(4):436-42.
PM:23442309

The medical records of patients who underwent PTCNB for consideration of enrollment in BATTLE were reviewed for diagnostic yield of 11 predetermined molecular markers and procedural complications. Univariate and multivariate analyses of factors related to patient and lesion characteristics were performed to determine possible influences on diagnostic yield. RESULTS: One hundred and seventy PTCNBs were performed using 20-gauge biopsy needles in 151 NSCLC patients screened for the trial. The biopsy specimens of 82.9% of the patients were found to have adequate tumor tissue for analysis of the required biomarkers. On multivariate analysis, metastatic lesions were 5.4 times more likely to yield diagnostic tissue as compared with primary tumors ($p = 0.0079$). Pneumothorax and chest tube insertion rates were 15.3% and 9.4%, respectively. CONCLUSIONS: Image-guided 20-gauge PTCNB is safe and provides adequate tissue for analysis of multiple biomarkers in the majority of patients being considered for enrollment into a personalized, targeted therapy NSCLC clinical trial. Metastatic lesions are more likely to yield diagnostic tissue as compared with primary tumors

Topal U, Ediz B. Transthoracic needle biopsy: factors effecting risk of pneumothorax. Eur J Radiol 2003;48(3):263-7.
PM:14652144

Variables that could increase the risk of pneumothorax were evaluated in 453 CT-guided transthoracic biopsies. Factors were evaluated in two groups: (1) lesion related (presence of emphysema around the lesion, lesion depth, cavitation, presence of fissure/atelectasis and pleural tag in the needle trajectory); and (2) procedure related (biopsy type, needle size, number of passages, level of experience of the operator). All variables were analysed by chi2 test and multivariate logistic regression statistics. RESULTS: pneumothorax was developed in 85 (18.8%) out of 453 procedures. A chest tube was inserted in ten (11.7%) of them. Variables that were significantly associated with an increased risk of pneumothorax were depth of the lesion ($P<0.001$) and severity of the emphysema ($P<0.01$). CONCLUSION: the length of the lung parenchyma traversed during the biopsy is the predominant risk factor for pneumothorax in patients undergoing CT-guided transthoracic biopsy. The risk of pneumothorax was also increased with the severity of the emphysema around the lesion.
Comment: Four sizes of needles were used: 6 16G, 242 18G, 190 20G and 14 22G. “No significant correlation was found between type of the biopsy (FNAB or tru-cut), needle size and number of passes.”

Topal U, Berkman YM. Effect of needle tract bleeding on occurrence of pneumothorax after transthoracic needle biopsy. Eur J Radiol 2005;53(3):495-9.
PM:16021686

This study was designed to evaluate the possible effect of needle tract bleeding on the occurrence of pneumothorax and on requirement of chest tube insertion. MATERIALS

AND METHODS: Two hundred eighty-four needle biopsies performed in 275 patients in whom the needle traversed the aerated lung parenchyma were retrospectively reviewed. Bleeding along the needle tract, occurrence of pneumothorax and need for chest tube insertion, type and size of the needle, size of the lesion, length of the lung traversed by the needle, presence or absence of emphysema were noted. Effect of these factors on the rate of pneumothorax and needle-tract bleeding was evaluated. The data were analyzed by chi2 test. RESULTS: Pneumothorax developed in 100 (35%) out of 284 procedures requiring chest tube placement in 16 (16%). Variables that were significantly associated with an increased risk of pneumothorax were depth of the lesion ($P < 0.001$) and severity of emphysema ($P < 0.05$). There was bleeding along the needle tract in 18.6% ($n = 53$) of the procedures. Pneumothorax occurred in 18 (33.9%) out of 53 procedures in which tract-bleeding was observed and in 82 (35.4%) out of 231 procedures in which tract-bleeding was not seen. The difference between the two groups was not significant ($P > 0.05$). However, analysis of the relation between length of lung traversed by the needle, tract-bleeding and pneumothorax rate indicated that tract-bleeding had a preventive effect on development of pneumothorax ($P < 0.001$). Occurrence of tract bleeding also had preventive effect on pneumothorax in the presence of emphysema ($P < 0.05$). The only variable which had effect on occurrence of tract-bleeding was the length of the lung traversed by needle ($p < 0.001$). Requirement for chest tube insertion was smaller in the tract-bleeding group than non-tract bleeding group, 11% (2/18) to 17% (14/82), respectively. But this difference was not significant statistically ($P > 0.05$). CONCLUSION: Bleeding in the needle tract has a preventive effect on the occurrence of the pneumothorax in deep-seated lesions and in the presence of emphysema, although it does not affect the overall rate of pneumothorax.
Comment: Three sizes of needles were used: 164 18G, 109 20G and 11 22G. “In our series, size of the needle, size of the lesion, presence of emphysema and histology of the lesion did not influence the occurrence of tract bleeding.”

Tung KT, Downes MO, O'Donnell PJ. Renal biopsy in diffuse renal disease--experience with a 14-gauge automated biopsy gun. Clin Radiol 1992;46(2):111-3. PM:1395398

The diagnostic and complication rates of 104 percutaneous renal biopsies performed for diffuse renal disease in native kidneys were retrospectively reviewed. Biopsies were performed by one radiologist using continuous ultrasound guidance and a 14-gauge biopsy needle in an automated gun (Biopty TM, Radiplast TM, Uppsala). 103 of 104 (99%) biopsies resulted in adequate tissue for a definitive histological diagnosis which improves on previously published diagnostic rates. Four patients (3.8%) experienced transient macroscopic haematuria. There were two symptomatic peri-renal haematomas, both of whom required transfusion, and one arteriovenous fistula which was successfully embolized (total 2.9% significant complications).

van Rijn JC, Bossuyt PM. Needle size in CT-guided transthoracic needle aspiration biopsy: complications and accuracy. Radiology 2004;232(1):305-6. PM:15220516

A letter to the editor about analysis of Geraghty 2003 paper, showing a significant loss of sensitivity from 18G to 19G, $P = 0.02$. He doubts that most clinicians would accept an almost two-fold increase in missed diagnoses.

Vijayaraghavan GR, Vedantham S, Rangan V, Karam A, Zheng L, Roychowdhury Aet al. Effect of needle gauge and lobe laterality on parenchymal liver biopsy outcome: a retrospective analysis. Abdom Imaging 2014.
PM:25367814

In this HIPAA-compliant, IRB-approved retrospective study, the data from 771 ultrasound-guided adult parenchymal liver biopsies were analyzed. Post-procedure complications were assigned a 3-point rating scale. Associations between specimen length and post-procedure complications with lobe laterality, needle gauge, and number of passes were analyzed. Multivariate logistic regression models were used to analyze the likelihood for achieving a specimen length of at least 2 cm. RESULTS: Post-procedure complications were not associated with lobe laterality, needle gauge, and number of passes ($p > 0.3$). Specimen length was associated with the number of passes dichotomized at the study mean ($p = 0.007$), but not with lobe laterality or needle gauge ($p > 0.2$). After adjusting for lobe laterality and needle gauge, procedures with 1 or 2 passes were associated with a higher likelihood of obtaining a 2 cm or longer specimen (OR 2.469; CI 1.08-5.63, $p = 0.0315$) than procedures with 3 or more passes, possibly due to poorer sample quality. After adjusting for lobe laterality, an 18-gauge needle was associated with higher odds of a biopsy procedure with 1 or 2 passes (OR 3.665; CI 1.93-6.95, $p < 0.0001$) than a 20-gauge needle. CONCLUSIONS: Lobe laterality was not associated with specimen length or post-procedure complications. An 18-gauge needle compared to a 20-gauge needle could reduce the need for a procedure with more than 2 passes. There was no difference in post-procedure complications between the two needle sizes.
Comment: an 18G needle was used in 93.6% of procedures and a 20G needle in 6.4%. The odds ratio of obtaining a satisfactory specimen in 1 or 2 passes was 3.67 for 18G vs 20G, $P < 0.0001$.

Wan YL, Chan SC, Chen YL, Cheung YC, Lui KW, Wong HFet al. Ultrasonography-guided core-needle biopsy of parotid gland masses. AJNR Am J Neuroradiol 2004;25(9):1608-12.
PM:15502149

We reviewed records for 40 benign and 13 malignant parotid lesions. USCNB was performed by using 14-20-gauge needles (mean, 16.6 gauge) with one to five (mean, 2.43) passes and a 15-mm throw or specimen notch… USCNB had a sensitivity of 83%, a specificity of 100%, and an accuracy of 97% in providing specific tissue diagnoses and in differentiating malignant from benign masses. Its positive and negative predictive values were 100% and 96%, respectively, in diagnosing malignancy. One patient (2%) with a Warthin tumor had a local hematoma without sequela. Core biopsy results were completely concordant with surgical findings in 30 (97%) of 31 cases. CONCLUSION: USCNB is a safe and efficient diagnostic procedure with an accuracy of 97% in the pathologic diagnosis of parotid masses. An 18-gauge needle is sufficient for accurate and specific tissue diagnosis of parotid masses.
Comment: They used the following needles: 6 14G, 26 16G, 20 18G and 1 20G tru-cut.

Welch TJ, Sheedy PF, Johnson CD, Johnson CM, Stephens DH. CT-guided biopsy: prospective analysis of 1,000 procedures. Radiology 1989;171(2):493-6.
PM:2704815

The authors prospectively analyzed 1,000 biopsies guided with computed tomography (CT) and performed in 955 patients over a 30-month period. CT-directed biopsy for accurate diagnosis was 91.8% sensitive and 98.9% specific, with a positive predictive value of 99.7% and a negative predictive value of 73.3%. Of 11 patients with complications, seven had hematomas, three had pneumothorax, and one had hematuria. No deaths occurred, and only one patient required surgery. This overall complication rate was 1.1%. The table below analyzes the increase in complication rate with needle size; note that the first group, with needles of 16G or larger, had 5 of the 11 complications, for a rate of 2.3%.

| Group comparisons: ≤16G, ≤17G, ≤18G, ≤19G | | | | |
|---|---|---|---|---|
| Group | N used | N complications not pneumothorax | rate % | Ratio of rates |
| ≤16G | 221 | 5 | 2.26% | 8.4 |
| >16G | 1119 | 3 | 0.27% | |
| ≤17G | 257 | 5 | 1.95% | 7.0 |
| >17G | 1083 | 3 | 0.28% | |
| ≤18G | 838 | 7 | 0.84% | 4.2 |
| >18G | 502 | 1 | 0.20% | |
| ≤19G | 1062 | 7 | 0.66% | 1.8 |
| >19G | 278 | 1 | 0.36% | |

Wilczek HE. Percutaneous needle biopsy of the renal allograft. A clinical safety evaluation of 1129 biopsies. Transplantation 1990;50(5):790-7. PM:2238054

We have evaluated the safety of percutaneous renal allograft biopsy by retrospectively studying 1129 biopsy specimens in 513 patients between 1974 and 1988. All biopsies were performed with a conventional 2.0 mm TruCut disposable needle (Travenol Labs.; Deerfield, IL) without radiographic aid for localization of the kidney. Kidney tissue was obtained in 1095 cases (97.0%). In 1037 biopsies (91.9%) enough renal tissue for histological evaluation was obtained. All the complications were demonstrated by macroscopic bleeding into the urinary tract system. Thirty-two patients (2.8%) developed hematuria requiring hospitalization and some type of active treatment (catheter-a-demeure, n = 14; cystoscopy, n = 11; percutaneous nephrostomy, n = 3; surgery, n = 4). On 8 biopsy occasions blood transfusion was required. Three graft removals (0.3%) were attributed to the procedure of biopsy for emergency diagnostic purposes. All three grafts were severely damaged by rejection and had little or no function. No grafts were lost among the biopsies taken for long-term follow-up. No deaths occurred. Biopsies yielding only renal medulla were found to carry a greater risk of bleeding than adequate biopsy specimens (P less than 0.001), as did biopsies from transplants with acute vascular

rejection. Conversely, biopsies taken for routine check-ups of long-term renal allografts were associated with a lower risk than biopsies taken because of poor or deteriorating renal function (P less than 0.05). An analysis of 340 biopsies, taken in accordance with a protocol during periods of stable renal function, revealed no deterioration in graft function at 1 and 12 months after the biopsy. In this study, we have found that conventional percutaneous needle biopsy of the renal allograft involves a certain risk of complications, even including graft loss.

Wu JS, Goldsmith JD, Horwich PJ, Shetty SK, Hochman MG. Bone and soft-tissue lesions: what factors affect diagnostic yield of image-guided core-needle biopsy? Radiology 2008;248(3):962-70. PM:18710986

A prospective study of 151 consecutive core needle biopsies (CNB) of bone (n = 88) and soft-tissue (n = 63) lesions. Each CNB specimen was reported separately in the final pathology report. Diagnostic yield (total number of biopsies that yield a diagnosis divided by total number of biopsies) was calculated for all lesions and subgroups on the basis of lesion composition (lytic, sclerotic, soft tissue), lesion size (< or = 2, > 2 to 5, or > 5 cm), biopsy needle gauge, image guidance modality, number of specimens obtained, and specimen length (< 5, 5-10, or > 10 mm)…. Chi^2 And Wilcoxon rank-sum tests were performed in bivariate analyses to evaluate associations between each factor and diagnostic yield. Significant factors were evaluated with multivariate logistic regression. RESULTS: Diagnostic yield was 77% for all lesions. Yield was 87% for lytic bone lesions and 57% for sclerotic bone lesions (P = .002)….Yield was 83%, 72%, 77%, and 83% for biopsies performed with 14-, 15-, 16-, and 18-gauge needles, respectively (P = .57). Yield was 77% with computed tomographic guidance and 78% with ultrasonographic guidance (P = .99). Diagnostic yield increased with number of specimens obtained and with longer specimen length; it reached a plateau at three specimens for bone lesions and four specimens for soft-tissue lesions. CONCLUSION: Diagnostic yield is higher in lytic than in sclerotic bone lesions, in larger lesions, and for longer specimens. Obtaining a minimum of three specimens in bone lesions and four specimens in soft-tissue lesions optimizes diagnostic yield.
Comments: Used 6 14G, 68 15G, 30 16G and 47 18G tru-cut needles. Yield did not differ between needle sizes, P = 0.57. There was one minor complication.

Yeow KM, Su IH, Pan KT, Tsay PK, Lui KW, Cheung YCet al. Risk factors of pneumothorax and bleeding: multivariate analysis of 660 CT-guided coaxial cutting needle lung biopsies. Chest 2004;126(3):748-54.
PM:15364752

Reviewed 660 biopsy procedures to determine the risk factors for pneumothorax and bleeding after CT-guided coaxial cutting needle biopsy of lung lesions. The risk factors for pneumothorax and bleeding were determined by multivariate analysis of variables related to patient demographics, lung lesions, biopsy procedures, and the individual radiologist. RESULTS: The main complications were pneumothorax (23%; 155 of 660 procedures), chest tube insertion (1%; 9 of 660 procedures), and hemoptysis (4%; 26 of 660 procedures), with no patient mortality. The highest pneumothorax rate correlated with a lesion size of </= 2 cm, a lesion depth of 0.1 to 2 cm, and less experienced radiologists. The highest bleeding risk correlated with a lesion size </= 2 cm, a lesion depth of >/= 2.1 cm, and the absence of pleural effusion.

Comments: They used 49 16G tru-cut needles, as well as 18G and 20G needles at the discretion of the radiologist. Needle size was not correlated to PTX or bleeding rates by multivariate analysis, $P > 0.05$.

Zech CJ, Helmberger T, Wichmann MW, Holzknecht N, Diebold J, Reiser MF. Large core biopsy of the pancreas under CT fluoroscopy control: results and complications. J Comput Assist Tomogr 2002;26(5):743-9.
PM:12439309

Sixty-three CT-guided biopsies were performed in 57 consecutive patients over a period of 20 months. Forty-nine of the 57 patients had a malignant lesion (85.9%). All procedures were done under CT fluoroscopic guidance. A high-speed biopsy gun with 14, 16, or 18 gauge cutting-type needles was used. Based on final pathologic diagnosis as the standard of reference, the diagnostic efficacy was determined. Complications during and afterward up to the patient's discharge from hospital (mean, 8.1 days; range, 1-48 days) were noted. RESULTS: Core biopsy of the pancreas resulted in a correct diagnosis in 51 of 63 biopsies, yielding a sensitivity for malignancy of 78.1%, a specificity of 100%, a positive predictive value of 100%, and an overall accuracy of 81.0%. One patient developed an acute pancreatitis related to the biopsy (1.6%). CONCLUSION: CT fluoroscopic-guided core biopsy is a safe and reliable tool for the pre-therapeutic evaluation of pancreatic lesions.
Comment: They used 5 14G, 54 16G and 4 18G needles.

**Data summary, needle gauge and biopsy complications** PTW 2/25/2015

| First Author | Journal | Year | Study type | Study Quality | Organ | N biopsies | Needle size 14G | 16G | 18G | 19G | 20G | >20G | Accuracy 14 - 19G | 20G+ | Complication rate (%) 14 - 19G | 20G+ | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anania | World J Gastrointe | 2014 | retrospective review | 4 | Liver | 226 | 0 | 167 | 59 | 0 | 0 | 0 | 96% - 92% | ND | Serious 0% | | |
| Brandt, K.R. | Radiology | 1993 | retrospective review | 4 | Pancreas | 269 | | | | | | | 92% | 85% | no difference, 1.1% major | | |
| Cheung, Y.C. | Lung Cancer | 2010 | retrospective review | 4 | Lung | 47 | 0 | 0 | 32 | 0 | 15 | 0 | 100% | 100% | 19% | 20% | |
| Chojniak, R. | Sao Paulo Med J | 2006 | retrospective review | 4 | Lung | 142 | 0 | 142 | | 0 | 0 | 0 | 94% | ND | 6% | NA | |
| Covey | SIR | 2004 | retrospective review multivari | 3 | Lung | 453 | 0 | 0 | 18 | 0 | 41 | 394 | NA | NA | no difference, P > 0.05 | | |
| de Kerviler | Cancer | 2000 | retrospective review | 4 | Lymphoma | 212 | 8 | 103 | 83 | 0 | 18 | 0 | 88% | ND | no difference, 7.5% minor | | |
| **Geraghty** | Radiology | 2003 | retrospective review multivari | 3 | Lung | 846 | 0 | 0 | 324 | 522 | 0 | 0 | 96% | 92% | 38% | 23% | |
| Giovanni | Asian J Androl | 2009 | randomized prospective trial | **1** | Prostate | 187 | 0 | 94 | 93 | 0 | 0 | 0 | no difference, P = 0.55 | | no difference, P = 0.22 -.9 | | |
| Haage | Rofo | 1999 | retrospective review | 4 | Liver | 272 | 101 | 0 | 171 | 0 | 0 | 0 | no difference | | 3% vs 0.6% 14G vs 18G | | |
| Inal | Prost Cancer Prost | 2008 | randomized prospective trial | **1** | Prostate | 204 | 0 | 103 | 101 | 0 | 0 | 0 | no difference, P = 0.13 | | no difference, P = 0.13 -.5 | | |
| Kakizawa | Hiroshima J Med S | 2010 | retrospective review | 4 | Lung | 91 | 0 | 0 | 26 | 0 | 60 | 0 | ND | | no difference, P = 0.24 | | |
| McCormack | Can Urol Assoc J | 2012 | prospective trial w/ control | **1** | Prostate | 105 | 0 | 105 | 105 | 0 | 0 | 0 | no difference, P = 0.33 | | no difference, P = 0.34 | | |
| Nicholson | Kidney Internationa | 2000 | randomized prospective trial | **1** | Kidney | 100 | 33 | 33 | 34 | 0 | 0 | 0 | 14G>16G>18G, P < 0.01 | | bleeding, ND; pain 14G > others | | |
| Plecha | Radiology | 1997 | animal study (pig) | **1** | Liver | 253 | 64 | 0 | 63 | 0 | 63 | 0 | NA | NA | blood and sample per size | | |
| Schubert | Diagn Cytopathol | 2005 | prospective series | 2 | Chest (US) | 97 | 85 | 0 | 0 | 0 | 0 | 97 | 80% | 82% | no complications at all | | |
| Screaton | Radiology | 2002 | retrospective review | 4 | Thyroid | 209 | 0 | 138 | 36 | 0 | 0 | 0 | 95% | ND | 2%, no correlation to size | | |
| Screaton | Radiology | 2003 | retrospective review | 4 | Lymphoma | 260 | 0 | not specified | | 0 | 0 | 0 | 97% | ND | 1%, no correlation to size | | |
| Silverman | Radiology | 1994 | retrospective review | 4 | Lymphoma | 102 | | 18 | | | 32 | | 72% | ND | 2%, no correlation to size | | |
| Stattaus | Der Radiologe | 2007 | retrospective review | 4 | Liver | 163 | 0 | 121 | 42 | 0 | 0 | 0 | 98% | 86% | 5% minor, 1 death vs 2.4% minor | | |
| Topal | Eur.J.Radiol. | 2003 | retrospective review multivari | 3 | Thorax | 453 | 0 | 6 | 242 | 0 | 190 | 14 | NA | NA | no correlation to needle size | | |
| Topal | Eur.J.Radiol. | 2005 | retrospective review | 4 | Thorax | 612 | 0 | 0 | needle size not specified | | | | NA | NA | no correlation to needle size | | |
| Vijayaraghavan | Abdom Imaging | 2014 | retrospective review multivari | 3 | Liver | 771 | 0 | 0 | 722 | 0 | 49 | 0 | OR 3.64 sample sooner | | no difference, P = 0.34 | | |
| Wan | AJNR | 2004 | retrospective review | 4 | Parotid gland | 53 | 6 | 26 | 20 | 0 | 1 | 0 | 97% | NA | 1 complication 2% | | |
| Welch | Interventional Radi | 1989 | prospective review | 2 | All sites | **1000** | 30 | 227 | 581 | 224 | 5 | 273 | 93% | ND | 11 complications 1.1% | | |
| Wilcsek | Transplantation | 1990 | retrospective review | 4 | Kidney | **1129** | 1129 | 0 | 0 | 0 | 0 | 0 | 92% | NA | 32 complications 2.8% | | |
| Wu | Musculoskeletal Im | 2008 | retrospective review multivari | 3 | Musculoskelet | 151 | 6 | 68 | 30 | 47 | 0 | 0 | 92% | NA | 1 complication 0.7% | | |
| Yeow | Chest | 2004 | retrospective review multivari | 3 | Lung | **660** | 0 | 49 | 611 not specified | | | 0 | ND | ND | 10 serious complications 1.5% | | |
| Zech | J Comput Assist To | 2002 | retrospective review | 4 | Pancreas | 57 | 5 | 54 | 4 | 0 | 0 | 0 | 82% | ND | 1 serious complication 1.5% | | |

Abbreviations: NA not available, ND not done