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ROSE Versus MOSE for Evaluation of EUS – Guided Tissue Samples



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Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) with rapid on-site evaluation (ROSE) has been a subject of debate over the past few decades. With the development of new core needles, endoscopic ultrasound-guided fine-needle biopsy (EUS-FNB) with macroscopic on-site evaluation (MOSE) has been shown to provide similar diagnostic accuracy with more cost-effectiveness compared to EUS-FNA with ROSE. This article aims to review the literature to provide a detailed description and comparison of outcomes of both sampling procedures.

BACKGROUND

Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) is a minimally invasive and well established technique for evaluation of tissue samples from pathologic lesions in the pancreas, abdominal lymph nodes, liver, spleen, and intramural lesions in the GI tract.¹ (Figure 1) Under real-time EUS guidance, the technique involves inserting a puncture needle into the target for aspiration biopsy to obtain tissue for cytologic analysis.² Over the past few decades, tissue

diagnosis from sampling has become crucial as the development of new treatments for pancreatic cancer grows. As a result, assessing the adequacy of the sample is important. In 1994, Wiersema et al. were the first to describe the importance of rapid on-site evaluation (ROSE) of aspirated tissue sample with an on-site cytopathologist.³ Follow-up studies have shown that ROSE effectively improves the diagnostic ability of EUS-FNA because it can assess whether or not the sample is adequate in real-time.^{4,5,6} However, there may be limited availability of ROSE at most facilities due to its costs of having an additional cytologist or, at the very least, a cytology technician, present during the procedure.⁷

Core biopsy needles have been developed to obtain larger amounts of tissue at a higher

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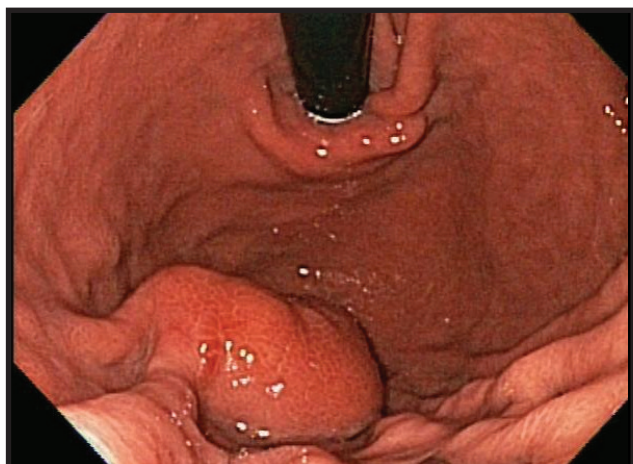


Figure 1a. Endoscopic image of a gastric submucosal mass

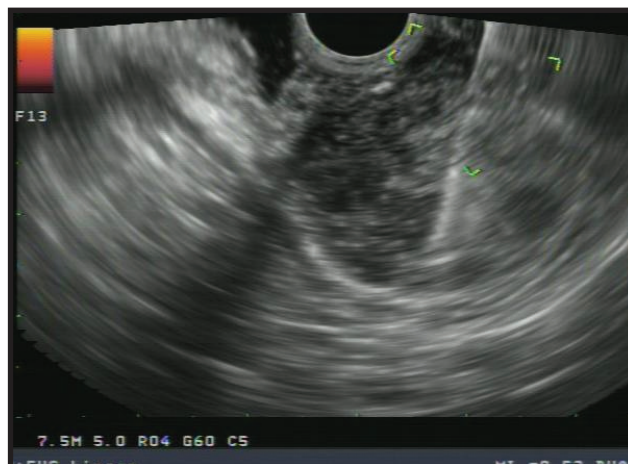


Figure 1b. EUS image of a gastric submucosal mass during needle sampling procedure

histologic and diagnostic yield compared to the traditional FNA.^{8,9,10} These needles obtain tissue that provides true histology, and not just cytology, to pathologists. This technique, using the newer core needles, is termed as endoscopic ultrasound-guided fine-needle biopsy (EUS-FNB), which has been shown to provide equal or even higher diagnostic yield to that of EUS-FNA with ROSE.^{11,12} Iwashita et al. were the first to show that macroscopic on-site evaluation (MOSE) using EUS-FNB provides similar diagnostic accuracy to the conventional EUS-FNA without ROSE. MOSE involves the visual assessment by the endoscopist for the presence and length of a visible core from the samples obtained during EUS-FNB. Subsequent studies on MOSE showed a reduction of needle passes with similar diagnostic yield and increased cost-effectiveness.^{11,12,13}

In this article, we aim to review the literature to assess the techniques and procedures of ROSE and MOSE as well as provide comparisons of outcomes between the two sampling procedures.

What is ROSE?

The purpose of ROSE is to improve the diagnostic performance of EUS-FNA.^{14,15} The EUS-FNA procedure starts with identification and aspiration of the target lesion, typically using a 22-gauge needle. The FNA material is then expressed on a slide and stained with diff-quick stain, or other stains as per the preference of the cytologist.¹⁶ The aspiration needle is also sometimes washed in 10%

formol in test tubes for cell block preparation.¹⁶ Next, ROSE is performed by the cytopathology team. They examine the smears and cell block in the endoscopy suite, in real time, to assess whether tissue is adequate and to provide an on-site diagnosis, or to suggest additional needle passes to obtain more tissue. (Figure 2)

The main advantage of ROSE is it can provide improved final sample quality and adequacy because the on-site cytopathologist can immediately evaluate the cells obtained. This reduces the likelihood of acquiring inadequate tissue samples and minimizes the need for repeat biopsy procedures, with their attendant risks and costs. Prior meta-analyses have shown that on-site cytopathology evaluation improves malignancy detection and diagnostic adequacy by 10-15% compared to EUS-FNA without ROSE.^{17,18,19,20,21} Compared to EUS-FNA without ROSE, EUS-FNA with ROSE has increased cost-effectiveness with significant savings of \$252 per EUS-FNA case.²²

The limited availability of ROSE is its primary major drawback. ROSE may sometimes be available in tertiary centers but is generally not available in smaller hospitals or community centers due to the manpower issues, the lack of on-site cytopathologists, and related costs.⁷ A global survey in 2016 revealed that ROSE is only available in 55% of Asian institutions.⁷ ROSE may be performed by a cytologist or a cytology technician. However, they must have the sufficient amount of training to interpret cytology, or at least

assess cellular adequacy, which adds additional cost burdens to the hospital to develop and hire them.²³ In addition, subjectivity in interpretation of the tissue sample between cytologists can affect diagnostic accuracy, ultimately leading to variations in diagnosis. The initial interpretation of adequacy is critical to determine if additional aspirates are required and must be performed in real time. Differences in interpretation of adequacy could lead to increased procedural costs, time, and even complication rates.²⁴

What is MOSE?

MOSE is utilized to determine the presence and length of a visible tissue core from the target lesion or organ in order to increase the diagnostic yield prior to histologic analysis.^{11,12} After the first pass, the core biopsy needle is removed to expel the tissue specimens onto a glass slide or into a formalin jar or blotter paper for visual inspection. MOSE is then performed by identifying a visible tissue core. The length of the core can vary but are typically 2-3 centimeters in length. Interestingly, prior studies have shown adequate tissue core lengths ranging from 4 millimeters to 1 centimeter.^{25,26} If a tissue core of at least 2-3 centimeters is obtained, the FNB is considered complete. (Figure 3) Based on the authors' experiences, many FNBs with adequate tissue core length are done with only one pass. Otherwise, the stylet is reinserted with the needle for preparation of a second pass. Most studies evaluating the outcomes of MOSE had a minimum of two needle passes before an adequate sample was obtained.^{27,28,29} The adequate sample is then placed in formalin and sent to the pathology department for histological analysis.

With MOSE, the endoscopist confirms if the visible core is adequate enough for cytology analysis, so there is no need for a cytologist to be on-site in the endoscopy suite. A systematic review done by Gadour et al. found that MOSE is cost-effective due to fewer needle passes and shorter procedural times when compared to ROSE.³⁰

The lack of confirmation in the adequacy of the tissue sample by the cytologist before sending it for cytology analysis is the primary drawback of MOSE. The cytologists on-site can make meaningful contributions during the biopsy process as confirming the tissue sample prior to cytology

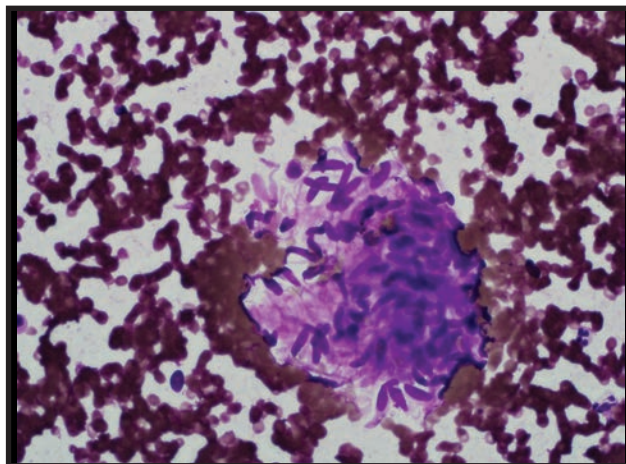


Figure 2. ROSE cytology image of spindle cells, confirming the lesion is a gastrointestinal stromal tumor (GIST)

analysis may increase the accuracy of the diagnosis. Bang et al. found that ROSE was an important factor that significantly increased the diagnostic yield of FNA of a tissue sample.³¹ False negatives and inaccurate macroscopic evaluation may be a drawback of MOSE. Different endoscopists may have varying interpretations of what constitutes an adequate sample via MOSE.³⁰

Outcome Comparisons Between ROSE and MOSE

Recently, multiple cohort studies have compared FNA with ROSE and FNB with MOSE in terms of diagnostic yield, number of passes taken, operation time, adverse events, and total costs.

In one study, the diagnostic yield was higher with MOSE compared to ROSE, but this difference was statistically insignificant (94.6% vs 89.6%, $p=0.406$, respectively).³² One study showed 90.6% diagnostic accuracy in the MOSE group compared to 75.0% in the ROSE group ($p=0.026$), although this study had an unusually low accuracy rate for ROSE when compared to prior studies.³³ Two other studies did not find statistically significant differences in diagnostic accuracy between the two groups.^{12,34} Prior studies also showed statistically insignificant differences in sensitivity, specificity, and positive predictive value between ROSE and MOSE.^{12,32,33,34}

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Based on these findings, there were generally no differences in overall diagnostic yield between MOSE and ROSE. However, studies have found that newer needles designed for EUS FNB may require fewer passes than EUS FNA with ROSE, while achieving the same diagnostic accuracy.^{9,30,31} In the study by Van Riet et al., 19% of patients in the ROSE group required more than 3 passes for the same diagnostic accuracy compared to 10% of patients in the MOSE group ($p=0.002$), who required that many passes.⁹ However, Guan et al. found statistically insignificant differences in the number of needle passes between MOSE and ROSE to achieve diagnostic accuracy ($p=0.151$), suggesting that the data by Van Riet et al. may be an outlier.³³ Proponents of MOSE suggested that fewer needle passes can limit traumatic injury and decrease procedural time.^{2,31} However, one could argue that the FNB needle is more stiff and may have difficulty procuring tissue in more difficult anatomic scope positions leading to decreased diagnostic yield.⁹

Two prior studies revealed lower procedural time with MOSE when compared to ROSE ($p<0.01$), which makes intuitive sense.^{12,32} This is expected given there is an additional time needed in ROSE for the cytologist to examine the tissue sample. However, with ROSE, the immediate evaluation of the sample by the cytologist may lead to more efficient downstream care. For example, ROSE has the ability to make an immediate preliminary diagnosis allowing for more timely subsequent care and may reduce the need for repeat biopsy procedures if tissue obtained via MOSE is ultimately felt to be non-diagnostic.

In regards to adverse events and complications, there were no statistically significant differences comparing EUS-FNB with MOSE and EUS-FNA with ROSE.^{32,33} Prior studies have estimated the adverse event rate of EUS FNA with ROSE to be approximately 1-2%, which was comparable to EUS FNB with MOSE.^{35,36} One can assume that increasing the number of passes would increase the risk of adverse events. Therefore, since the average number of passes for both MOSE and ROSE are similar, it would explain why both procedures have similar numbers of adverse events.

Chen et al. conducted a cost-minimization

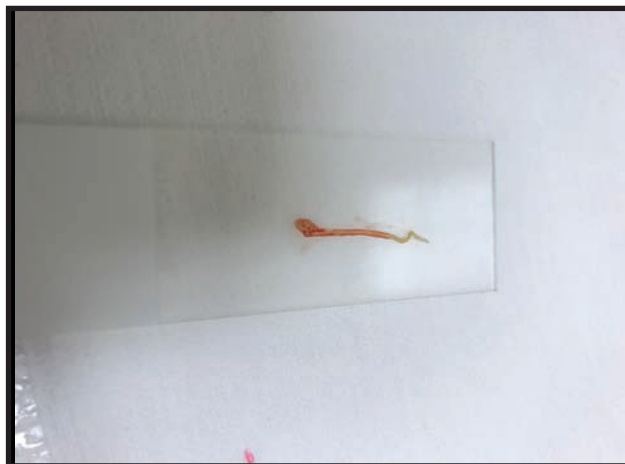


Figure 3a. Macroscopic tissue core obtained during MOSE

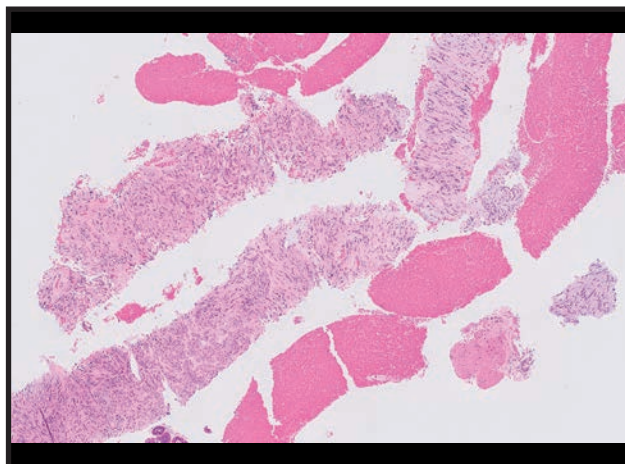


Figure 3b. Histology slide showing significantly more tissue obtained via MOSE, also showing spindle cells and confirming the lesion is a GIST

analysis between MOSE and ROSE, which found that MOSE was only slightly more costly overall than ROSE, saving an additional \$45 per procedure.¹² This may be due to the more expensive newer core biopsy needles used for procedures with MOSE. Although costs appear to favor ROSE, the difference between ROSE and MOSE is marginal and unlikely to have a significant impact on hospital budgets in North America.¹² Sbeit et al. conducted a similar cost-minimization analysis, which found no differences in cost-effectiveness between MOSE and ROSE.³⁷ Both ROSE and MOSE have been found to adequately evaluate and diagnose different types of lesions including both pancreatic and

non-pancreatic.^{12,32,34} Puncture paths of the needle in both ROSE and MOSE include trans-esophageal, trans-gastric, and trans-duodenal.^{12,32,34}

CONCLUSIONS

ROSE and MOSE are valuable techniques when acquiring tissue samples during an EUS procedure. ROSE allows real-time cytological assessment of tissue quality and adequacy, which may improve efficiency in clinical management downstream. On the other hand, MOSE provides a gross assessment of core tissue samples without the need for on-site cytopathology and offers savings of both money and time. MOSE is currently widely utilized to assess the adequacy of tissue sample in hospitals where ROSE is not available or time limitations make ROSE impractical. Both techniques have similar diagnostic yield of the extracted tissue sample, number of needle passes required, and adverse events.

MOSE remains a popular choice for endoscopists, but ROSE still has its value for difficult cases with complex diagnoses or cases requiring repeat tissue sampling due to the benefit of having immediate cytological evaluation and feedback. The choice between these two techniques should be guided by hospital resources, endoscopist preference for preferred technique, and the clinical need for immediate cytological evaluation. ■

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