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Research Article

Miniprobe Endoscopic Ultrasonography for the Gastrointestinal Tract Assessment: A Cumulative Experience of 1000 Procedures

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Abstract

Background: Utilization of conventional endoscopic ultrasonography has allowed precise diagnostics without disturbances occurring at the conventional ultrasound imaging. Miniprobes can be easily introduced through the biopsy channel of the endoscope and the use of Miniprobe Endoscopic Ultrasonography has many benefits compared to conventional endoscopic ultrasonography. In spite that is well known that has precise indications for use in the endoscopic digestive tract study, such as the study of stenosis, cancer staging, or the non-tumoral condition assessment, among other utilities, still needs to be more widely spreaded among physicians and commonly used by most endoscopists. The objective of this study is to use our cumulative experience using Miniprobes, to present with examples and statistics, the applicability and usefulness of this technology in the daily activity of an endoscopy department.

Methods: A multicenter retrospective review of a database of 1000 patients that underwent Endoscopic Ultrasonography-guided by Miniprobe of different brand and model, performed in three hospitals from November 1996 to July 2007.

Results: from our experience, the indications of Miniprobes utilization, are: cancer staging 35%, subepithelial lesions 30%, others 35%. In any of the procedures there were no major adverse events; the most frequent was abdominal pain (5%) induced by the endoscopy.

Conclusions: Miniprobe Endoscopic Ultrasonography appears to be a feasible, safe, and effective procedure for endoscopic assessments, with no major adverse events, that increase the quality of procedures with a high degree of resolution and the ability to perform real time imaging during diagnostic and therapeutic interventions.

ABBREVIATIONS

Meus: Miniprobe Endoscopic Ultrasonography; DPR: Dual-Plane Reconstruction; EGCD: Endoscopic Gastro-Cyst Drainage; EST: Esophagic Subephitelial Tumors; EUS: Endoscopic Ultrasonography; EUS-FNA: EUS-Fine-Needle Aspiration-Puncture; FFPE: Formalin-Fixed And Paraffin-Embedded; FN: False Negative; GIST: Gastrointestinal Stromal Tumor; IDUS: Intraductal Ultrasonography; MALT: Mucosa-Associated Lymphoid Tissue; Mhz: Megahertz; Mps: Miniprobes; PP: Pancreatic Pseudocysts; PSC: Primary Sclerosing Cholangitis, TP: True Positive

INTRODUCTION

With Miniprobe Endoscopic Ultrasonography (mEUS) can be determined the shape, size, the origin and nature of tissue of some lesions. Nowadays this technique has precise indications,[1] such as the study of pancreatobiliary and gastrointestinal tract stenosis [2], esophageal, gastric and colorectal cancer staging; [3] the assessment of non-tumor esophageal conditions and subepithelial lesions below 20 mm in size. It also may even become an alternative to both, the radial and sectorial endoscopic ultrasonography (EUS) in the diagnosis enviroment, since the indications of miniprobes (MPs) are increasingly more numerous and the technical refinement is higher, which it has increased the detection rate of some tumors [4].

The aim of this publication is to report retrospectively our extensive experience using MPs by describing the indications, technical details, durability and results of a series of 1000 consecutive procedures, that may be of interest in the daily activity of an endoscopy department.

MATERIALS AND METHODS

A multicenter study, where four endoscopists participated performing a total of 1000 examinations with mEUS along more than 10-years, in three private hospitals, from November 1996 to July 2007. All procedures were carried out after patients signed the corresponding informed consent.

Procedure

All patients underwent EUS-guided by MP with the assistance of an anesthetist for the sedation. In 1996 the percentage of sedations was about 10%, turning into 95% in 2007, because patients requested conscious sedation in our private center (Figure 1) Sedation applied was intravenous propofol (Figure 1).

Miniprobe endoscopic ultrasonography (mEUS)

Since the 90s, many articles have been published describing technical details of use of miniprobes [4-7].

The choice of the miniprobe for each procedure has several considerations, some of them would be the localization of lesion to explore and the definition that we need for the procedure/assessment. Models with higher ultrasonic frequency have less penetration and higher resolution. For example, 20 MHz is suitable for clear images of superficial lesions. Conversely, devices with lower MHz have greater penetration but lower resolution. In this case, 12 MHz and 7.5 MHz are more suitable for the evaluation of the big lesions and contiguous tissues [8]. Another issue is the working channel more suitable, in this series was used a 3.2 mm working channel with a wire-guided G20-29R, miniature probe; Olympus Ltd. (Tokyo, Japan), whereas a 2.8 mm working channel was used with the remaining MPs.

Along this period, we have had the opportunity to use different devices to perform the explorations and this work tries to reflect the experience with some of them that are listed below.

Radial MP of 12.5 MHz (20 mm penetration) 6.2 F, (2 mm diameter) and 950 or 2000 mm in lenght; Endosound/Microvasive (Watertown, MA, U.S.A.). This MP was used in 20 explorations.

Radial MP of 12 MHz (29 mm mean depth) or 20 MHz (18 mm mean depth), UM-2R and UM-3R; Olympus Ltd. (Tokyo, Japan), (Figure 2) are ultrasonic miniature probes designed to be inserted through the working channel of a standard endoscope with a compatible biopsy channel diameter of 2.8mm or more, allowing effortless ultrasonic examination during routine endoscopy. This radial ultrasound probe offers high-resolution ultrasound imaging for a wide range of applications, including the upper and lower digestive tract assessment. Can be used in the esophagus, stomach, colon and rectum and improves diagnostic capabilities in both digestive tracts. This device was used in 20 procedures (Figure 2).

Radial 12 MHz (2.5 mm diameter) UM-DP12-25R or Radial 20 MHz (2.5 mm diameter) UM- dual-plane reconstruction (DPR), (8 F) in diameter and 2050 mm in length; Olympus Ltd. (Tokyo, Japan). A frequency of 12 MHz allows deep tissue penetration of the ultrasound signal and examination of deep tissue layer and the DPR function allows the acquisition of 3D ultrasound images. (Figure 3) This MP was used in 100 procedures (Figure 3).

Figure 1 Endoscopy Service with Miniprobe Endoscopic Ultrasonography (mEUS) facilities.

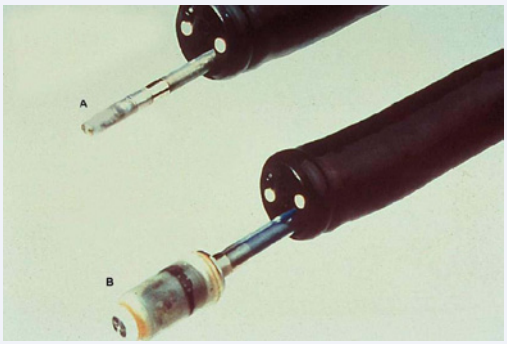

Figure 2 12 or 20 MHz UM-2R/3R Olympus miniprobe (A); 7.5 MHz, 2.6 mm radial balloon microprobe with a preload system. Fuji probes (B).

Radial 20 MHz (2.9 mm diameter) wire-guided G20-29R, miniature probe; Olympus Ltd. (Tokyo, Japan). This is a miniature ultrasound probe that allows high-resolution ultrasound images to be taken through 360° via the channel of a standard medical endoscope of 3.2 mm, allowing ultrasonic examination during routine intraductal ultrasonography (IDUS). Wire-guided insertion allows the miniprobe to be inserted into even tight pancreatobiliary duct strictures during IDUS.(Figure 4) This model was used in 10 intraductal studies (Figure 4).

Radial and linear Miniprobe of, 12, 15 or 20 MHz, with 2-2.6 mm in diameter and 1900 mm in length Fuji [Singapore]; and with a 7.5 MHz, 2.6 mm radial balloon microprobe with a preload system. Fuji probes. This model was used from 1999 to 2007 in a total of 850 examinations.

Whenever was possible, acoustic coupling was achieved using the direct water immersion technique or, otherwise, by the distal balloon attachment method. Latex-free mini balloons were used, except with the 7.5 MHz microprobe.

Anatomopathological studies

Formalin-fixed and paraffin-embedded (FFPE) tissue samples were cut in 4-µm-thick sections on a microtome using standard procedures. Haematoxylin and eosin (H&E) was the stain of choice for routine examination. When immunohistochemical differential diagnosis was needed, different diagnostic panels were used, depending on the morphological pattern.

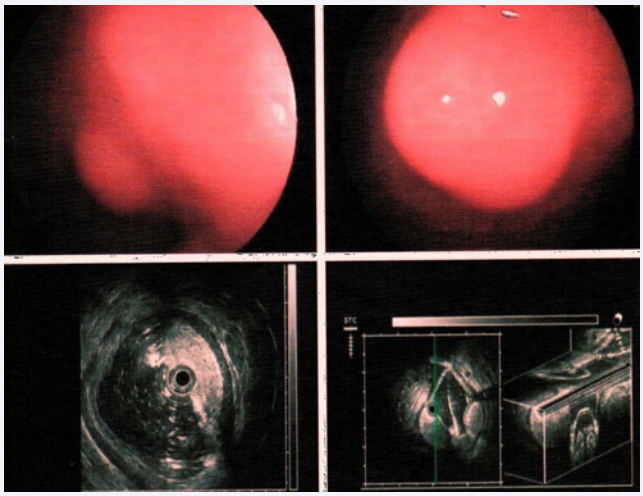

Figure 3 Radial 20 MHz UM- dual-plane reconstruction; Olympus Ltd. (Tokyo, Japan) 3D MP. Antral Lipoma.

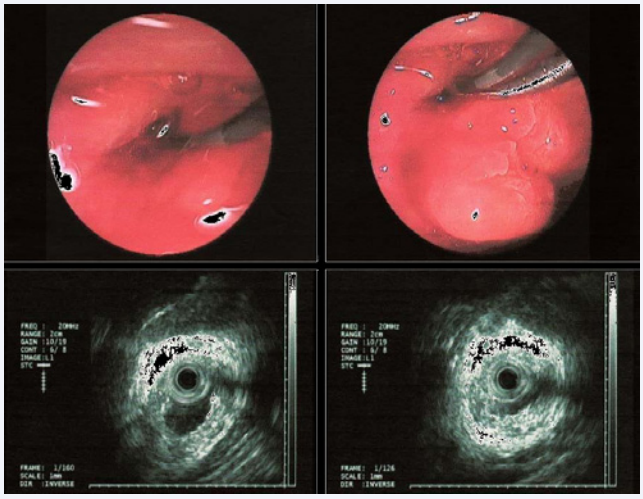

Figure 4 Radial 20 MHz MP. Bile duct wall thickening. Suspicion of primary sclerosing cholangitis (PSC).

Statistical analysis

Data obtained were, number of explorations performed, the duration of the procedure with miniprobe, indication and organ to be explored, adverse events, morbidity and mortality. All statistical analyses were performed using the statistical package SPSS v11. The diagnostic sensitivity, regarding to the biopsy result, was obtained by the formula: TP/TP+ FN, where TP and FN mean true positive and false negative, respectively.

RESULTS AND DISCUSSION

The experience of more than 10 years carrying out procedures with mEUS could be summarized as follows: Explored organs: esophagus and stomach (60%); rectum and colon (30%); others (duodenum, papilla, bile ducts) (10%).

a.The indications for the procedCancer staging in 35% of cases (including 20 Mucosa-associated Lymphoid Tissue (MALT) lymphoma and 100 stenosis).

Miniprobe EUS identified T stage in MALT lymphoma. MPs demonstrated to be an effective tool to identify MALT lymphoma stages (n=20): T stage (88% of cases) and N stage (33% of cases).

Radial MP of 7.5 MHz identified T stage (uTN versus pTN) in rectal cancer (83%).

b. Subepithelial lesions 30%

c. Other indications 35% of patients, including esophageal non-tumoral conditions (20%):

The experience with Endosound/Microvasive probe 12.5 MHz has shown us that is not a good election for gastrointestinal examinations (Figure 5). We performed 20 gastrointestinal assessments with this device and it may be broken when is tried to pass through the papilla. Currently we use a 20 MHz and 2.9 mm, G20-29R guided miniprobe, Olympus Ltd., Tokyo, Japan. This was used in 10 intraductal studies (Figure 5).

For gut examinations, one single Fuji MP (12 or 7.5 MHz) was chosen in 100 cases, and one single Olympus MP the 12 MHz in 60 cases. Miniprobe's durability was of a maximum of 60 to 100 gut explorations (Figure 6).

In the therapeutic field, miniprobes may be of help for echoendoscopy-guided mucosectomy and tumorectomy.

Intraductal ultrasound (IDUS) gives clinically important data, because by visualizing the wall layers in biliary strictures, may estimate the extent of potentially cancerous infiltration and may contribute to appropriate therapeutic decisions in malignant biliary strictures.

In the 100 first patients studied of this series of 1000 assessments, carried out by mEUS, there was a change in the diagnostic and therapeutic management in 44 cases [9]. In such cases, the demographic data, initial indications, the anatomic area explored and changes in diagnostic and therapeutic approach, which occurred following the MP study, were all recorded.

All strictures (n=100) were successfully passed through, except one anorectal malignant stenosis. The most frequent complication was abdominal pain (5%) induced by the endoscopy

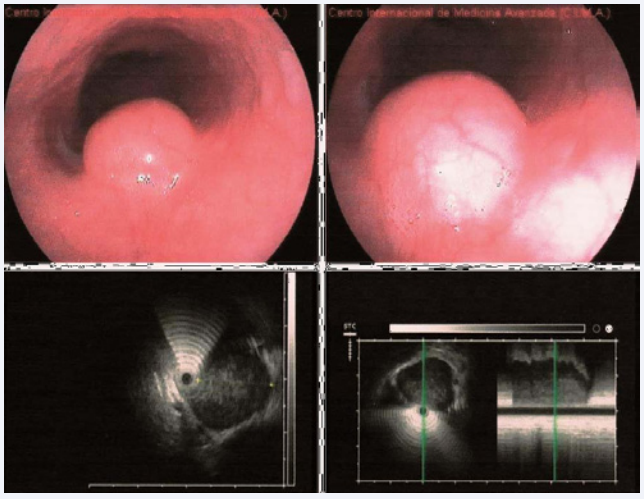

Figure 5 Radial/lineal 12 MHz MP. Gastrointestinal Stromal Tumor (GIST).

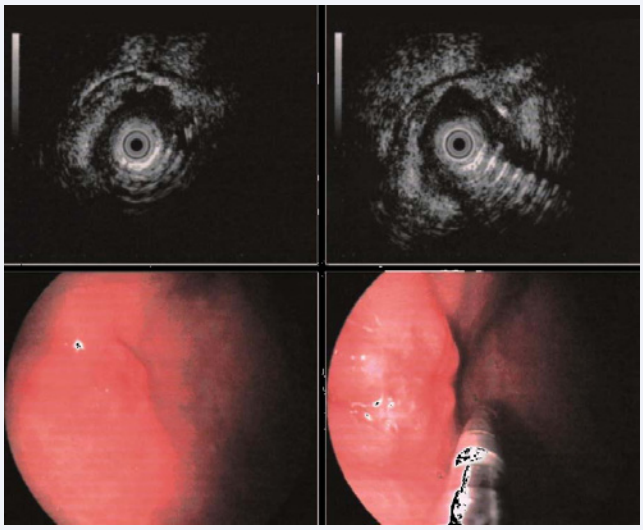

Figure 6 Radial 20 MHz MP. Early Gastric T1sm N0.

procedure, particularly when sedation was not applied. No severe adverse events such as aspiration, perforation or death were observed.

Discussion

Miniprobe EUS has a wide range of indications and benefits for endoscopists, but has some limitations that have to be known. One of them is their limited durability. Nowadays, studies performed on the MP durability are few; in relation to intraductal conditions, Napolèon and colleagues limit the use of each MP to 30 examinations [10]. In our experience on the gastrointestinal tract assessment (60-100 explorations) using endoluminal MP, we obtained the same result regarding to the limited durability of these devices in these procedures.

A proof of this benefit contributed by MPs is the additional information obtained during the endoscopic assessments that may suppose a change in the patient management and treatment.

Nesje et al studied 123 patients and found additional information for 70% of cases, [11] whereas Waxman studied 23 patients and found information additional in 74% and a change in the patient management in 57% [12]. The organ most investigated was the esophagus, and major indications included subepithelial or epithelial tumors and esophageal stenosis.

Chak et al studied 66 patients and performed a comparative investigation of EUS and MPs with similar results: 18% versus 16% regarding diagnostic changes, and 21% versus 15% (31% in total) regarding to therapeutic changes [13]. The organs most commonly explored were esophagus and stomach and major indications were epithelial and subepithelial tumors and stenosis (n=15).

We obtained similar results to these groups when studied the first 100 cases of our series, with a clinical impact on 44% of procedures [8]. Esophagus and stomach were the most commonly explored organs and cancer staging and subepithelial lesions being the main indications of the procedures.

Hünerbein et al. performed locoregional TN staging in 173 patients with esophageal-gastric cancer and concluded that the results are similar with a 12.5 MHz MP or 7.5 MHz linear EUS [14,15].

Our experience with intraductal ultrasonography (IDUS) is small; we have used it in the staging of ampullary tumors [16] and for the study of cholangiocarcinoma versus sclerosing cholangitis [17] cholecocholithiasis or residual lithiasis [18-25].

Another very positive results that the use of MPs may offer, is in the assessment of pancreatobiliary tumors [26-32] including the precise diagnosis of tumoral extension using 3-D or DPR [30,31].

The major benefits of the use of MPs that we have found along these years are the reduction of procedural time, high resolution images in endosonography, the ability to go through strictures and to enter the common bile and pancreatic ducts, better maneuverability in areas such as cardia and pylorus. In addition, they are useful in mucosectomies [33] and tumorectomies [34]. By this, we currently use MPs in most of our procedures and are a valuable tool for our department.

However, there are some disadvantages or shortcomings with mEUS such as a longer training than with conventional EUS, its limited penetration 30 mm at most, whereas EUS reaches 60 mm on average), greater fragility (limited durability), and its inability to support EUS-Fine-needle aspiration-puncture (EUS-FNA) and interventionist procedures (neurolysis, puncture-injection, etc) [35].There is also a potential risk of aspiration when utilizing the water immersion for scanning the esophagus; some cases of pancreatitis after of IDUS in 0.4-1.5% of procedures were reported [35].

Major indications of mEUS include digestive cancer staging and the assessment of subepithelial lesions, [36-38] including subepithelial abnormalities of the appendix [39]. Shimoyama et al studied the staging of esophageal cancer using 12- to 20-MHz miniprobes for T staging and differentiated correctly T1 cancers in 86% of cases, [40] and Chemaly M et al. obtained accuracy with mEUS of 73.5% to differentiate T1sm from T1m tumors [41-43].

In the staging of early Barrett´s carcinoma, T category was correctly assessed with EUS in 49% of patients and 64% with mEUS [44].

Lügering t al. in their studies of the staging of T of MALT lymphoma, comparing the results of mEUS and EUS, identified a T1 lesion in 53 % and EUS in 60 % of cases [45] and Varas et al. gastric MALT lym-phoma (25 cases), using MPs (12- and 20-MHz) identified T stages in 88% of cases and with conventional EUS (7.5- radial 20-MHz) 91% of cases,; [46] the application of miniprobe EUS in long-term followup enables adequate evaluation in most of patients [47-49].

During preoperative evaluation, mEUS has obtained positive results [50-52]. Latest articles present new indications for MEUS utilization with very good results: De Angelis et al, in their study with 13 patients with endoscopic gastro-cyst drainage (EGCD) under endoscopic ultrasonography (EUS) in symptomatic pancreatic pseudocysts (PP), used MP for this new indication, they concluded that when conservative therapy is ineffective,

EGCD represents a viable option to resolve PP permanently and MEUS provides a valuable contribution to help endoscopic cystogastrostomy in children and also in difficult situations, allowing a safe and effective endoscopic procedure [51].

Haji et al. where 104 patients underwent 20-MHz high-frequency mini probe ultrasound of the colorectal lesion during colonoscopic examination to assess the depth of infiltration of the colorectal tumor. They found that MP has high accuracy in determining the depth of colorectal lesion and is useful before endoscopic resection [52].

However mEUS has limitations in determining the T stage in early colorectal cancer and the accuracy decreased when tumor size was >2 cm or the tumor had invaded the submucosal layer [53].

CONCLUSION

Although this series was done some years ago, data obtained can be applicable at present. Miniprobe EUS appears to be a highly valuable modality, feasible, safe and an effective procedure for the assessment of tumoral and non-tumoral lesions and the staging of cancer, with no major adverse events, that increases the quality of procedures with a high degree of resolution and the ability to perform real time imaging during diagnostic and therapeutic interventions.

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