

3D US as a base for virtual surgery in thyroid mass.

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INTRODUCTION

Ultrasound (US) is a sensitive method providing valuable information about thyroid lesions. 3D US technologies, possesses high accuracy in interpretation of the ultrasound data and open new opportunities for noninvasive diagnostics of thyroid nodules. MEDISON introduced new three-dimensional technology, Multi-Slice View and Oblique View modes. Multi-Slice View represents sequential sectional scans in A, B and C plans of the scanned 3D volume, similar to those used in CT and MRI technologies. Newer thyroid imaging of patients with nodules requires an imaging modality that is not only highly sensitive in detecting pathology legions but also able to provide reliable characterizations of the lesions. On a base of volumetric US data virtual surgery could become a new prospective tool for operations planning.

PURPOSE

To determine the clinical value of the volumetric US data in preoperative planning for patients with thyroid nodules and to correlate virtual surgery results with real intra-operative findings.

MATERIAL AND METHODS

94 patients with thyroid pathology were studied. 3D US was performed using automatically scanning technique on ACCUVIX XQ (MEDISON Co.,Ltd, Korea) with the help of 6-12MHz frequency volume linear transducer. (Fig. 1)



FIGURE 1 : 3D linear transducer

3D image rendering included 3D Multi-planar reconstruction, Multi-Slice View with slice interval of 0.2 ~ 0.5 mm, Oblique View modes, and 3D Power Doppler.

Ultrasound evaluation of thyroid nodule included:

- segmental anatomy of the thyroid gland
- localization of the nodules in relation to the lobe
- invasion of the capsule or deeper structures
- relationship with vascular structures

Virtual operation simulations were performed in 15 selected cases before surgery: 4 carcinomas, 2 adenomas, 3 solitar goiter nodules, 6 multinodular goiters.

3D US data were compared with fine needle biopsy results, intra-operative findings and final pathomorphology.

RESULTS

By comparing the multi-planar US slices with intra-operative data a topographic evaluation of nodules location in the thyroid gland has been worked out accompanied by the surgeons. Multi-planar reslicing of 24 thyroid gland segments was used for the analysis of nodules location. (Fig. 2)

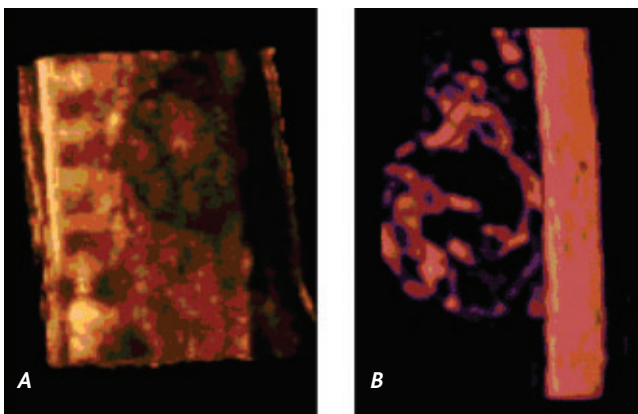


FIGURE 2: Thyroid adenoma, left lobe.
A: 3D rendered image. Adenoma in the superior- anterior- lateral segments. B: Vascularization of thyroid adenoma in 3D Power Doppler.

The preliminary decision to perform a lobectomy or a total thyroidectomy was based on a variety of factors, many of which were delineated by detailed ultrasound examination. Multi-Slice View accurately showed structural characteristics of nodules and its relationship with surrounding tissues. Malignant lesion showed irregular or blurred margins in 78%, microcalcifications in 42%, distorted vascular branching pattern in 96%. These characteristic were well defined in the 3D coronal planes of the nodules. (Fig. 3)

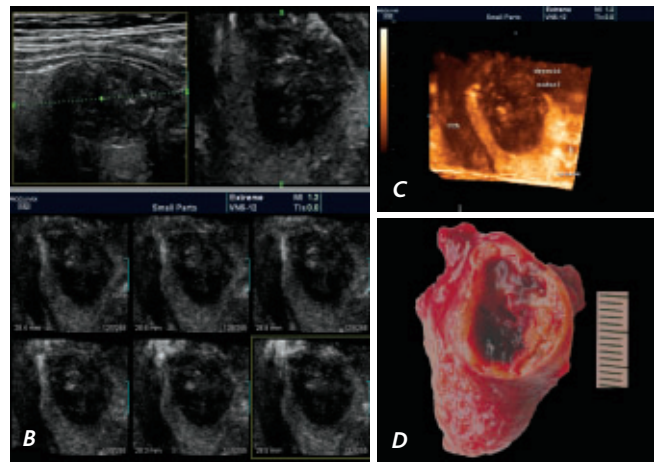
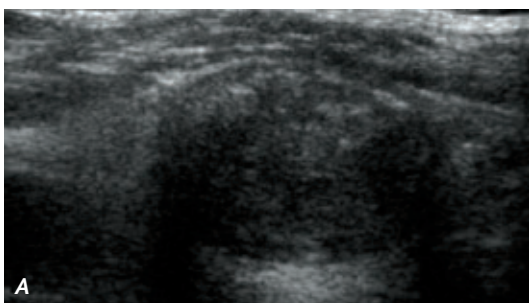


FIGURE 3: Follicular carcinoma, right lobe
A: 2D image. B: Oblique View and Multi-Slice View show irregular margination and microcalcifications. C,D: Intra-operative findings well correlated with 3D rendered image.

3D US data present more precise information than conventional 2D ultrasound in diagnosis of malignant and benign tumors. (Fig. 4)

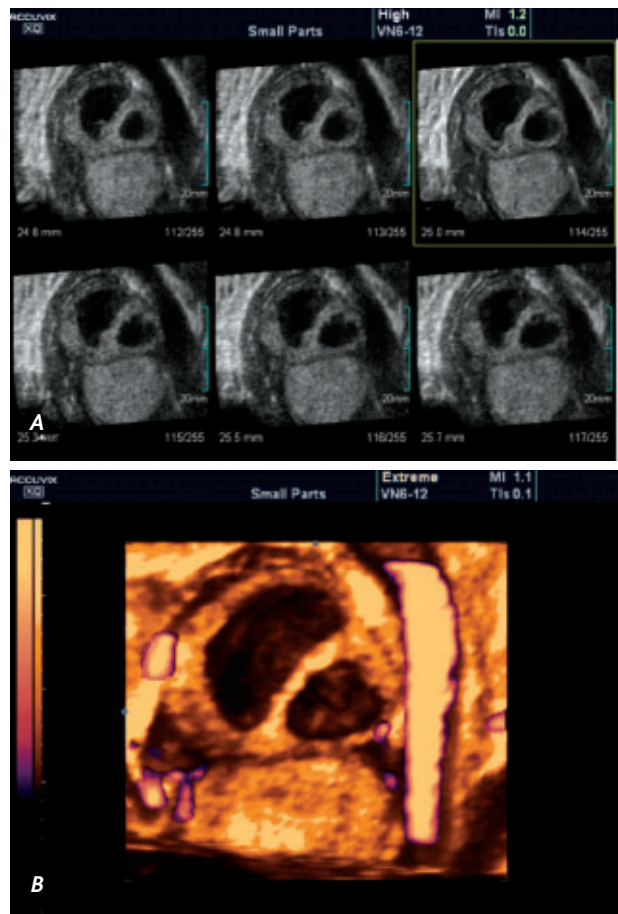


FIGURE 4: Goiter nodules, left lobe
A: Multi-Slice View (layout 2X3, multi-slice interval 0.2mm) shows well-defined cystic and solid mass with sharp edges. B: Vascularization of goiter nodule in 3D Power Doppler.

Preoperative 3D US mode of thyroid lesion and thyroid vascular anatomy was of value for changing surgical management for thyroid resections and in rejecting the necessity of operation. In 2 cases FNA biopsy showed thyroid follicular tumor. Preoperative 3D US results allowed us to suspect the diagnosis of adenoma. The patients underwent lobectomy. (Fig. 5)

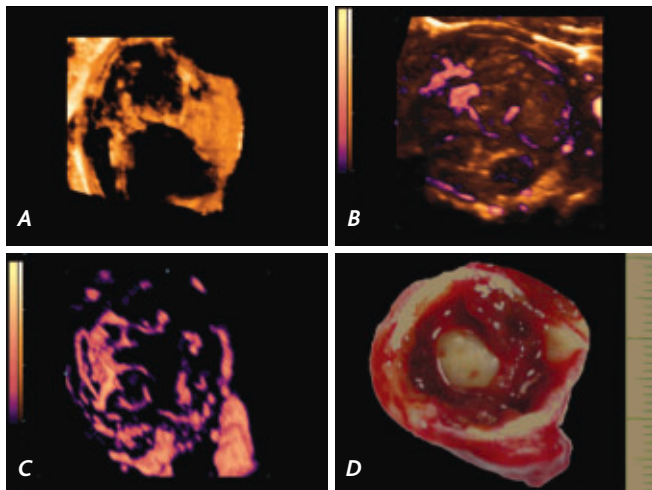


FIGURE 5: Adenoma, left lobe
A: 3D rendered image shows complex solid and cyst nodule. B, C: 3D Power Doppler shows hypervascularization of the nodule, with typical adenomas pattern. D: Intra-operative findings correlated well with US volume data.

Multi-Slice View plays an important role in performing biopsy. 3D XI imaging provided accurate information about needle direction in 3 orthogonal planes. (Fig6)

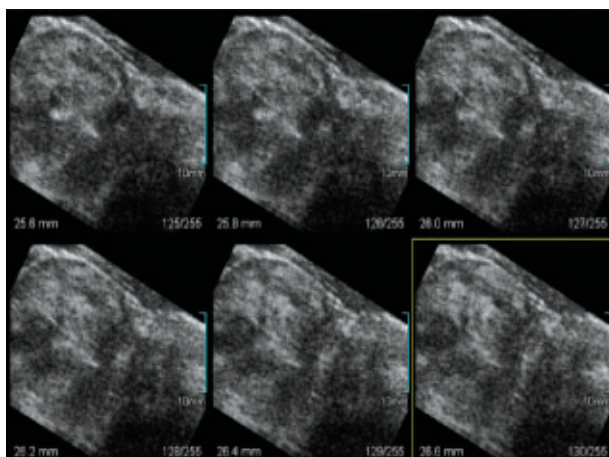


FIGURE 6: 3D Multi-Slice View (layout 2X3, multi-slice interval 0.2mm) shows position of the needle within the nodule on different planes.

3D Virtual surgery provided details of thyroid anatomy and help planning intervention in patients with carcinoma. 3D volume reconstruction accurately showed relationship of thyroid lesion with surrounding tissues and vessels. (Fig. 7)

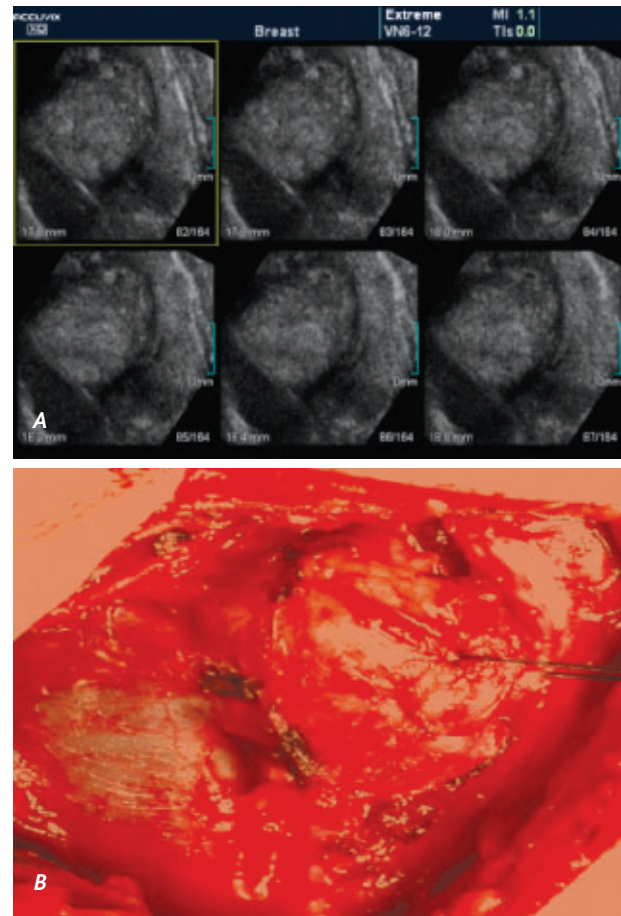


FIGURE 7: Papillary carcinoma
A: Multi-Slice View (layout 2X3, multi-slice interval 0.2mm) clearly shows that jugular vein is not compressed by carcinoma. B: Intra-operative findings correlated well with US volume data.

The topographic evaluation of nodules location in the thyroid gland played an important practical role for operations planning. 3D US and Multi-Slice View allowed precise evaluation of affected segments and preserved tissues of the thyroid gland. This information helps in organ-preserving surgery. (Fig. 8)

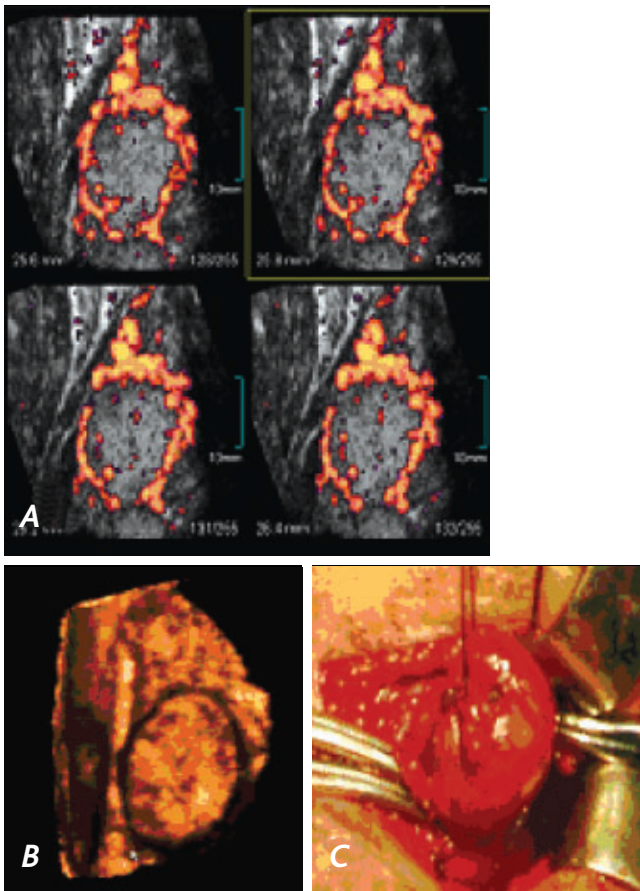


FIGURE 8: Comparison between virtual and real operation in a case of benign solitary nodule
A: Multi-Slice View and Power Doppler show ring-like vascularization pattern of benign nodule. **B:** 3D rendered image shows benign nodule with well defined margins. **C:** Intra-operative well correlated findings with US volume data.

Virtual operation procedures included total thyroidectomy in 2 cases and tissue preserving surgeries (excision of the nodule in 2 cases, selective resection in 2 cases, classic subtotal resection remnant in 4 cases, lobectomy in 2 cases) The findings of real operations were in close agreement with virtual ones in 11 cases (91.6%) and disagreed with them in 1 (8.3%) case. The disagreement between virtual and real operation findings could be explained by difficulties in recognizing carcinoma with multinodular goiter.

CONCLUSIONS

3D US provided effective data and could become the eyes of an operating surgeon.

Virtual surgery based on the 3D US allows optimal variant of surgery and makes it possible to predict and prevent complications.

This method could become an important tool in planning a surgical operation on thyroid mass.

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