In recent decades, thyroid ultrasonography has become one of the most important procedures performed in daily endocrinological practice. This convenient, fast, non-invasive and cheap procedure benefits in many aspects on determination of thyroid morphology.

The advantages of thyroid US include measurement of thyroid volume, evaluation of its echogenicity with visualization of parenchyma vascularisation. Also, thyroid ultrasonography is necessary for selection of so-called suspicious features of potential malignancy among thyroid lesions. According to numerous studies, combination of some specific sonographic features indicate higher risk of malignancy, and indicate necessity for fine needle aspiration biopsy (FNAB).

Sonographic features of the lesion, that rise the suspicion of malignancy include: decreased echogenicity; irregular, diffused boarders; microcalcifications; local limphadenopathy; taller than wide orientation in parenchyma; increased vascular pattern in the center; documented, rapid growth of the lesion [1-3]. However, according to a recent meta-analysis by Brito et al., evaluating predictive values of different combination of those features, ultrasonography does not benefit in satisfactory values of sensitivity and specificity (table 1) [4].

Similar results were obtained in recent meta-analysis performed in our center, in which newer publications had been evaluated and slightly different criteria for inclusion in the study had been used [5]. Only prospective studies were included. We have excluded studies focusing only on particular subgroups of patients and nodules – e.g. surgical or pediatric patients only, follicular lesions or lesions with previous non-diagnostic result of FNAB only etc. Finally, we analyzed the data of 5439 thyroid lesions. Just like in the paper of Brito, we have revealed the usefulness of some sonographic features in selecting potential malignancies. Both studies revealed significant value of “taller than wide feature” with positive predictive value of 76%. Different, independent features of higher risk of malignancy included hypoechogenicity, and the presence of microcalcifications. According to both metaanalyses, the value of Doppler analysis of the nodule vascularisation in prediction of thyroid malignancy, seems doubtful. (table 2, graph 1). We have also performed another meta-analysis dedicated specifically to sonographic features medullary thyroid cancers (MTCs); according to the pool results, MTCs presents similar sonographic appearance than other thyroid cancers (TCs); however, most markers of malignancy were less common for MTCs than papillary TCs (PTCs). Some features turned out to be important factors decreasing risk of MTC – e.g. none of the 157 included MTCs were hyperechogenic [6].

On the basis of: Woliński K, Szkudlarek M, Szczena

nek-Parulśka E, Ruchala M. Usefulness of different ultrasound features of malignancy in predicting the type of thyroid lesions: a meta-analysis of prospective studies. Pol Arch Med Wewn. 2014; 124: 97-104.

However, as the values sensitivity, specificity, PPV and NPV of thyroid ultrasonography as an independent procedure, are unsatisfactory, this procedure is not recommended for determination of thyroid malignancies and fine needle aspiration biopsy remains the “gold standard”. This invasive procedure, despite nowadays being the most accurate, it also has some disadvantages. Firstly, it’s invasive. Secondly, the whole diagnostic process, which includes ultrasonography, obtaining the material with the needle, fixation of the specimen and eventual cytological assessment by the pathologist is time consuming and quite expensive. Finally, there is a significant amount of indeterminate or inconclusive results (follicular lesions
and smears inconclusive for adequate evaluation) [7]. Thus, exploration for new methods seems desirable.

Recently sonoelastography has been introduced in endocrinology practice, as an additional tool for ultrasonographic evaluation. This modern, non-invasive method, uses the acoustic radiation force in the assessment of the elasticity of examined tissue. Its value has been previously proven in the diagnosis of non-thyroidal oncologic conditions, such as breast cancer [8]. The first paper, describing its potential in thyroidology was published by Lyshchik et al. [9]. The researchers performed the procedures with the use of static, free-hand elastography, which demanded specific kind of compression, thus the results depended on the experience of the sonographist. Also, static elastography was time-consuming and did not provide adequate measurements of cystic and calcified lesions. As it did not let for quantitative measurement of the force needed for effective compression of the nodule, it was very subjective. Also, first generation of elastography was not reliable in selection of potential malignancies in multinodular goiter.

In 2010 Sebag et al., estimated the accuracy of shear wave elastography in non-invasive diagnosis of thyroid malignancies [10]. New method provided simultaneous quantitative and qualitative real time measurements without the need for manual compression of the tissue. Thusly, it was operator independent and highly repeatable. Sebag et al revealed very promising results, indicating high accuracy of SWE in the determination of thyroid malignancies. Recent years brought another information about potential use of SWE in monitoring the therapy of the subjects with acute, and subacute thyroiditis [11,12].

The potential of SWE in the diagnosis of thyroid malignancies had also been studied in detail in our Table 1. The main characteristics of studies included in the meta analysis

| Author               | Year | Patients | Mean age | Nodules | Malignancies |
|----------------------|------|----------|----------|---------|--------------|
| Azizi et al. [6]     | 2012 | 706      | women – 48.5, men – 47.7 | 912 | 86 |
| Bojunga et al. [7]   | 2012 | 99 women, 39 men | 520 | 158 | 21 |
| Rossi et al. [8]     | 2012 | 1439 women, 417 men | 52 | 2421 | 233 |
| Trimboli et al. [9]  | 2012 | 438 women, 138 men | 530 | 498 | 126 |
| Bhatia et al. [10]   | 2011 | 89 patients* | not given | 89 | 19 |
| Merino et al. [11]   | 2011 | 89 women, 14 men | 58 | 106 | 10 |
| Unlutürk et al. [12] | 2011 | 157 women, 37 men | women - 43.7, men – 47.5 | 237 | 58 |
| D’Souza et al. [13]  | 2010 | 151 women, 49 men | not given (range 8 – 74) | 200 | 26 |
| Friedrich-Rust et al. [14] | 2010 | 37 women, 13 men | women – 54, men 52 | 53 | 7 |
| Gietka – Czernel et al. [15] | 2010 | 42 women, 10 men | 45 | 71 | 22 |
| Yunus et al. [16]    | 2010 | 58 women, 8 men | not given (range 18 – 75) | 78 | 25 |
| Asteria et al. [17]  | 2008 | 54 women, 12 men | women – 51.3, men – 60.5 | 86 | 17 |
| Brunese et al. [18]  | 2008 | 264 women, 79 men | 412 | 479 | 66 |
| Rubaltelli et al. [19] | 2008 | 25 women, 15 men | 55 | 51 | 11 |

Table 2. Mean and median stiffness expressed in kPa in benign and malignant lesions. On the basis of: Szczepanek-Parulska E, Woliński K, Stangierski A, Gurgul E, Biczysko M, Majewski P, Rewaj-Losyk M, Ruchała M. Comparison of diagnostic value of conventional ultrasonography and shear wave elastography in the prediction of thyroid lesions malignancy. PLoS One. 2013; 8(11): e81532

|                  | Mean | SD   | median | P      | range  |
|------------------|------|------|--------|--------|--------|
| Q-box max [kPa]  |      |      |        |        |        |
| Malignant        | 174.2| 90.4 | 191.3  | <0.0001| 141-299.9 |
| Benign           | 55.6 | 59.3 | 35.1   |        | 1.3-298.1 |
| Q-box mean [kPa] |      |      |        |        |        |
| Malignant        | 139.3| 83.1 | 142.6  | <0.0001| 7.8-294.0 |
| Benign           | 35.1 | 30.6 | 25.3   |        | 1.2-180.9 |

Figure 1 Pooled odds ratios with 95% confidence intervals for analysed sonographic markers of malignancy. On the basis of: Woliński K, Szkudlarek M, Szczepanek-Parulska E, Ruchała M. Usefulness of different ultrasound features of malignancy in predicting the type of thyroid lesions: a meta-analysis of prospective studies. Pol Arch Med Wewn. 2014; 124: 97-104.
Another problem in endocrine practice is the issue of the selection of nodules for FNAB in case of multinodular goiter where the amount of lesions can be high and it is not possible to puncture all nodules. Study performed in our department showed that SWE is also valuable tool in the selection of lesions for FNAB [14]. All analyzed cancers turned out to be the least elastic lesions in particular goiters; even ones which were not very stiff in absolute values were stiffer than other lesions present in the same goiter.

Despite many benefits and high diagnostic value in differentiation of benign and malignant thyroid lesions SWE is not free of limitations. Some features were described as interfering results of sonoelastographic examination and potentially leading to overestimation of the cancer risk. According to the study performed by Bhatia et al. [15] partially cystic lesions were less elastic than solid ones; stiffness was also positively correlated with the diameter of the nodule. Study performed in our department brought the first, systematic analysis of biochemical and ultrasonographic parameters influencing elasticity of thyroid nodules [16]. According to our results, numerous parameters can increase stiffness of the lesion. Most important among them were micro- and especially macrocalcifications, cystic components, isthmal location; stiffness was also correlated with the maximal diameter of the lesion.

In conclusion, conventional sonographic markers of malignancy seem to be valuable for the preliminary assessment of thyroid nodules; however, these features do not benefit in satisfactory values of sensitivity and specificity. Elastography and particularly SWE seems to be important advance of conventional ultrasonography allowing for the more reliable distinction between benign and malignant thyroid nodules as well as better selection of lesions for FNAB in case of multinodular goiter. However, SWE can be not credible in case of some lesions (e. g. partially cystic, with calcifications, etc.). Also data about usefulness of SWE in case of some particular types of thyroid cancer – such as follicular and medullary TCs are very limited. Altogether, there is still a need for further techniques allowing for more reliable distinction between benign and malignant thyroid nodules as well as further studies on the available techniques.

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