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S-DETECT SOFTWARE AS A TOOL FOR ULTRASOUND DIAGNOSIS OF THYROID LESIONS

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ABSTRACT

Relevance: *Thyroid cancer (TC) is the most common oncological pathology of the endocrine organs. According to the International Agency for Research on Cancer (IARC), 567,233 new cases of thyroid cancer were registered worldwide in 2018. According to IARC, in 2018, 486 new cases were detected in Kazakhstan, which accounted for 1.4% of all cases in Asian countries. TC ranks 10th in the overall structure of cancer incidence globally; TC accounts for 3.1% of all cases of primary malignant tumors. Despite the relatively low incidence, the problems of pathogenesis have been extremely relevant in recent decades due to the increasing prevalence of thyroid cancer. Samsung Medison introduced AI-based S-Detect to improve sensitivity, specificity, and accuracy in the differential diagnosis of thyroid masses.*

The study aimed to *explore the S-Detect program capacities in differential diagnostics of thy-roid masses.*

Methods: *75 patients with focal lesions in the thyroid gland were examined using the Samsung Medison RS85 ultrasound machine equipped with the S-Detect program; additionally, Doppler and non-Doppler methods were used.*

Results: *The S-Detect program made it possible to make a correct diagnosis in 97% of patients (73 of 75), which was confirmed by the results of morphological verification (histology, cytology). The sonoelastography method showed correct results in 91% of patients (68 of 75).*

Conclusion: *The use of the S-Detect program for thyroid examination positively affects the diagnostic value of ultrasound in the differential diagnosis of thyroid masses, increasing the sensitivity, specificity, and accuracy of diagnosis, as well as avoiding redundant biopsies.*

Keywords: *ultrasound diagnostics, S-Detect, Ti-RADS, sonoelastography, thyroid formations.*

Introduction: According to the International Agency for Research on Cancer (IARC), 567,233 new cases of thyroid cancer were registered worldwide in 2018. According to IARC, in 2018, 486 new cases were detected in Kazakhstan, which accounted for 1.4% of all cases in Asian countries [1].

Given the large number of patients with various focal masses in the thyroid gland, the diagnostic problem of masses requiring biopsy becomes evident. Malignant masses are detected in 50% of cases on cytological examination [1, 2].

In late November 2018, Samsung Medison introduced S-Detect, an artificial intelligence-based program. The S-Detect system analyzes thyroid masses in B-mode ultrasound, helps to standardize reports, and classifies nodular masses according to the TI-RADS (Thyroid Imaging Reporting and Diagnostic System) [3].

The TI-RADS system is a classification of sure signs detected during ultrasound examination of the thyroid gland according to the risk of malignancy. The scale makes it possible to significantly improve the interpretation of detected thyroid pathology and standardize the treatment and diagnostic algorithm [4].

TI-RADS classification

TI-RADS 1 – normal thyroid gland;
TI-RADS 2 – benign thyroid changes;
TI-RADS 3 – probably benign thyroid changes;
TI-RADS 4 – suspected malignant thyroid changes;
TI-RADS 5 – probably malignant thyroid changes (more than 80% chance of malignancy);
TI-RADS 6 – malignant process (morphologically confirmed).

One of the additional methods for differential diagnosis of a thyroid mass is ultrasound sonoelastography. Elastography is a special ultrasound examination mode that examines tissue stiffness and elasticity. The method allows up to 80-85% of cases to diagnose nodules, nodal formations, and other pathological processes. Healthy tissues have high elasticity, but the presence of pathological changes increases their rigidity tenfold. A specialist who performs elastography evaluates tissue elasticity through quantitative and qualitative analysis of color elastograms. The multiplicity of increase in pathological changes in relation to healthy tissue is also assessed [5].

The study aimed to explore the S-Detect program capacities in differential diagnostics of thyroid masses.

Materials and methods: The study was performed at "Kazakh Institute of Oncology and Radiology" JSC

(KazIOR) on a Samsung Medison RS85 ultrasound machine by L3-12A and LA2-9A linear probe.

The study group included 75 patients with focal lesions in the thyroid gland.

The S-Detect function was used in addition to Doppler and non-Doppler methods to analyze thyroid masses in B-mode. The essence of the technique is as follows: when using the S-detect function, the program offers automatic contouring with the choice of several image template options, the most similar to the selected nidus; contouring can also be performed manually. Based on the selected template, the system offers the operator a classification and probable scoring of the thyroid mass using the standard TI-RADS lexicon. S-Detect Thyroid technology uses a “deep learning” algorithm that uses an array of data (Big Data) derived from accumulating information from thyroid ultrasound scans. The neoplasms classified as categories 4-6 are considered malignant, and those classified as categories 1-3 are considered benign [6].

Ultrasonic sonoelastography can also be used for differential diagnosis of thyroid masses. E-Thyroid software automatically calculates the Elasticity Contrast Index (ECI) of a selected thyroid gland area [7]. The linear probe is used for thyroid gland analysis. Elastography results are classified according to the Rago ball scale. Green-colored masses 1-3 or 1-2 are presumed benign and blue-colored masses 4-5 or 3-4 are presumed malignant [8]. E-Thyroid analysis results in tissues with greater stiffness being colored blue in the image and tissues with less stiffness being colored red [9].

Results: According to the results obtained by morphological verification, S-Detect Thyroid ultrasound program, and sonoelastography, the following conclusions were drawn (Table 1):

Table 1 – Distribution of pathologies by nosological forms

Pathology	Type of examination		
	Morphological verification	S-Detect Thyroid ultrasound function	Sonoelastography method
Thyroid cancer	10 (13.3%)	12 (16%)	15 (20%)
Adenoma	14 (18.6%)	14 (18.6%)	16 (21.3%)
Cyst	15 (20%)	15 (20%)	15 (20%)
Pseudoknot (in the hy-pertrophic form of auto-immune thyroiditis)	17 (22.6%)	15 (20%)	10 (13.3%)
Colloid goiter	19 (25.3%)	19 (25.3%)	19 (25.3%)

Assessment of masses by S-Detect coincided with morphological verification in 73 of 75 cases (97%); S-Detect interpreted all high-risk lesions by TI-RADS as probably malignant. The sonoelastography score matched the morphological verification in 68 of 75 cases (91%).

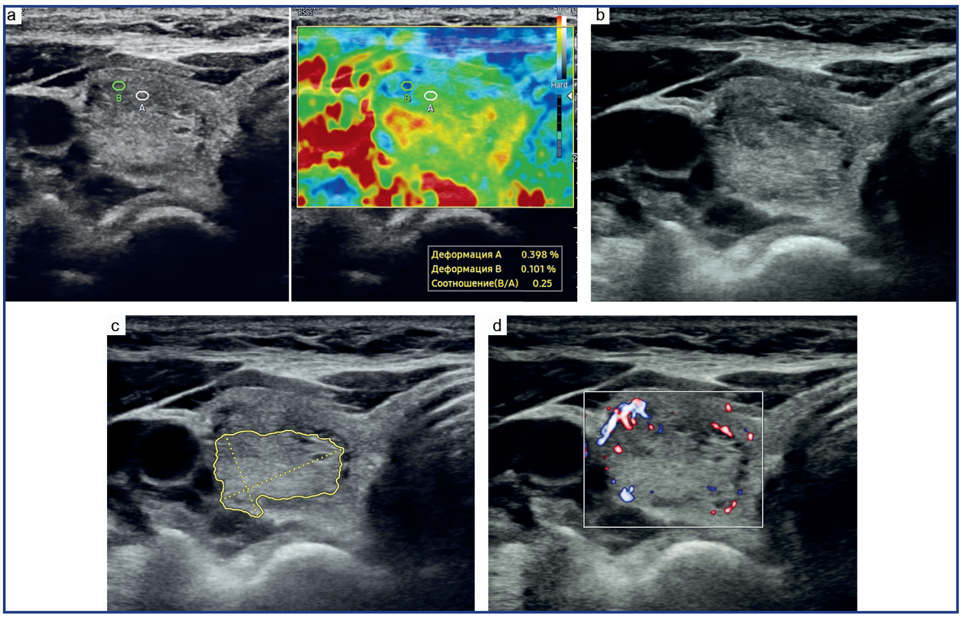

Figure 1 – Colloidal goiter (cross-sectional view):
a – elastography, b – *B*-mode, c – S-detect, d – CDI mode

Figure 1a shows an image of a colloidal thyroid goiter obtained by elastography. Figures 1b (B-mode) and 1c (S-detect method) visualize the parenchyma of the thyroid gland with a coarse-grained, heterogeneous structure. Figure 1d (CDI mode) shows increased vascularization. Zones of the hypoechogenic structure are visible along the entire surface.

Conclusion: Elastography (a) showed Rago type 2 – a benign process. S-detect – TI-RADS 2 (benign changes of the thyroid gland). Morphological verification has confirmed a colloidal goiter.

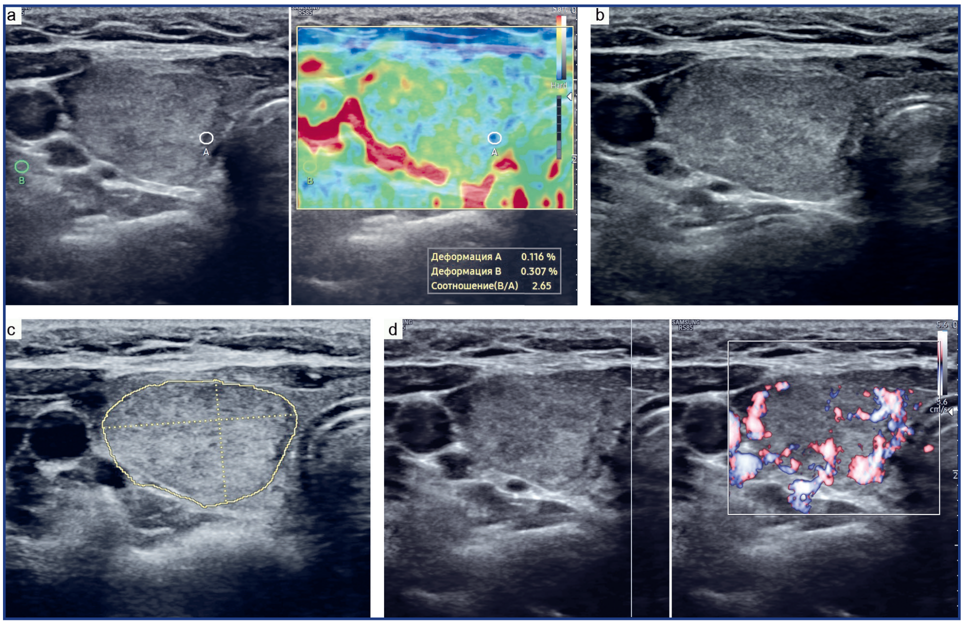

Figure 2 – Adenoma (in transverse section):
a – elastography, b – *B*-mode, c – S-detect, d – CDI mode

Figure 2a shows an image of medium-density (stiffness) thyroid parenchyma obtained by elastography. Figures 2b (B-mode) and 2c (S-detect method) visualize an echogenic circular mass with a homogeneous structure, an anechoic rim, and even precise contours. Figure 2d (CDI mode) shows perinodular blood flow.

Conclusion: Elastography (a) – Rago type 2 – delicate process. S-detect – TI-RADS 2 (benign changes of the thyroid gland), CDI mode (d) – perinodular blood flow; Morphological verification - thyroid adenoma.

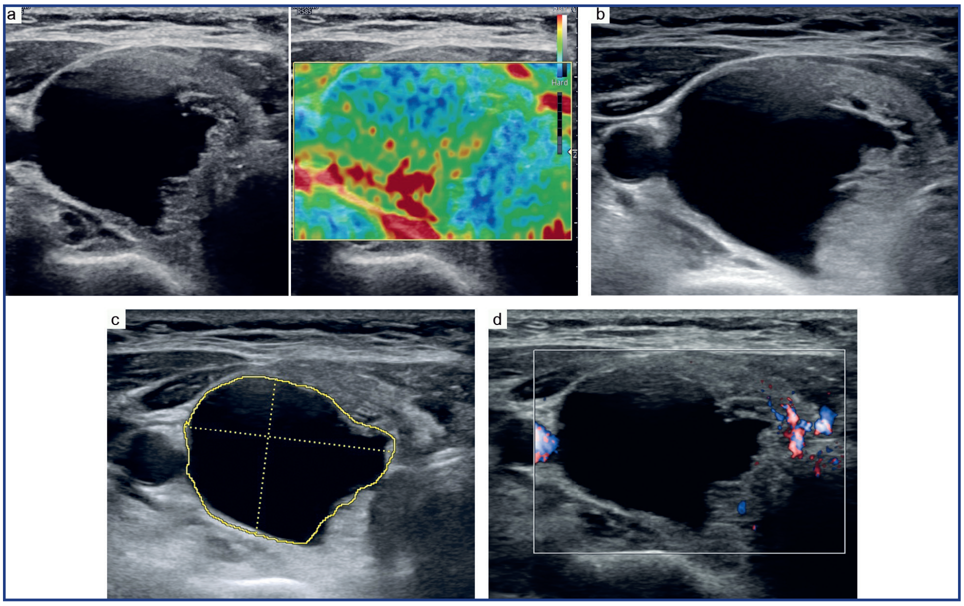

Figure 3 – Thyroid cyst (in cross-section):
a – elastography, b – *B*-mode, c – S-detect, d – CDI mode

Figure 3a shows an image of a thyroid cyst obtained by elastography. Figures 3b (B-mode) and 3c (S-detect method) show an anechoic circular mass, homogeneous structure with even, precise contours. Figure 3d (CDI mode) shows an avascular mass.

Conclusion: Elastography (a) – type 1 on Rago scale – a delicate process, S-detect – TI-RADS 2 (benign thyroid gland changes). Morphological verification – a thyroid cyst.

Figure 4a shows an image of thyroid cancer obtained by elastography. Figures 4b (B-mode) and 4c (S-detect method) visualize a mass of reduced echogenicity with indistinct uneven contours and multiple calcinates. Figure 4d (CDI mode) shows perinodular vascularization.

Conclusion: Elastography – Rago type 5 – a malignant mass. S-detect – TI-RADS 5 (probably malignant changes of the thyroid gland). Morphological verification – thyroid cancer.

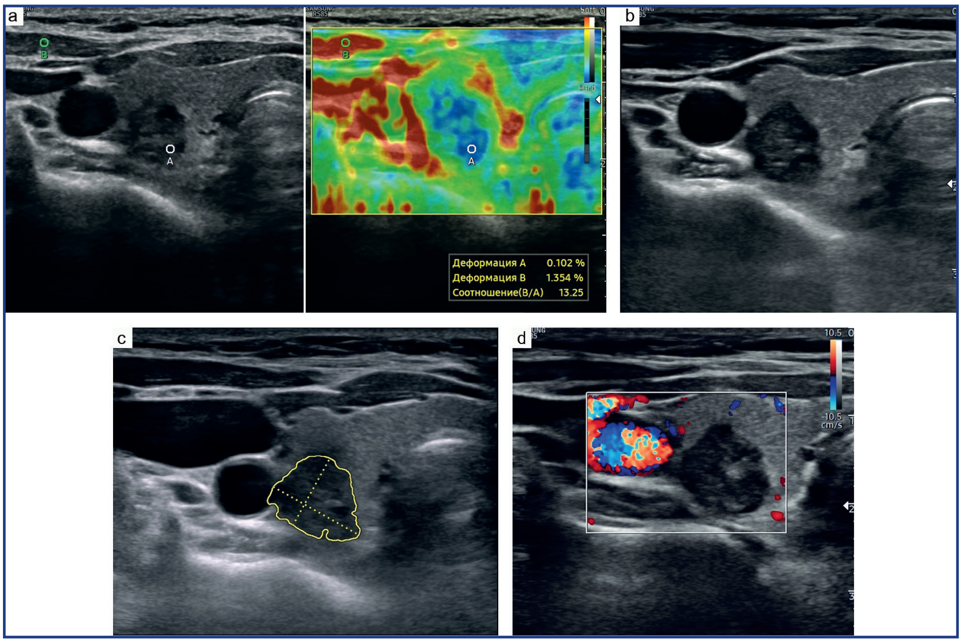

Figure 4 – Thyroid cancer (cross-sectional view):
a – elastography, b – *B*-mode, B – S-detect, d – CDI mode

Discussion: Our study of using artificial intelligence-based S-Detect ultrasound function in diagnosing thyroid masses showed concordance with the results of morphological verification in 73 of 75 cases (97%). The S-Detect function interpreted all lesions of high risk according to TI-RADS as probably malignant. Discrepancies between S-Detect conclusions and morphological verification results were observed in two cases (2.67%, 2/75). The S-Detect function demonstrated exemplary performance in comparing thyroid masses with B-mode, Doppler, and non-Doppler studies and sonoelastography. Using the S-Detect ultrasound function increased the diagnostic value of ultrasonography for thyroid masses due to a specificity of 97.3% and sensitivity of 98%. In the presence of a thyroid mass, the S-Detect ultrasound function detected the mass, highlighted its borders, and displayed a characteristic of the mass.

The sonoelastography assessment coincided with morphological verification in 68 of 75 cases (91%). The final comparative results of the study show the potential efficacy of S-Detect (97%) versus sonoelastography (91%).

A well-known study by the School of Medical Ultrasound at AECC University College (UK) compared the S-Detect program and standard thyroid ultrasound in recognizing neoplasms according to the British Thyroid Association (BTA) classification. Researchers used S-Detect to classify a nodule in the thyroid gland, and the result was compared with the sonologist's classification on the same image. The study aimed to assess the potential clinical relevance of the S-Detect program to clinical practice in the United Kingdom. A total of 51 National Healthcare Service patients with thyroid nodules were examined using an ultrasound machine RS80 (Samsung Medison, Co. Ltd., Korea) equipped with the S-Detect program, according to BTA guidelines. The following results were obtained: 2 of 51 cases were classified as positive using the S-Detect program, and the sonologist, i.e., were true positives. The S-Detect program did not classify as unfortunate any cases that would have been classified as positive by the sonologist, i.e., no false negatives were recorded. S-Detect and the sonologist classified 41 cases as unfavorable, i.e., 41 negative cases were identified. Eight cases classified as positive by S-Detect were unfavorable by the sonologist, giving a false-positive rate of 16.3% (8/51). The sensitivity of the S-Detect program was 100%, reflecting its ability to detect disease, if any. The specificity of the S-Detect program was 83.7%, reflecting its ability to correctly classify the absence of disease [10].

S-Detect ultrasound function was also used in KazIOR to diagnose breast neoplasms on a Samsung Medison RS85 ultrasound machine. In addition to B-mode, CDI and Power Doppler Imaging (PDI), S-Detect, and sonoelastography method were used to analyze neoplasms. In case of discrepancy in the conclusions, the final diagnosis was established based on morphological verification. The ultrasound findings of breast neoplasms in 50 women were included in the study. The S-Detect program diagnosed the neoplasm correctly and gave results similar to morphological verification (histology, cytology) in 87-93% of cases (46 of 50 neoplasms) [11].

The S-Detect ultrasound function to assess thyroid lesions is a new technological addition designed to improve the accuracy of radiologists performing ultrasound examinations. Chang et al. reported that the use of the S-Detect thyroid ultrasound function to differentiate malignant from benign neoplasms showed accuracy similar to that obtained by visual examination by radiologists. Choi *et al*. evaluated 102 thyroid nodules in 89 patients (including 43 malignant and 59 benign masses) and found that the S-Detect ultrasound function showed similar sensitivity as the experienced radiologist (90.7% *versus* 88.4%, P>0.99) [12].

Data from a meta-analysis aimed to determine the accuracy of S-Detect ultrasound function in the differential diagnosis of thyroid nodules. The meta-analysis was performed using STATA software ver. 14.0 and Meta-Disc ver. 1.4. Summary statistics were calculated for sensitivity (Sen), specificity (Spe), positive and negative likelihood ratios (LR+/LR-), diagnostic odds ratio (DOR), and receiver operating characteristic (SROC) curves. The Cochrane Q-statistic and I2 criteria were used to assess potential heterogeneity between studies. In addition, sensitivity analyses were performed to assess the effect of individual studies on the overall estimate, and meta-regression analyses were performed to examine potential sources of heterogeneity. The data obtained from a study of 1,595 benign and 1,118 malignant nodes showed that the composite Sen value was 0.87, the Spe value was 0.74, and the DOR value was 18.83. The above results show that S-Detect is highly accurate in clinical diagnostics of thyroid nodules, so it is an excellent diagnostic tool. According to the results of this meta-analysis, S-Detect can accurately distinguish malignant thyroid nodules from benign ones [13].

The above results show that S-Detect does not tend to under-classify foci. The method is radiologically safe, fast, and has no contraindications. Therefore, examination with S-Detect enables the doctor, without puncture, to determine the presence and stage of the fibrotic process in tissues and to follow the dynamics of pathological changes.

Of course, along with the significant advantages of the S-Detect function, there are also limitations. For example, after classifying a mass with S-Detect, the doctor sometimes has to manually use some functions, such as “associated symptoms” and “special cases,” to get a broader picture when diagnosing. In our study, we also noticed that additional manual contouring of the borders of some large formations provided more reliable results of using the ultrasonic S-Detect function than automatic contouring. The reason was that automatic mode does not always cover the entire mass area or capture an excessive area.

Nevertheless, the advantages of S-Detect are undeniable. Another advantage of this program is that S-Detect is based on a deep learning algorithm. This automated diagnostic system is integrated into ultrasound equipment, representing artificial intelligence technology, allowing radiologists to recognize and classify benign and malignant masses, reducing the burden on the physician and improving the diagnostic process based on lesion signatures.

S-Detect can be used in both top-tier hospitals and smaller local hospitals. This tool can help small hospitals improve the quality of diagnostics of malignant thyroid tumors.

Conclusion: Thus, the S-Detect ultrasound function has a high potential for use in modern clinical practice as an additional method of thyroid examination.

For example, compression sonoelastography is an operator-dependent technique and largely depends on the qualification and experience of the physician.

The S-Detect ultrasound function automatically highlights the border, and adjustments can be made to the area of interest manually if necessary, and the result is displayed on the screen.

The S-Detect ultrasound function is a simple and very effective method of differentiating focal changes in the thyroid gland.

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АҢДАТПА

S-DETECT БАҒДАРЛАМАЛЫҚ ҚҰРАЛЫ ҚАЛҚАНША БЕЗІНІҢ ЗАҚЫМДАНУЫН УЛЬТРАДЫБЫСТЫҚ ДИАГНОСТИКАЛАУ ҚҰРАЛЫ РЕТІНДЕ

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Өзектілігі: *Қалқанша безі (ҚБ) онкология саласында жиі кезедсетін эндокринологиялық мүше.*

Халықаралық онкологиялық зерттеулер агенттігінің (IARC) мәліметі бойынша, 2018 жылы дүние жүзінде қалқанша безінің қатерлі ісігінің 567 233 жаңа жағдайы тіркелген. IARC мәліметтері бойынша, 2018 жылы Қазақстанда 486 жаңа жағдай анықталды, бұл Азия елдеріндегі барлық жағдайлардың 1,4%-ын құрады.

Қалқанша безінің қатерлі ісігі әлемде онкологиялық аурулардың жалпы құрылымында 10-шы орынды алады, қалқанша безінің қатерлі ісігі біріншілік қатерлі ісіктердің барлық жағдайларының 3,1% құрайды. Аурудың салыстырмалы түрде төмен болуына қарамастан, патогенез проблемалары соңғы онжылдықтарда қалқанша безінің қатерлі ісігінің таралуының артуына байланысты өте өзекті болып табылады.

Samsung Medison қалқанша безінің массаларының дифференциалды диагностикасында сезімталдықты, ерекшелікті және дәлдікті жақсарту үшін жасанды интеллект негізіндегі S-Detect енгізді.

Зерттеудің мақсаты *– Қалқанша безінің массасын дифференциалды диагностикалауда S-Detect бағдарламасының мүмкіндіктерін зерттеу.*

Әдістері: *Қалқанша безінде ошақты зақымдануы бар 75 науқас S-Detect бағдарламасымен жабдықталған Samsung Medison RS85 ультрадыбыстық аппаратының көмегімен қаралды; қосымша, доплерлік және доплерлік емес әдістер қолданылды.*

Нәтижелері: *S-Detect бағдарламасы 97% жағдайда (75 адамның 73-інде) дұрыс диагноз қоюға мүмкіндік берді, бұл морфологиялық тексеру (гистология, цитология) нәтижелерімен расталды. Соноэластография әдісі 91% жағдайда (75 адамның 68-і) дұрыс нәтиже көрсетті.*

Қорытынды: *Қалқанша безді зерттеу үшін S-Detect бағдарламасын пайдалану қалқанша безінің массаларының дифференциалды диагностикасында ультрадыбыстың диагностикалық мәніне оң әсер етеді, диагностиканың сезімталдығын, ерекшелігін және дәлдігін арттырады, сонымен қатар артық биопсияларды болдырмайды.*

Түйінді сөздер: *ультрадыбыстық диагностика, S-Detect, Ti-RADS, соноэластография, қалқанша түзіліс.*

АННОТАЦИЯ

ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ S-DETECT КАК ИНСТРУМЕНТ УЛЬТРАЗВУКОВОЙ ДИАГНОСТИКИ ОБРАЗОВАНИЙ ЩИТОВИДНОЙ ЖЕЛЕЗЫ

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Актуальность: *Рак щитовидной железы (РЩЖ) – наиболее часто встречающаяся онкологическая патология эндокринных органов. Согласно данным Международного агентства по исследованию рака (МАИР) во всем мире в 2018 г. зарегистрировано 567 233 новых случаев РЩЖ. По данным МАИР в 2018 г. в Казахстане было выявлено 486 новых случаев, что составило 1,4% от всех случаев в странах Азии.*

РЩЖ занимает 10-е место в общей структуре онкозаболеваемости в мире, на долю РЩЖ приходится 3,1% всех случаев первичных злокачественных образований. Несмотря на относительно низкую заболеваемость, проблемы патогенеза чрезвычайно актуальны в последние десятилетия в связи с ростом распространенности РЩЖ.

Компания Samsung Medison представила программу S-Detect на основе искусственного интеллекта для повышения чувствительности, специфичности и точности в дифференциальной диагностике образований щитовидной железы.

Цель исследования *– изучить возможности программы S-Detect в диффереciальной диагностике образований щитовидной железы.*

Методы: *75 пациентов с очаговыми образованиями в щитовидной железе были обследованы с использованием ультразвукового аппарата Samsung Medison RS85, оснащенного программой S-Detect; дополнительно применялись допплеровские и не допплеровские методы.*

Результаты: *Программа S-Detect позволила верно поставить диагноз в 97% (73 из 75 человек) случаев, что было подтверждено результатами морфологической верификации (гистология, цитология). Метод соноэластографии показал верные результаты в 91% (68 из 75 человек) случаев.*

Заключение: *Применение программы S-Detect для обследования щитовидной железы положительно влияет на диагностическую ценность ультразвукового исследования в дифференциальной диагностике образований щитовидной железы, повышая чувствительность, специфичность и точность диагностики, а также позволяя избежать избыточных биопсий.*

Ключевые слова: *ультразвуковая диагностика, S-Detect, TI-RADS, соноэластография, образования щитовидной железы.*

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