Prognostic Models for the Development of Diffuse Idiopathic Skeletal Hyperostosis

Mariela Geneva-Popova1,2, Vladimir Hodzhev3,4, Stanislava Popova-Belova1

1 Medical University of Plovdiv, Faculty of Medicine, Department of Propedeutics of Internal Diseases
2 Clinic of Rheumatology, St George University Hospital, Plovdiv, Bulgaria
3 Department of Internal Diseases, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
4 Clinic of Pulmology, St George University Hospital, Plovdiv, Bulgaria

Corresponding author: Mariela Geneva-Popova, Department of Propedeutics of Internal Diseases, Faculty of Medicine, Medical University of Plovdiv, 15A Vassil Aprilov Blvd., 4002 Plovdiv, Bulgaria; Email: genevapopova@yahoo.com; Tel.: +359 898 523 128

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Abstract

Introduction: Diffuse idiopathic skeletal hyperostosis (DISH) is a common worldwide disease in adults over 50 years of age. The clinical diagnosis at the beginning of the disease is very difficult, even impossible, without typical symptoms and image changes. Mathematical models for searching risk factors include analysing medical history data, comorbidities, biochemical and instrumental results.

Aim: The aim of the study was to analyse the demographic, clinical, biochemical, and imaging findings in patients with DISH and develop prognostic models to help identify risk factors for the disease.

Materials and methods: We analysed 124 patients with diffuse idiopathic skeletal hyperostosis treated at the Clinic of Rheumatology in St George University Hospital, Plovdiv between 2013 and 2020. All biochemical and imaging studies were performed in the facilities of the University Hospital. SPSS, ver. 26 was used for the statistical analysis.

Results: One-way analysis of history and clinical symptoms showed the highest prognostic value with OR>4 for over 50 years, mechanical pain in the thoracic and cervical spine, and Ott’s symptom, OR >3 for Hirz’s symptom, and OR>2 for thoracic spine stiffness, clinical evidence of spine fracture, and the Shober’s symptom. We found that the highest prognostic value for the risk factors of DISH is elevated triglycerides, increased glucose, increased total cholesterol, and increased uric acid (OR over 5).

Conclusions: Our mathematical models determined the risk factors for development of DISH using different variables from the history, laboratory parameters, and imaging studies. These mathematical models are easy to apply and can be used routinely in clinical practice.

Keywords
diffuse idiopathic skeletal hyperostosis, mathematical models

INTRODUCTION

Diffuse idiopathic skeletal hyperostosis (DISH) is a common disease in adults over 50 years of age worldwide.[1-3] According to most authors, it is observed in 10% of the adult population, and its frequency is described in higher percentages in individual populations.[4,5] The disease affects mainly males and is more common with advancing age.[6,7] Although the disease has been extensively studied since 1950 and a significant number of reports have already been published, a number of DISH-related problems have not been resolved. There is no definition of the nature of the disease that is accepted by all authors. According to Resnick et al.[8] “… diffuse idiopathic skeletal hyperos-
tosis is a common ossifying diathesis in middle-aged and elderly people⁴. It is characterized by bone proliferation on the front of the spine and the extraspinal ligaments and tendons, where they attach to the bone⁵. Rhotschild defines DISH as “a protective phenomenon that is likely to be a normal option for the protection of mechanical damage to spine due to an increased risk of cerebrovascular damage, fractures and the development of myelopathy.”⁶⁷ In recent years, researchers have been looking for new clinical and laboratory criteria to be used for early diagnosis of the disease.⁸⁹ 

The clinical diagnosis at the beginning of the disease is very difficult, even impossible, without typical symptoms and image changes.¹⁰¹¹ The disease is suspected in patients aged 50 and older, men who complain of prolonged diffuse back pain, in the area of various enthese, tendons, joints, bone edges and tubers, in normal or slightly altered routine laboratory tests.¹²¹³ This suspicion is heightened by the establishment of muscle rigidity and restriction of movement around the pain region.¹⁴ Sometimes the disease is painless¹⁵¹⁶ and is suspected in obscure dysphagia, especially dry food and head strain, accompanied by dysphonia, dyspnoea, existing myelopathy with quadriplegia, cauda equina syndrome, in palpation of bone thickenings and spines, in fractures of the spine with minimal trauma or twists.¹⁶¹⁷ 

DISH may be suspected in the presence of various risk factors: obesity, elevated BMI, type 2 diabetes mellitus or impaired glucose tolerance, hypertension, gout (hyperuricemia), hyperinsulinemia, increased pituitary growth hormone, impaired lipid metabolism (increased, triglycerides, fatty acids), etc. In case of any suspicion of the disease, it is necessary to conduct an X-ray examination of the affected area and of the middle and lower part of the thoracic spine, where the earliest characteristic radiological changes usually occur.¹⁸¹⁹

Diagnosis of DISH is made using various criteria such as the following:

A. Criteria of Resnick and Niwayama¹⁵
B. Criteria of Julkunen et al.¹⁶
C. Criteria of Utsinger²⁹

DISH is a disease that is unconditionally associated with other vascular and metabolic diseases.²⁰²³ In some patients, vascular diseases such as ischemic heart disease and transient ischemic attack precede the manifestations of diffuse hyperostosis, in others the diagnosis of one disease is an occasion to discover another by chance. In the absence of a long-term follow-up, it is difficult to establish which disease appears first, and which disease is a consequence of an already developed one.²⁴²⁵

Mathematical models for searching diagnostic criteria include history data, comorbidities, biochemical and instrumental results to help us build the prognostic mathematical model.²⁶

**AIM**

The aim of the study was to analyse the demographic, clinical, biochemical, and imaging findings in patients with diffuse idiopathic skeletal hyperostosis and develop prognostic models related to these clinical and laboratory results to help identify the risk factors for the disease.

**MATERIALS AND METHODS**

The study included 124 patients with diffuse idiopathic skeletal hyperostosis treated at the Clinic of Rheumatology in St George University Hospital, Plovdiv. All biochemical and imaging studies were conducted in the facilities of the University Hospital.

The inclusion criteria for this study were as follows:
1. Age 18 years and over.
2. Confirmed diagnosis of DISH according to the criteria of Resnick and Niyama¹⁵, with documented radiographic evidence of the disease. Patients presented with more than 24-month history of complaints.
3. Different duration of the disease.
4. Patients who assist in the study and provide medical documentation for concomitant diseases and previous hospitalisations.

Exclusion criteria:
1. History of psoriasis or family history of this condition.
2. History of inflammatory bowel disease.
3. History of hematological and renal diseases.
5. Presence of a neoplasm manifested in the last 5 years.

**Research approach**

**Observational study of suitable patients from 2013–2020**

The results of the patients were compared with 270 sex- and age-matched individuals with spondylosis.

Comprehensive clinical data were collected about the patients, which were coded and made available to the research team, of which patients were informed. The individual results from the obtained data, indices, and functional samples were calculated.

We measured the blood count, ESR, C-reactive protein, the biochemical indicators and the indicators of bone metabolism. All clinical and laboratory tests were performed in the Central Clinical Laboratory of St George University Hospital. Fasting blood samples were taken in the morning following strictly the manufacturer’s instructions.

Readings are the results of conventional radiography of all patients from the study and from computed tomography and magnetic resonance imaging.
Statistical analysis

SPSS v. 26 was used for statistical analysis. Developing the prognostic models for DISH in the study patients goes through the following stages:

- Formation of a sample of 124 patients to identify independent, statistically significant prognostic factors for the disease onset.
- All factors that were proven to be statistically significant by the one-way analysis were analysed by a multifactor analysis. A regression model with a stepwise procedure of choice was used.
- The condition for proportionality of all covariants included in the model of the regression procedure was checked. Presence of single cases from the database was investigated, which had sharply deviating values for the covariants participating in the model, which had a strong influence on the estimation of the regression coefficients.
- Multifactor analysis of all 124 patients was repeated.

The following variables significant in the one-way analysis were tested to compile a prognostic mathematical model: anamnestic data (sudden increase in acute back pain, acute compression fracture of the thoracolumbar spine, presence of mechanical back pain, presence of combined pain and lumbar spine, stiffness in the thoracic and cervical spine), concomitant diseases (arterial hypertension, ischemic heart disease, gout, cerebral atherosclerosis (transient ischemic attack)), elevated values above normal of glucose, C-peptide, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, uric acid, serum osteocalcin, serum osteoprotegerin, and findings of the imaging studies (ossification of anterior, posterior, and anterior ligament, enlarged lumen of the vertebral arteries).

RESULTS

One-way regression analysis – evaluation of OR

Clinical findings, comorbidities, laboratory and imaging results were analysed using one-way regression analysis by calculating OR. One-way analysis of history and clinical symptoms showed (Table 1) the highest prognostic value with OR>4 for over 50 years, mechanical pain in the thoracic and cervical spine, and Ott’s symptom, OR>3 for Hirz's symptom, and OR>2 for thoracic spine stiffness, clinical evidence of spine fracture, and the Shober’s symptom.

When determining the OR by analysing some diseases (Table 2), we found that the highest prognostic value for the risk factors of DISH was the presence of long-term treated hypertension, followed by coronary heart disease (confirmed by coronary angiography), dyslipidemia, obesity, type 2 diabetes, gout, cerebral atherosclerosis (transient ischemic attack). The table does not show these diseases or patient complaints in which the studied factor does not affect the development of the disease, such as myocardial infarction (OR=0.878) and type 1 diabetes mellitus (OR=0.978).

One-factor regression analysis did not prove prognostic value of gender, place of residence, level of education, alcohol intake and smoking for the development of DISH.

The results of the laboratory tests were also analysed using one-way regression analysis by calculating OR in the same patients (Table 3). We found that the highest prognostic value for the risk factors of DISH was elevated levels of triglycerides and glucose, increased total cholesterol, and increased uric acid.

Table 1. Risk assessment of occurrence of DISH from history and clinical symptoms - one-way analysis

<table>
<thead>
<tr>
<th>Factors</th>
<th>Control group n (%)</th>
<th>DISH n (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age over 50 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>21 (7.77)</td>
<td>4 (3.22)</td>
<td>Rc (1)</td>
<td>[2.121–7.184]</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Yes</td>
<td>158 (92.3)</td>
<td>120 (96.7)</td>
<td>4.652</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain in the thoracic and cervical spine of mechanical type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>220 (81.1)</td>
<td>65 (52.5)</td>
<td>Rc (1)</td>
<td>[2.527–6.414]</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Yes</td>
<td>50 (18.9)</td>
<td>59 (47.5)</td>
<td>4.135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stiffness in the thoracolumbar spine lasting up to 10 minutes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>239 (88.5)</td>
<td>91 (73.4)</td>
<td>Rc (1)</td>
<td>[1.619–4.829]</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Yes</td>
<td>31 (11.5)</td>
<td>33 (26.6)</td>
<td>2.796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive symptom of Ott</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>220 (81.1)</td>
<td>65 (52.5)</td>
<td>Rc (1)</td>
<td>[2.527–6.414]</td>
<td>0.001*</td>
</tr>
<tr>
<td>Yes</td>
<td>50 (18.9)</td>
<td>59 (47.5)</td>
<td>4.135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive symptom of Hirz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>205 (76.0)</td>
<td>91 (73.4)</td>
<td>Rc (1)</td>
<td>[1.679–5.390]</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Yes</td>
<td>65 (24.0)</td>
<td>39 (31.45)</td>
<td>3.762</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive symptom of Shober</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>130 (48.1)</td>
<td>53 (42.8)</td>
<td>Rc (1)</td>
<td>[0.922–4.421]</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Yes</td>
<td>140 (51.8)</td>
<td>71 (57.2)</td>
<td>2.413</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A ROC curve was constructed for the indicators of carbohydrate profile – serum glucose, glycated hemoglobin, and C-peptide in patients with DISH. The results are presented graphically in Fig. 1, the reliability is presented in Table 4.

Exemplary values of threshold points of the studied indicators of the carbohydrate profile and their exact mathematical expressions of specificity, sensitivity, predictive value, and accuracy are presented in Table 5.

A ROC curve was constructed for the indicators of the lipid profile – total cholesterol, HDL cholesterol, triglycerides in patients with DISH. The results are presented graphically in Fig. 2, the reliability is presented in Table 6.
**Figure 1.** ROC curve for assessment of serum glucose (mmol/l), glycated hemoglobin (%), C-peptide (ng/ml) in patients with DISH.

**Figure 2.** ROC curve for the assessment of total cholesterol (mmol/l), HDL-cholesterol (mmol/l), triglycerides (mmol/l) in patients with DISH (n=224).

**Table 4.** ROC indicators of serum glucose (mmol/l), glycated hemoglobin (%), C-peptide (ng/ml) in patients with DISH (n=224)

<table>
<thead>
<tr>
<th>Data</th>
<th>Area under the ROC curve</th>
<th>95% Confidence interval</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>glucose (2.8–6.1 mmol/l)</td>
<td>0.733</td>
<td>0.050</td>
<td>0.635</td>
</tr>
<tr>
<td>glycated hemoglobin (3.5–6.3%)</td>
<td>0.744</td>
<td>0.051</td>
<td>0.643</td>
</tr>
<tr>
<td>C-peptide (0.51–2.72 ng/ml)</td>
<td>0.758</td>
<td>0.048</td>
<td>0.664</td>
</tr>
</tbody>
</table>

**Table 5.** Exemplary threshold values of the studied indicators of glucose, glycated hemoglobin, and C-peptide and ROC in patients with DISH (n=224)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Exemplary threshold values</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>glucose (2.8–6.1 mmol/l)</td>
<td>9.950</td>
<td>79.2%</td>
<td>45.3%</td>
<td>81.2%</td>
<td>75%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>10.250</td>
<td>75%</td>
<td>39.6%</td>
<td>80.3%</td>
<td>72.2%</td>
<td>87%</td>
</tr>
<tr>
<td>glycated hemoglobin (3.5–6.3%)</td>
<td>7.150</td>
<td>83.8%</td>
<td>85.1%</td>
<td>65.2%</td>
<td>65%</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>7.250</td>
<td>83.3%</td>
<td>83.2%</td>
<td>62.1%</td>
<td>62.2%</td>
<td>77%</td>
</tr>
<tr>
<td>C-peptide (0.51–2.72 ng/ml)</td>
<td>4.150</td>
<td>97.9%</td>
<td>86.8%</td>
<td>86.2%</td>
<td>85%</td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td>4.250</td>
<td>95.8%</td>
<td>83%</td>
<td>86.3%</td>
<td>82.2%</td>
<td>86%</td>
</tr>
</tbody>
</table>

**Table 6.** Indicators of ROC curve for the assessment of levels of total cholesterol (mmol/l), HDL-cholesterol (mmol/l), triglycerides (mmol/l) in patients with DISH (n=224)

<table>
<thead>
<tr>
<th>Data</th>
<th>Area under the ROC-curve</th>
<th>95% Confidence interval</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>total cholesterol (3.0–5.2 mmol/l)</td>
<td>0.733</td>
<td>0.050</td>
<td>0.635</td>
</tr>
<tr>
<td>HDL-cholesterol (1.1–1.7 mmol/l)</td>
<td>0.744</td>
<td>0.051</td>
<td>0.643</td>
</tr>
<tr>
<td>triglycerides (0.6–1.71 mmol/l)</td>
<td>0.758</td>
<td>0.048</td>
<td>0.664</td>
</tr>
</tbody>
</table>
Exemplary values of threshold points of the studied indicators of the lipid profile and their exact mathematical expressions of specificity, sensitivity, predictive value and accuracy are presented in Table 7.

**Construction of ROC curves for protein profile**

ROC curve was constructed for the indicators of the protein profile – urea, uric acid, creatinine in patients with DISH. The results are presented graphically in Fig. 3, the reliability is presented in Table 8.

Exemplary values of threshold points of the studied indicators of the lipid profile and their exact mathematical expressions of specificity, sensitivity, predictive value and accuracy are presented in Table 9.

**Table 7.** Exemplary threshold values of the studied indicators of total cholesterol (mmol/l), HDL-cholesterol (mmol/l), triglycerides and ROC indicators in patients with DISH (n=224)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Exemplary threshold values</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol (3.0–5.2 mmol/l)</td>
<td>0.750</td>
<td>84.7%</td>
<td>84.1%</td>
<td>85.2%</td>
<td>80%</td>
<td>89%</td>
</tr>
<tr>
<td></td>
<td>0.850</td>
<td>83.1%</td>
<td>69.6%</td>
<td>86.3%</td>
<td>72.2%</td>
<td>76%</td>
</tr>
<tr>
<td>HDL cholesterol (1.1–1.7 mmol/l)</td>
<td>6.350</td>
<td>87.9%</td>
<td>48.9%</td>
<td>78.2%</td>
<td>69%</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>6.450</td>
<td>89.9%</td>
<td>49.8%</td>
<td>75.1%</td>
<td>71.2%</td>
<td>76%</td>
</tr>
<tr>
<td>Triglycerides (0.6–1.7 mmol/l)</td>
<td>4.350</td>
<td>89.5%</td>
<td>70%</td>
<td>86.2%</td>
<td>85%</td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td>4.450</td>
<td>88.7%</td>
<td>67.8%</td>
<td>86.3%</td>
<td>82.2%</td>
<td>86%</td>
</tr>
</tbody>
</table>

**Table 8.** Indicators of ROC curve for assessment of the level of urea (mmol/l), creatinine (µmol/l) and uric acid (µmol/l) in patients with DISH (n=224)

<table>
<thead>
<tr>
<th>Data</th>
<th>Area under the ROC curve (AUC)</th>
<th>Se</th>
<th>95% Confidence interval</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower bound</td>
<td>Upper bound</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Urea (2.6–7.2 mmol/l)</td>
<td>0.556</td>
<td>0.031</td>
<td>0.494</td>
<td>0.617</td>
</tr>
<tr>
<td>Creatinine (74–134 µmol/l)</td>
<td>0.633</td>
<td>0.030</td>
<td>0.573</td>
<td>0.693</td>
</tr>
<tr>
<td>Uric acid (male 208–398 µmol/l; female 149–363 µmol/l)</td>
<td>0.842</td>
<td>0.023</td>
<td>0.796</td>
<td>0.887</td>
</tr>
</tbody>
</table>

**Table 9.** Exemplary threshold values of the studied indicators of urea (mmol/l), creatinine (µmol/l) и uric acid (µmol/l) and ROC indicators in patients with DISH (n=224)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Exemplary threshold values</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea (2.6–7.2 mmol/l)</td>
<td>10.01</td>
<td>97%</td>
<td>67%</td>
<td>74.2%</td>
<td>72%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>10.15</td>
<td>73%</td>
<td>56%</td>
<td>78.3%</td>
<td>63.1%</td>
<td>73%</td>
</tr>
<tr>
<td>Creatinine (74–134 µmol/l)</td>
<td>87.5</td>
<td>78.2%</td>
<td>60.7%</td>
<td>70.2%</td>
<td>65%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>88.5</td>
<td>75.8%</td>
<td>60.4%</td>
<td>72.1%</td>
<td>61.2%</td>
<td>72%</td>
</tr>
<tr>
<td>Uric acid (male 208–398 µmol/l; female 149–363 µmol/l)</td>
<td>411.50</td>
<td>60.5%</td>
<td>81%</td>
<td>72.1%</td>
<td>73%</td>
<td>65%</td>
</tr>
<tr>
<td></td>
<td>414.01</td>
<td>58.9%</td>
<td>81%</td>
<td>71.1%</td>
<td>57.2%</td>
<td>71%</td>
</tr>
</tbody>
</table>

**Figure 3.** ROC curve for the assessment of urea (mmol/l), creatinine (µmol/l) and uric acid (µmol/l) in patients with DISH (n=224).
DISCUSSION

At the end of the 20th century, a number of factors were identified that were positively associated with the risk of developing DISH. The data about them are contradictory. From the diseases that are risky for the development of DISH, the authors take type 2 diabetes mellitus, obesity with increased BMI, arterial hypertension, coronary heart disease, atherosclerosis, gout, etc.; from the biochemical abnormalities – high serum glucose, total cholesterol, triglycerides, uric acid, some hormones and growth factors, etc.

According to our data, age over 50 years is a risk factor for the development of DISH, which is supported by the results of other authors[37], which proves that the number of patients with DISH increases with age.

The results obtained from the prognostic mathematical models based on the anamnestic data, physical examination, laboratory, and imaging findings serve to build recommendations for diagnosis based on many and different findings of the patient. Combining these results provide a clear clinical and laboratory algorithm for diagnosis and has differential diagnostic significance.

We have not found that males are at risk for developing the disease as claimed by a number of authors[38,39].

According to the results obtained for the assessment of risk factors in DISH, we found that the altered carbohydrate, protein, and lipid metabolism, proven by some of the most common tested samples for them, are a risk factor for the disease. The developing metabolic syndrome in patients with DISH increases their cardiovascular risk and further worsens their quality of life.

Our data shows that in patients with DISH there is a change in all metabolism – protein, lipid, carbohydrate, bone, and we believe that as an element of the metabolic syndrome we should include the altered bone metabolism, which is clinically presented with diffuse hyperostosis.

Osteoporosis is not mentioned in the literature as a risk factor for the development of DISH. Our hypothesis is that osteoporosis is also a basal stimulus for the development of DISH along with the metabolic syndrome. It is no coincidence that Rhotschild notes that “DISH is a phenomenon for the protection of mechanical damage to the spine due to an increased risk of fractures, myelopathies and cerebrovascular injuries.” This protection is achieved by the formation of new bone substance on the bones and the soft tissues around them. It can be assumed that the ossification of the longitudinal ligaments, as a ‘splint’ protects against spinal fractures and dislocation of fragments. By resisting developing osteoporosis, the body responds by increasing the function of certain hormones and growth factors, as well as the migration of mesenchymal cells into the soft tissues around the bones. The fact that the significantly higher levels of s-osteocalcin and lower levels of s-RANKL found in DISH patients is in support of this hypothesis. The protective mechanism adopted in this way explains why DISH is more common in diseases that cause certain hormonal changes with a decrease in bone strength (pituitary diseases with increased growth factor, parathyroid hyperfunction, pancreatic with increased insulin, etc.).

The results obtained from multivariate regression analysis to assess risk factors for the disease are used to make recommendations for early diagnosis.

CONCLUSIONS

Our mathematical models determined the risk factors for development of DISH using different variables from the history, laboratory parameters, and imaging studies. These mathematical models are easy to apply and can be used routinely in clinical practice.

These mathematical models could also be used for to make recommendations for early diagnosis of DISH.

Author contributions

All authors confirm participation in the design of the study, data collection, interpretation of results, data analysis, and manuscript preparation. All authors have participated in the writing of the manuscript and have given their consent to its publication.

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Prognostic Models for DISH

Прогностические модели развития диффузного идиопатического скелетного гиперостоза

Мариела Генева-Попова1,2, Владимир Ходжев3,4, Станислава Попова-Белова1

1 Кафедра пропедевтики внутренних болезней, Факультет медицины, Медицинский университет – Пловдив, Пловдив, Болгария
2 Клиника ревматологии, УМБАЛ „Св. Георгий”, Пловдив, Болгария
3 Кафедра внутренних болезней, факультет медицины, медицинский университет – Пловдив, Пловдив, Болгария
4 Клиника пульмонологии, УМБАЛ „Св. Георгий”, Пловдив, Болгария

Адрес для корреспонденции: Мариела Генева-Попова, Кафедра пропедевтики внутренних болезней, Факультет медицины, Медицинский университет – Пловдив, бул. „Васил Априлов” № 15А, Пловдив, Болгария; Email: genevapopova@yahoo.com; Тел.: +359 898 523 128

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Резюме

Введение: Диффузный идиопатический скелетный гиперостоз (ДИСГ) является распространённым во всём мире заболеванием у взрослых старше 50 лет. Клинический диагноз в начале заболевания очень труден, даже невозможен без типичных симптомов и изменений картины. Математические модели поиска факторов риска включают анализ данных анамнеза, сопутствующих заболеваний, результатов биохимических и инструментальных исследований.

Цель: Цель исследования состояла в том, чтобы проанализировать демографические, клинические, биохимические и визуализационные данные у пациентов с ДИСГ и разработать прогностические модели, помогающие определить факторы риска заболевания.

Материалы и методы: Мы проанализировали 124 пациентов с диффузным идиопатическим скелетным гиперостозом, лечившихся в Клинике ревматологии Университетской больницы Святого Георгия в Пловдиве в период с 2013 по 2020 год. Все биохимические и визуализирующие исследования проводились в условиях университетской больницы. SPSS, ver. 26 использовали для статистического анализа.

Результаты: Однофакторный анализ анамнеза и клинических симптомов показал наибольшую прогностическую ценность при OR>4 в течение более 50 лет, механической боли в грудном и шейном отделах позвоночника и симптоме Отта, OR>3 для симптома Герца и OR>2 для тугоподвижности грудного отдела позвоночника, клинических признаков перелома позвончика и синдрома Шобера. Мы обнаружили, что наибольшей прогностической ценностью факторов риска ДИСГ является повышенный уровень триглицеридов, повышенный уровень глюкозы, повышенный уровень общего холестерина и повышенный уровень мочевой кислоты (OR более 5).

Заключение: Наши математические модели определили факторы риска развития ДИСГ с использованием различных переменных из анамнеза, лабораторных параметров и исследований изображений. Эти математические модели просты в применении и могут рутинно использоваться в клинической практике.

Ключевые слова

dиффузный идиопатический скелетный гиперостоз, математические модели