Diffuse Idiopathic Skeletal Hyperostosis: Prevalence and Risk Factors

Maria Cecilia Madariaga  
Nassau University Medical Center

Hannah Groff  
Nassau University Medical Center

Nicholas A. O’Malley (.nickomalls@icloud.com)  
New York Institute of Technology College of Osteopathic Medicine

Jeffery Thompson  
Nassau University Medical Center

Alexios Apazidis  
Nassau University Medical Center

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Abstract

Background

Diffuse Idiopathic Skeletal Hyperostosis (DISH) is a degenerative disease of the spine which has been estimated to affect anywhere from 8–37% of the population. In addition, previous literature has shown an association between DISH and serious disability including dysphagia. Previous research detailing prevalence and risk factors for DISH, however, have been limited by studying homogenous populations.

Methods

Patients who received CT scans of the spine during hospital admission were included. Demographic data including age, sex, race/ethnicity, smoking history, alcohol use, and comorbidities were collected via chart review. DISH was defined as the presence of flowing ossifications along \( \geq 4 \) contiguous vertebral bodies on CT. The location, number of levels, and side of ossification were also collected. Results were analyzed using t-test and chi-square analyses. Significance was set to p < 0.05

Results

1097 patients with CT scans were identified, revealing a DISH prevalence of 20.3%. Patients with DISH were significantly older than those without DISH and had significantly higher CCI scores when compared to the non-DISH cohort. Significant differences were also observed between ethnic groups. Men were found to have a significantly higher prevalence of DISH when compared to women. Finally, those with DM, PVD, Dementia, COPD, and CHF were noted to have higher prevalence of DISH when compared to those without DISH.

Background

Diffuse idiopathic skeletal hyperostosis (DISH) is a condition of unknown etiology is characterized by the presence of ossification of the anterior longitudinal ligament over four or more contiguous vertebral bodies, with no accompanying degeneration of the intervertebral joint spaces at those levels.\(^1\) While the pathophysiology of DISH is yet to be fully defined, vascular, metabolic, genetic, and mechanical factors are thought to play a role.\(^2,3\) DISH is associated with hypertension, elevated BMI, diabetes mellitus, atherosclerosis, advanced age, obesity, and male sex.\(^4,5\)

Previous studies demonstrated the prevalence of DISH to be as high as 19.5% in Japanese or Korean patient populations, with limited focus on prevalence in other races.\(^6,7\) Another cross-sectional study performed in 2021 found the prevalence of DISH to be 7.7% in a population of 3299 African- and Caribbean-American patients.\(^8\) Further studies are needed to determine the prevalence of DISH in additional patient populations.
Methods

This was a retrospective cohort review of a single Level 1 Trauma center on Long Island, NY from 2019–2020. This study received approval from the hospital IRB. Inclusion was met if patients were asymptomatic, and if they received axial and lateral CT scans in the emergency department. Patients were excluded if they were below age 14, received CT scans which did not allow for, adequate visualization of the vertebral column, and if they had acute fracture of the vertebral column.

Relevant demographic and radiologic criteria were collected via chart review. Demographic information collected included age, biological sex, smoking status, alcohol use, and Charlson Comorbidity Index (CCI). Relevant radiographic information included radiographic identification of DISH, number of levels of DISH, location of DISH (i.e., cervical, thoracic, lumbar), and whether DISH on axial CT was right, left, central). DISH was defined as the presence of flowing vertebral ossification at greater than or equal to 4 contiguous vertebral segments.

Data analysis was performed using SPSS (v.28, IBM Statistics, Armonk, NY). T-test, chi-squared, and multivariate logistic regression analyses were used to analyze demographic and radiographic data. Significance was set to $p < 0.05$.

Results

1328 patients met inclusion, and 231 met exclusion, leaving a total study population of 1097 met inclusion and exclusion criteria. Among the total cohort the prevalence of DISH was revealed to be 20.3%. The most common upper level for DISH was T6 and the most common lower level was T10. Mean number of vertebrae involved in DISH was 5.79.

With regard to significant differences among the DISH and non-DISH cohort, it was found that patients with DISH were significantly older (72.3 ± 14.8 yrs. vs. 53.3 ± 23.1 yrs., $p < 0.001$) and had significantly higher CCI (0.39 ± 0.647 vs. 0.19 ± 0.475, $p < 0.001$) (Table 1). In addition, a higher proportion of females were observed to be in the non-DISH cohort when compared to the DISH cohort (40.2% female vs 30.5% female, $p = 0.009$). Patients with DISH had higher rates of Diabetes Mellitus (23.3% vs. 12.2%, $p < 0.001$), COPD (6.27% vs. 2.29%, $p = 0.004$), dementia (11.2% vs. 5.84%, $p = 0.007$), peripheral vascular disease (3.13% vs. 0.92%, $p = 0.019$), and congestive heart failure (8.97% vs. 1.83%, $p < 0.001$). In addition, significant differences were also observed in the presence of DISH between ethnic groups [Caucasians 25.9%, African-Americans 12.7%, Asians 6.3%, Hispanics/Latinos 11.2%, and other 16.1% ($p < 0.001$)]. Further, men were found to have a significantly higher prevalence of DISH vs women (22.9% vs 16.2%, $p = 0.009$). There was no significant differences between the DISH and non-DISH cohort with regard to prevalence of cerebrovascular accidents (1.79% vs. 0.92%, $p = 0.278$), myocardial infarction (1.35% vs. 0.34%, $p = 0.102$), or liver disease (0.45% vs. 0.11%, $p = 0.365$) (Table 2).
In order to assess which of these factors might be predictive of the development of DISH, a backward stepwise logistic regression analysis was run. Variables included in the first step of the regression analysis included age, biological sex, CCI, ethnic background, DM, COPD, dementia, and CHF. After four steps, the regression identified age (OR: 1.053, 95% CI: 1.043–1.063, p < 0.001), sex (OR: 3.561, 95% CI 2.447–5.181, p < 0.001), DM (OR: 0.643, 95% CI 0.403–0.962, p = 0.032) and CHF (OR: 0.473, 95% CI 0.227–0.988, p = 0.046) as significant risk factors for the development of DISH (Table 3).
Table 3
Results of Binary Logistic Regression

<table>
<thead>
<tr>
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<th>Odds Ratio</th>
<th>95% C.I.</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.053</td>
<td>1.043–1.063</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Sex (Female)</td>
<td>3.561</td>
<td>2.447–5.181</td>
<td>&lt; .001</td>
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<tr>
<td>DM</td>
<td>0.643</td>
<td>0.43–0.962</td>
<td>0.032</td>
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<tr>
<td>CHF</td>
<td>0.473</td>
<td>0.227–0.988</td>
<td>0.046</td>
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Discussion

This study is the most racially heterogeneous sample to assess the prevalence of DISH in the community and the associated risk factors. Caucasian patients made up the largest portion of the DISH cohort when compared to African-Americans, Hispanics, Asians, and other races. Prevalence of DISH found in this study (20.3%) is similar to that encountered in the literature that studied Japanese and Korean populations.

Previous literature has shown that rates of DISH were either higher or displayed no significant differences comparing non-Caucasian and Caucasian cohorts.\(^8\)\(^-\)\(^10\) One study without said limitations demonstrated that among patients at two hospitals in the same county in the United States, Caucasians had significantly higher rates of DISH.\(^11\) These studies were often limited by studying only two populations at a time, preventing a larger and more heterogeneous comparison between ethnic groups. This study found significant differences in the presence of DISH between ethnic groups, with Caucasians 25.9%, African-Americans 12.7%, Asians 6.3%, Hispanics/Latinos 11.2%, and other 16.1% (p < 0.001). Evidence still remains inconclusive with regard to a genetic predisposition to DISH, and more research should be done to further elucidate this relationship.

This study also followed trends previously established by the literature including significant associations between DISH and age and male sex. Both the mean age and the relationship between age and the development of DISH was similar to that found in the literature. Previous literature has found the average at which DISH was diagnosed was between 57 years old and 68 years old, similar to but slightly younger than the mean age shown in the present study's DISH cohort.\(^6\)\(^-\)\(^8\),\(^12\) There is an increased prevalence of DISH at older ages.\(^4\),\(^5\) Literature has also found that males have a higher prevalence of DISH.\(^8\),\(^11\)\(^-\)\(^13\)

This study found that patients with DISH had a higher prevalence of diabetes mellitus, congestive heart failure, and dementia. Previous studies have also shown higher prevalence of DISH in patients with DM. This relationship has been attributed to increased inflammatory and growth factors released as part of the pathogenesis of DM which in turn encourage bone and osteophyte growth.\(^13\)\(^-\)\(^15\) Coacolli et al. demonstrated that worsening degrees of DM correlated to increased prevalence of DISH.\(^16\)
Close relationship between cardiovascular disease and DISH also has been shown. Patients with DISH were shown to have higher risk of cardiac events, cardiac atherosclerosis and coronary artery disease, and congestive heart failure.\textsuperscript{17–19} The risk of CV disease in these patients as estimated by current methods may actually grossly underestimate the true risk.\textsuperscript{20} Many of the studies have identified age and DM as potential risk factors, raising questions about which insult might come first and how exactly the four are interrelated.\textsuperscript{17–20} Despite this, this study also showed a strong association between DISH and CHF, further strengthening the data supporting this association.

One relationship that has not been previously discussed in the literature is the relationship between DISH and dementia. This relationship has face validity as the DISH cohort was shown to be significantly older than the non-DISH cohort, and dementia is a disease of old age. A possible limitation of this analysis, however, was that the type of dementia was not specified during data collection. It is difficult to hypothesize any other pathological basis for this relationship other than increased age. Future research should further investigate this association.

Despite the strong evidence discussed above, when controlled for DM and CHF, age and female sex were the major predictors for the development of DISH. Women were roughly 3.6 times more likely to develop DISH, while analysis of age demonstrated a 1.1 times increase in risk per year. Results regarding the analysis of sex are contrary to the current literature, and demonstrate that previous research may not have fully controlled for confounding factors. This, coupled with the fact the prevalence of dementia, diabetes, and heart failure was higher in DISH cohorts suggests that age may, in fact, be the major determinant in the development of DISH.

This study was limited by its retrospective nature and its lack of follow-up. Further, the study was unable to determine risk factors associated with the development of clinically significant DISH. While this study found a number of risk factors for the development of DISH, it cannot discriminate which of those patients will need intervention. Future research should address this question.

**Conclusions**

This study represents one of the largest and most ethnically heterogeneous samples to date, which will improve diagnostic accuracy and screening with regard to this condition. This study found significant associations between DISH and increased age, male sex, diabetes, congestive heart failure, and dementia. When controlled for diabetes and congestive heart failure, age and female sex are the strongest predictors for developing DISH. This suggests that age is the major determining factor in DISH. More research is needed to further establish these relationships.

**Declarations**

*Ethics Approval and Consent to Participate*
The NUMC Institutional Review Board waived requirements for informed consent for this research due to its retrospective nature.

Consent for Publication

Not-applicable

Availability of Data and Materials

The data generated during the conduct of this research is available upon reasonable request to the corresponding authors.

Competing interests

The authors have no relevant financial or non-financial conflicts of interest to disclose.

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Authors Contributions

M.C.M and N.A.O were involved in data acquisition, data interpretation, and writing main manuscript text. H.G., J.T., and A.A were involved in conception, data interpretation, and reviewed the final manuscript. All authors have reviewed the submitted version and agree to be held accountable for their contributions.

References


