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Published in:
Journal of Shoulder and Elbow Surgery

DOI:
10.1016/j.jse.2019.08.003

Publication date:
2020

Document version:
Accepted manuscript

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Citation for published version (APA):

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Download date: 15. Sep. 2023
Subacromial space outlet in female patients with multidirectional instability based on hypermobile Ehlers-Danlos Syndrome and Hypermobility Spectrum Disorder measured by ultrasound.

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IRB/Ethical Committee Approval: The Ethics Committee of Ghent University Hospital approved this study (Protocol Reference Number 2017/0941).

Abstract

Objective

The objective of the study was to compare the acromiohumeral distance (AHD) between patients diagnosed with hypermobility type of the Ehlers-Danlos syndrome (hEDS) or Hypermobility...
Spectrum Disorder (HSD) and healthy controls by evaluating the relative amount the tendon occupies in the subacromial area. Furthermore, the aim was to evaluate if there was a change in AHD with arm elevation within and between groups.

**Methods**

Twenty-nine female hEDS/HSD patients (age 34 ± 12.9 years) and twenty healthy controls (age 33 ± 10.8 years) participated in the study. The supraspinatus tendon (SST) thickness and AHD were measured using ultrasound (US). The interplay between the SST and the AHD was expressed as the occupation ratio (OcAHD), calculated as the SST thickness as a percentage of AHD. The measures were performed in resting position and in subsequently 45° and 60° of active arm elevation in the scapular plane.

**Results**

The main finding is that hEDS/HSD patients have a larger subacromial space outlet compared to the controls when measured by US. Furthermore, in both groups we found an increased OcAHD during active arm elevation compared with the resting position, which indicates that similar mechanisms occur for hEDS/ HSD patients and healthy controls.

**Conclusion**

hEDS/HSD patients have a larger available subacromial space outlet compared to healthy individuals. OcAHD increased during active arm elevation compared with the resting position in both groups. This knowledge is important when designing rehabilitation exercise programs for shoulder instability patients with abnormal glenohumeral biomechanics.

**Level of evidence:** 3
Keywords
Ehlers–Danlos Syndrome, Hypermobility, shoulder pain, supraspinatus tendon, acromiohumeral distance, ultrasound, physiotherapy

Introduction
Ehlers-Danlos syndrome (EDS) is a rare genetically heterogeneous group of heritable connective tissue disorders (prevalence 1:5000), characterized by soft tissue fragility and joint hypermobility. EDS is currently classified into 13 types, of which the hypermobility type (hEDS) is most prevalent with more than 90% of the patients being female. At present, the genetic background of the hypermobility type of EDS is unclear. The diagnosis is therefore based upon stringent clinical criteria. The presence of generalized joint hypermobility (GJH), systemic tissue abnormalities, musculoskeletal complaints and a hereditary pattern strongly suggest a broader underlying abnormality in the formation and tensile strength of the connective tissue. Patients who do not fulfill the criteria for ‘hEDS’ but also present with GJH and at least one secondary musculoskeletal complaint are labeled as having a hypermobility spectrum disorder (HSD).

Generalized or poli-articular joint hypermobility is associated with an extra demand on the ligaments, tendons and other connective tissue, which may lead to recurrent overload injuries, subluxations, dislocations and pain complaints. Focusing on the upper extremity, 85% of the hEDS patients report shoulder pain and more than 60% of the patients report shoulder dislocations or episodes of subluxations that lead to impaired shoulder function. It is unclear whether the experienced shoulder pain is caused by shoulder instability, subacromial pain syndrome (SPS) or rotator cuff (RC) dysfunction as a result of increased glenohumeral translations.
One quantitative method to measure subacromial biomechanics noninvasively is ultrasound (US). Assessing the acromiohumeral distance (AHD) and the concurrent supraspinatus tendon (SST) thickness may provide us a better understanding of the outlet of the subacromial space expressed as subacromial space outlet (SSO)\(^7, 34, 39, 45\).

The process of evaluating the AHD by ultrasound has been used in several patient populations, in comparison to healthy controls. Increased proximal humeral head migration was found in patients with RC tears reflected by a reduced AHD\(^45\). In patients experiencing post-hemiplegic shoulder subluxations increased AHD was demonstrated compared to the unaffected side\(^39\). Other studies did not find any statistically significant differences in AHD between patients with SPS and healthy controls when AHD was measured at rest on radiograph\(^13\) or by ultrasound\(^21, 24, 34\). To our knowledge only one study has reported AHD measures in individuals with joint hypermobility compared to matched controls. Although significant decrease was found in AHD after an elevation fatigue task, no significant differences between groups were established\(^1\). However, the participants in that study were asymptomatic.

Further, concurrent thickening of the SST in the presence of reduced AHD is anticipated to contribute to SPS as a result of increased tendon volume in a smaller space\(^22, 33\). Thus, to understand the biomechanics of the available subacromial area it is relevant to characterize the interplay between the SST and the AHD. That can be expressed as the occupation ratio (OcAHD), which is calculated as the SST thickness as a percentage of AHD\(^34\).

At present the relationship between AHD and SST thickness is unknown in patients with GJH. Accordingly, the objectives of the present study were to compare the AHD between hEDS/HSD
patients and healthy controls by evaluating the relative amount the tendon occupies in the subacromial area. Furthermore, our aim was to evaluate if there is any change in AHD with arm elevation within and between groups.

**Methods**

**Subjects**

Participants were recruited consecutively among patients with hEDS/HSD after a routine follow-up consultation at the Center for Medical Genetics at Ghent University Hospital, Belgium. The patients consisted of hEDS or HSD according to the current criteria. As more than 90% of the hEDS and HSD patients are female, the current study included only women. Only hEDS and HSD patients presenting with multidirectional shoulder instability (MDI) were selected. MDI was defined as ‘symptoms of glenohumeral joint instability in more than one direction’. Inclusion criteria were: 1) women with a current subjective experience of shoulder instability in daily life (e.g., recurrent subluxations/dislocations) without a traumatic onset; 2) shoulder pain for at least three months prior to the study; 3) symptomatic at the time of testing; 4) shoulder instability in at least two directions on the Frequency, Etiology, Direction, and Severity (FEDS) tests: a positive sulcus sign (increased laxity), and a positive apprehension-relocation test (anterior instability), and/or a positive jerk test (posterior instability), and/or a load-and-shift test positive for another direction than the three previous tests. Exclusion criteria for the patients were: 1) other diseases in addition to hEDS/HSD (e.g., diabetes, multiple sclerosis, etc.); 2) a severe vertebral malalignment (e.g., scoliosis); 3) history of frozen shoulder or shoulder surgery (of the most unstable shoulder) in the past five years; 4) patients who were unable to perform an elevation in the scapular and sagittal plane up to 120°; 5) patients with a traumatic onset of their shoulder instability. All patients were screened for GJH with the use of Beighton’s tests and criteria (0–9 score) where a Beighton score above 4/9 determines GJH. Additionally, patients also filled in the Western Ontario Shoulder
Instability Index (WOSI) questionnaire, designed to measure health-related quality of life in patients with shoulder instability. WOSI covers four domains (physical symptoms, sport/recreation/work, lifestyle, and emotions) comprising 21 items. Each item is scored on a 0-100-point visual analogue scale with a total score of 2100 which can be converted into a percentage (with 0% as the level of no trouble; 100% most trouble).

Asymptomatic non-athletic healthy controls within same age and BMI were recruited from the community. They were excluded if they had a history of shoulder pain or pathology in their dominant arm during six months prior to the study and if they had a Beighton score above 4/9. Informed consent was obtained for all participants. The Ethics Committee of Ghent University Hospital approved this study (Protocol Reference Number 2017/0941).

Instruments

The equipment used was a Hitachi Noblus scanner, serial number G330131514 (Santax Medico/Santax Nordic Group) and Hitachi Medical Systems Musculoskeletal Linear Probe type L64 18-5 MHz, 50 mm with center frequency of 10 MHz in grey scale B-mode. A special preset was made in order to optimize image quality, allowing adjustment of focus. For anterior viewing the depth preset was 2.75 cm and for posterior viewing it was 3.75 cm.

Ultrasound measurements

Ultrasound images were obtained by a single examiner who was a licensed physiotherapist with 9 years of experience in musculoskeletal ultrasound imaging. In a previous study we found a high intra- and inter examiner reliability of the SST thickness and AHD in healthy populations and in patients with symptomatic RC tendinopathy and SPS.
Ultrasound images were captured with the patients seated in an upright position, feet flat on the floor, neutral trunk posture, and head facing forward. A previously published protocol was followed thus the testing order of arm positions was not randomized. Ultrasound image were captured anonymously and saved for later measurements on the Hitachi machine using the “read” functionality. Measurements were performed blinded to group allocation but not to arm position.

All structures were measured in mm. In the patient group the most symptomatic shoulder was taken for assessment. In the control group, the dominant shoulder was evaluated. During all examinations a second physiotherapist helped set up and maintaining patients position including scapular plane and arm angle during US imaging.

For the SST measure patients were asked to place their involved hand on the ipsilateral posterior hip with the humerus in extension (the modified Crass position) \(^{12}\). The transducer was placed on the anterior aspect of the acromion in a coronal plane, and then moved anteriorly and distally. Landmarks were the anterior part of the SST insertion, the humeral head and the subacromial bursa above the tendon (Figure 1). SST thickness was measured perpendicular to tendon fibers at 20 mm distance from supraspinatus insertion (footprint) on the humeral head (Figure 3) \(^{24}\). This measurement has proved excellent reliability and that the tendon thickness does not change significantly between positions \(^{24}\).

For the AHD measure in resting position (AHD0) patients were asked to place their arm resting at the side with 90 degrees flexed elbow. For the AHD measure in 45° and 60° elevation (AHD45 and AHD60), the arm is kept in 45°/ 60° degrees of active elevation with elbow flexed 90° according to description by Pijls et al (2010) \(^{40}\), however in the scapular plane. The second physiotherapist aligned the arm to scapular plane using a reference plane as marked on the floor and monitored the
patients to the 45°/ 60° degrees of active arm elevation during US imaging using an Iphone clinometer app. For all AHD measures the transducer was placed on the most anterior aspect of the anterior acromial margin, as confirmed with palpation, with the long axis of the transducer placed in the plane of the scapula and longitudinally with respect to the SST (Figure 2) \(^\text{10}\). The humeral head and acromion were imaged to capture the anterior aspect of the subacromial area. The AHD was measured at the shortest linear distance between the inferior edge of acromion and the upper edge of the adjacent humeral head (Figure 4) \(^\text{10, 21, 24, 45}\).

**Statistics**

Variables of interest were the SST thickness (in mm), the AHD in 0°, 45° and 60° of elevation (in mm), and the OcAHD in the same 3 positions, reflecting the % of the AHD that is occupied by the supraspinatus. This variable was calculated as OcAHD = (SST thickness /AHD)*100. Descriptive statistics were calculated for all variables, and all continuous dependent variables were controlled for normal distribution on histogram and QQ-plot, and using the Shapiro-Wilk test. Homogeneity of variance was evaluated using Levene’s test. Since all data were normally distributed with equal variances, parametric statistics were performed.

Group differences for the SST thickness were analyzed using an independent t-test. For AHD and OcAHD, an ANCOVA for repeated measures design was used (General Linear Model), in which the within subject factor was angle (3 levels) and the between subject factor was group (2 levels). Interaction effects angle*group, as well as main effects for group and angle were of interest. In case of interaction effects, and in case of main effects for angle, a Bonferroni procedure was performed to correct for multiple pairwise comparisons. In case of main group
effects, no post-hoc tests were performed. Statistical significance was set as $\alpha = 0.05$. Statistical analysis was carried out in the IBM SPSS Statistics Version 25.0 software (SPSS Inc., Chicago, IL).

**Results**

**Subjects**

Between September and December 2017, twenty-nine patients (age 34 $\pm$ 12.9 years) diagnosed with hEDS ($n=14$) or HSD ($n=15$) and twenty healthy controls (age 33 $\pm$ 10.8 years) volunteered for the study. The patients had a mean Beighton Score of 5.72 and a WOSI of 50 (range 7-76), with the healthy controls having a mean Beighton Score of 1.45 (Table 1).

**Ultrasound measurements**

All descriptive data are displayed in table 2. There was no statistical significant group differences on SST ($p=0.083$). The SST was 5.05 mm (SD 0.68 mm) in patients, and 5.38 mm (SD 0.56 mm) in healthy controls (Table 2).

For AHD, there was no significant group*angle interaction effect ($p=0.120$), and no significant main group effect ($p=0.088$), however, a significant main effect of angle ($p < 0.001$). Post-hoc tests revealed significant differences between AHD0 and AHD45 ($p<0.001$), and AHD0 and AHD 60 ($p<0.001$), however, not between AHD45 and AHD60 ($p=1.00$) (Table 3).

For OcAHD, no significant group*angle interaction effect ($p=0.054$) was found, however, significant main effects for angle ($p<0.001$) and group ($p=0.005$), showing the patient group to have smaller OcAHD across elevated arm angles than the controls. Post-hoc tests for the factor angle revealed significant differences between OcAHD0 and OcAHD45 ($p<0.001$) and OcAHD0 and
OcAHD60 (p<0.001), however, with no significant differences between OcAHD45 and OcAHD60 (p=0.956) (Table 3).

**Discussion**

The primary aim of this study was to compare the AHD and SST thickness between shoulder hypermobile hEDS/ HSD patients and healthy people, at different angles of arm elevation in the scapular plane. The main finding is that patients have a larger SSO compared to the controls. Furthermore, in both groups, we found an increased OcAHD in higher arm elevation angles compared to the resting position, indicating that narrowing occur for both hEDS/ HSD patients and healthy people. A higher OcAHD means that the SST takes more of the space between the humeral head and the acromion during shoulder elevation regardless of group allocation.

The larger AHD in hEDS/ HSD patients may be explained by increased capsular laxity, compromising the passive restraints (performed by superior capsule, superior glenohumeral ligament and the coracohumeral ligament) to prevent the caudal pull on the arm caused by gravity. Additionally, dysfunctional muscle recruitment and decreased muscle tension has also been found in patients with MDI which may even increase the humeral head translations in the inferior direction. Another possible reason for the patients having a larger SSO compared to the controls could be that these patients may have altered scapular position, which could appear as more protracted and downward rotated scapula as previously shown in patients with GJH and during arm elevation in MDI patients. This insufficient upward rotation allows the humeral head to slide inferiorly and is mentioned as a causative mechanism for subluxations and dislocations. However, in general, shoulder girdle kinematics and muscle activity in individuals with GJH is scarcely described.
The subacromial area has only sparsely been studied in patients with shoulder pain related to joint hypermobility. Furthermore, previous studies did not report the OcAHD, which hampers direct comparison. However, it is important to note that OcAHD is a clinically useful measure to report, as there may be large individual variations in AHD (10-15mm) and tendon thickness (2.5 – 8.5 mm) \(^{13, 24}\). Therefore the ratio of the two measures is a relevant clinical measure to evaluate the relative available subacromial space \(^{34}\).

The decrease we found in AHD and OcAHD in higher elevation angles compared to the resting position, in both shoulder hypermobile hEDS/ HSD patients and healthy individuals are in line with other studies that demonstrated increased superior humeral head translation/ decrease in the subacromial area during active glenohumeral elevation in subjects with healthy shoulders \(^{13, 14, 24}\), patients with SPS \(^{41}\) and in patients with RC tendon degeneration \(^{38, 41, 50}\).

Further, in line with the current results, one study found decreased AHD in higher elevation angles compared with the resting position in two groups representing twenty women with asymptomatic GJH and 16 matched controls (no symptoms, no GJH) \(^{1}\). They also showed that a repetitive shoulder muscle fatigue protocol reduced the AHD at 90° of elevation. This decreased AHD is thought to be related to an increased presence of scapular dyskinesia (e.g. downward rotation, anterior tipping and protraction) \(^{1}\). In contrast, Maenhout et al. found that after a rotational task fatigue protocol, the AHD increased in healthy overhead athletes with arm angles at 45° and 60° elevations \(^{28}\). Whether a fatigue protocol on hEDS/ HSD patients will have a similar effect on AHD as seen in healthy (non-athletic) or asymptomatic individuals with GJH is still to be investigated.
The subacromial area has been assessed in other patient groups with shoulder pain, and a reduction in available subacromial area (excessive proximal humeral head migration) has been hypothesized to cause SPS and RC degeneration. However, this is currently highly debated, as the factors influencing the subacromial area are multifactorial and the evidence is still inadequate.

The increase in available subacromial area or increased inferior humeral head position that is found in this patient group is also found in post stroke patients with a prevalence of shoulder pain varying between 5 and 84%. Shoulder subluxation is the most frequent contributing factor of shoulder pain in post stroke patients with high correlations with clinical signs.

The question is whether our results may help in explaining shoulder pain in hEDS/HSD patients. At first, our results do not confirm the anticipation that shoulder pain and dysfunction is caused by SPS in this patient group. Since we found that these patients have a larger SSO compared to the controls, they may not have pain due to excessive proximal humeral head migration but rather due to excessive multidirectional shoulder motion affecting shoulder joint kinematics. However, we should consider that the causes of pain are multifactorial and that a proportion of the experienced pain may be the result of central sensitization and not solely based on mechanical constraints.

Strengths, limitations and future research

The major strength of the study is that in a large sample size the SSO was evaluated in this patient population, despite the fact that hEDS/HSD is a rare disease. Since intra-rater reliability is reported to be higher than inter-rater reliability, another strength of our study is that one researcher performed all US measurements following a strict predefined protocol for US examinations.
However, the current study has some limitations. One limitation could be that AHD measurements using US were performed at low-elevation angles, to be able to display the RC in the SSO\textsuperscript{10}, however, it means that we have no data on AHD at angles greater than 60°. When actively elevating the arm a decreased AHD and an increased OcAHD were seen, which is in line with studies also using US in healthy as well as in patients with RC pathology\textsuperscript{10,21,45}. AHD reduction was greatest during elevation of 45° as opposed to MRI-studies showing decreased AHD up to 70° elevation in patients with SPS\textsuperscript{15} and 90°- 120° abduction\textsuperscript{14}.

Another limitation was that evaluation of scapular 3D kinematics, synchronized with the AHD assessment, was not incorporated in this study. To be able to support our finding that hEDS/ HSD patients have a larger available subacromial area or a functional subluxation with possible insufficient scapular upward rotation allowing the humeral head to slide inferiorly\textsuperscript{37} evaluation of scapular 3D kinematics would have been ideal. With synchronized evaluation of scapular 3D kinematics it would have been possible to take the changes in scapula positioning between groups into account. The changes in AHD may be the result of changes in scapular position.

In addition, performing our own reliability study was not possible due to the exposure of the required number of examination repetitions in this low endurance fragile population. However, in a prior study we reported an excellent intra-rater reliability of SST thickness (Minimal Detectable Change (MDC) 0.59 mm) and AHD (MDC 0.98 mm) measurements in healthy and patients with SPS\textsuperscript{24} and since it was the same researcher performing the US measurements, following the same protocol, our US measurements are considered reliable.
Since we did not provide a power analysis we do not know if the lack of finding on some of our measures is simply due to low sample size. The incomplete matching was a significant weakness/limitation in this study. The two groups of 29 hEDS/HSD and 20 healthy were within same age, sex (only women) and BMI, however, a possible limitation could be that in the patient group the most symptomatic shoulder was evaluated, but in the control group the dominant shoulder was evaluated. In addition, its also a limitation that we only included women and therefore the findings are not able to be generalized to men. Our exclusion criteria were prior shoulder surgery (of the most unstable shoulder) in the past five years which means that participants could have had surgery at an earlier stage which may have confounded study results. Finally, since the healthy controls did not have MDI or hypermobility, it is unknown which of the two factors that may have caused the group differences.

US was preferable for the present study because of its low cost, safety, and feasibility of examining the hEDS/HSD patients and healthy in a seated position allowing free movement of the arm and scapula. However, there are limitations using US since we can not get information’s on the underlying structures and their mechanics beneath the acromion. Furthermore, AHD is only a limited single plane representation of the total glenohumeral joint which is functionally a multiaxial joint. Likewise, we did also not use radiographic examination and therefore we did not examine the acromion index where a high index represents an acromion that projects far laterally and covers the biggest portion of the humeral head.

US can be used to e.g. evaluate tendon thickness alone or as OcAHD as a potential aid to treatment decision-making. However, we did not evaluate the change in these measures with treatment or over time, therefore future studies, using US, are needed to determine the usefulness of these measures in monitoring treatment response.
Clinical or practical implications

The results may help clinicians in designing exercise programs for shoulder instability patients with abnormal glenohumeral biomechanics focusing on exercises in appropriate starting positions. Specifically, an attention point may be the use of dumbbells due to the risk of subluxation of the humeral head. Furthermore, thorough considerations should be made when using exercises in 45° elevation or forward flexion since that could induce increased compression on subacromial tissue as a result of reduced AHD at the SSO.

Based on our results, we may assume that pain in patients with multidirectional instability may not be based on impingement symptoms since they have a larger available subacromial area. But symptoms may possibly originate from the humeral head subluxation/inferiorly displaced humeral head and loss of normal shoulder proprioception, particularly in the supraspinatus and posterior deltoid muscles, where simply the weight of the upper limb stretch the joint capsule, muscles, tendons and ligaments. Other mechanisms must be explored such as alterations in joint kinematics as a result of increased joint laxity.

Conclusion

In conclusion, hEDS/HSD patients with shoulder instability have larger available subacromial area with humeral head subluxation/inferiorly displaced humeral head compared with healthy controls. Furthermore, in both groups we found increased OcAHD in higher arm elevation angles compared to the resting position, which indicates that similar mechanism occurs. The present findings should be taken into account when designing rehabilitation exercise programs for shoulder instability patients with abnormal glenohumeral biomechanics.
Figure and table legends

Figure 1. Participant position for US measurement of the supraspinatus tendon.

Figure 2. Participant position for US measurement of the acromiohumeral distance.

Figure 3. SST thickness was measured perpendicular to tendon fibers at 20 mm distance from supraspinatus insertion (footprint) on the humeral head. H, humerus; SST, supraspinatus tendon.

Figure 4. US measurement of AHD in neutral position of the shoulder. A, acromial surface; AHD, acromiohumeral distance; H, humerus; SST, supraspinatus tendon.

Table 1. Demographics characteristic of the hEDS/ HSD and healthy controls (n = 49).

Table 2. Descriptive data with P-values for measures and occupation ratios in hEDS/ HSD and healthy controls.

Table 3. Pairwise Comparison for the angle in all participants.

Disclosure statement

The authors declare that they have no competing interests.

Funding declaration

The study received no funding.

Acknowledgments

We would like to express our gratitude to the patients with hEDS/ HSD for participation in this study. We also thank the healthy controls/ colleagues from the University Hospital for participation.
We thank Iryna Broucke, Laure Peelman, Matthias Van Daele and Aaron Van den Abeele for help with data collection. We thank photographer David Wagelmans and hEDS patient Sonja Buttafuoco for consent to publish photos.

Author contributions

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Kjær had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design: Kjær, De Wandele, Juul-Kristensen and Cools.

Acquisition of data: Kjær, De Wandele and Spanhove.

Analysis and interpretation of data: Kjær and Cools.

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Table 1 Demographics characteristic of the hEDS/ HSD and healthy controls (n = 49)

<table>
<thead>
<tr>
<th>Participants (female)</th>
<th>hEDS/ HSD (n=29)</th>
<th>Healthy (n=22)</th>
<th>P-value</th>
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<tr>
<td>Mean Age in years, mean (SD)</td>
<td>34 (12.9)</td>
<td>33 (10.8)</td>
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<tr>
<td>Height (cm), mean (SD)</td>
<td>168.3 (7.4)</td>
<td>169.5 (5.7)</td>
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<tr>
<td>Weight (kg), mean (SD)</td>
<td>65.1 (13.5)</td>
<td>62.7 (9.6)</td>
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<tr>
<td>BMI, mean (SD)</td>
<td>23.0 (4.9)</td>
<td>21.8 (3.4)</td>
<td>0.314</td>
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<tr>
<td>Beighton, mean (SD)</td>
<td>5.72 (2.1)</td>
<td>1.45 (1.5)</td>
<td>&lt;0.001</td>
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<tr>
<td>hEDS, no.</td>
<td>14</td>
<td>N/A</td>
<td></td>
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</table>
Table 2 Descriptive data with P-values for measures and occupation ratios in hEDS/ HSD and healthy controls

<table>
<thead>
<tr>
<th>Measure</th>
<th>hEDS/ HSD (n=29) Mean in mm (SD in mm)</th>
<th>Healthy Control (n=20) Mean in mm (SD in mm)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST</td>
<td>5.05 (0.68)</td>
<td>5.38 (0.56)</td>
<td>0.083</td>
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<tr>
<td>AHD0</td>
<td>11.13 (1.73)</td>
<td>11.09 (1.60)</td>
<td>0.939</td>
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<tr>
<td>AHD45</td>
<td>9.25 (3.18)</td>
<td>7.79 (2.20)</td>
<td>0.081</td>
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<tr>
<td>AHD60</td>
<td>9.66 (3.50)</td>
<td>8.14 (1.88)</td>
<td>0.084</td>
</tr>
<tr>
<td>Occupation Ratio</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>OcAHD0</td>
<td>46.23 (8.17)</td>
<td>49.60 (9.32)</td>
<td>0.186</td>
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<tr>
<td>OcAHD45</td>
<td>58.94 (15.89)</td>
<td>73.72 (19.18)</td>
<td>0.005</td>
</tr>
<tr>
<td>OcAHD60</td>
<td>57.48 (18.34)</td>
<td>69.77 (18.53)</td>
<td>0.026</td>
</tr>
</tbody>
</table>

Table 3 Pairwise Comparison for the angle in all participants

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean Diff</th>
<th>P-value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHD0 vs AHD45</td>
<td>2.59</td>
<td>&lt;0.001</td>
<td>(1.60- 3.58)</td>
</tr>
<tr>
<td>AHD0 vs AHD60</td>
<td>2.21</td>
<td>&lt;0.001</td>
<td>(1.19- 3.23)</td>
</tr>
<tr>
<td>AHD45 vs AHD60</td>
<td>0.38</td>
<td>=1.00</td>
<td>(-0.61- 1.37)</td>
</tr>
<tr>
<td>OcAHD0 vs OcAHD45</td>
<td>18.41</td>
<td>&lt;0.001</td>
<td>(12.75- 24.07)</td>
</tr>
<tr>
<td>OcAHD0 vs OcAHD60</td>
<td>15.71</td>
<td>&lt;0.001</td>
<td>(9.85- 21.57)</td>
</tr>
<tr>
<td>OcAHD45 vs OcAHD60</td>
<td>2.701</td>
<td>0.956</td>
<td>(-3.95- 9.35)</td>
</tr>
</tbody>
</table>

Pairwise Comparison for the angle: Mean Diff, mean difference; 95% CI, 95% confidence interval; vs, versus