1 Background
Systemic sclerosis (SSc) is a multi-system disease manifesting with both visceral and cutaneous fibrosis. Dermal elasticity is reduced and stiffness increased due to excessive dermal and subcutaneous deposition of collagen leading to increased skin thickness as well as hardening and tightening of the skin. Skin thickening in SSc has been demonstrated previously in ultrasound studies, although soft tissue thickness have not been evaluated yet.

The purpose of this study was to compare thickness and relative stiffness of soft tissues in SSc and healthy controls (HC).

2 Methods
The study sample was composed of 25 SSc patients (23F and 2 M, mean age of 56.6±9.9 years) with a mean disease duration of 11.1±7.0 years and 18 HC (16F and 2M, mean age of 51.9±10.6 years)

- **Soft tissue thickness** was measured by high-frequency ultrasound using the LOGIQ 9 (GE, Healthcare) ultrasound system (Figure 1)
- **Relative soft tissue stiffness** was measured by compression-elastography using the LOGIQ 9 (GE, Healthcare) ultrasound system with the proprietary Elasto Q-Mode™ (Figure 2)

Measurements sites:
- Third metacarpophalangeal joint (3rd MCPJ), third metatarsophalangeal joint (3rd MTPJ), heel

3 Results

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Control (n=18)</th>
<th>SSc (n=25)</th>
<th>p-value for difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmar skin (3rd MCPJ)</td>
<td>0.11 (0.10 to 0.12)</td>
<td>0.15 (0.13 to 0.16)</td>
<td>0.001*</td>
</tr>
<tr>
<td>Palmar skin (3rd MTPJ)</td>
<td>0.17 (0.14 to 0.19)</td>
<td>0.16 (0.14 to 0.18)</td>
<td>0.497</td>
</tr>
<tr>
<td>Skin (Heel)</td>
<td>0.2 (0.17 to 0.24)</td>
<td>0.2 (0.17 to 0.23)</td>
<td>0.854</td>
</tr>
<tr>
<td>Fibro-fat pad (3rd MCPJ)</td>
<td>0.27 (0.30 to 0.37)</td>
<td>0.38 (0.34 to 0.40)</td>
<td>0.822</td>
</tr>
<tr>
<td>Fat-pad (3rd MTPJ)</td>
<td>0.52 (0.44 to 0.59)</td>
<td>0.41 (0.35 to 0.47)</td>
<td>0.023</td>
</tr>
<tr>
<td>Fibro-fat pad (Heel)</td>
<td>1.11 (0.99 to 1.22)</td>
<td>0.95 (0.89 to 1.09)</td>
<td>0.100</td>
</tr>
<tr>
<td>Tendon (3rd MCPJ)</td>
<td>0.34 (0.30 to 0.37)</td>
<td>0.38 (0.34 to 0.40)</td>
<td>0.146</td>
</tr>
<tr>
<td>Tendon (3rd MTPJ)</td>
<td>0.22 (0.18 to 0.25)</td>
<td>0.21 (0.19 to 0.23)</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Table 1 Soft tissue thickness (right) and relative stiffness (left) in patients with SSc and controls, mean (95% CI).**

The combined soft tissue thickness at the palmar and plantar sites were similar for the SSc group vs. control group, except for:
- Palmar skin over the 3rd MCPJ was thicker (p=0.001) in the SSc group
- Fibro-fat pad in the plantar surface of 3rd MTPJ was thinner in the SSc group (p=0.023)

- Greater tissue stiffness values in SSc patients vs. controls.
- Palmar skin relative stiffness over 3rd MCPJ was greater in SSc vs. control
- Fibro-fat pad relative stiffness over the 3rd MCP and heel was significantly greater in SSc group vs. controls.
- Tendon relative stiffness over the 3rd MTPJ was greater in SSc group vs. controls.

4 Discussion
This is the first study reporting soft tissue damage and biomechanical changes in people with SSc using compression-elastography.

Possible implications:
- Novel information about the changes in biomechanical properties of the palmar and plantar soft tissue stiffness occurring in patients with SSc
- The altered biomechanical properties in plantar soft tissues may result in reduced ability to dissipate pressure over the plantar area, resulting in increased discomfort or increased risk of development of foot ulcers in patients with SSc.

Further studies are needed to determine the relationship between soft tissue stiffness, pain and plantar pressures in people with SSc.

5 Conclusions
a) Measurements of soft tissue relative stiffness by compression-elastography add a new dimension to the clinical assessment of soft tissue in SSc.

b) Changes in thickness and stiffness of palmo-plantar soft tissues may lead to functional limitations of the hands and feet, as well as a decrease in shock attenuation properties and the inability to distribute foot-ground contact load affecting the foot during walking.