INTRODUCTION:
Numerous studies have been done to evaluate the impact of sustained compression-tension loading on spinal growth for early onset of scoliosis [1]. Despite all this research, only [2] investigated the effect of torque on segmented bodies. However, this study was an in-vitro investigation rather than in-vivo in the examination of the torque on growth.

The goals of this study were to: 1) design an in-vivo torque device for application of controlled torque and axial compressions to rat-tails, 2) determine the histological changes of the caudal vertebrae due to the torsional load.

METHODS:
A torque device (Figure 1) was developed so that controlled torsional and compressive forces may be applied to a rat tail. The torsional and compressive loads are controlled through the use of linear springs as in [1].

Six devices were constructed using a computer controlled Haas four axis milling machine. The devices were implanted in six 5-week-old male Sprague-Dawley rats. Three rats served as a sham group and did not receive torsional or axial compression. The remaining three rats received a torque of 1.024 N·m and a bending moment of 0.106 N·m. The devices were checked daily, the torque and forces recorded then readjusted so that a roughly constant torque and compressive force was applied to the tail.

Four rats (two with torque and two control rats) were sacrificed after two weeks of growth. The remaining two rats were sacrificed after 3.5 weeks of growth. Histomorphological analysis was performed on the rat tails.

RESULTS:
Figure 2 shows the relaxation rate of the torque. The relaxation rate is 2.712 N·m per day. However the curve reaches an asymptote at 17.5 days, at which point the relaxation rate appears to slow down.

Although there are no significant changes in x-rays between the sham and torque group over time (less than 4 weeks), histological study does present with apparent differences. The morphology of the growth plate is seen more curved in torque-induced rat, while more flat in the sham rat (Figure 3). This leads to a 29% reduction of the width of the physe as compared to sham at 3.5 weeks, and an 18% reduction of the width of the physe at 2 weeks.

Table 1. The average caudal vertebral body height, width, disc space and growth plate thickness in left, medial and right region (n=5, mean)

<table>
<thead>
<tr>
<th>Parameter (mm)</th>
<th>Left Torque</th>
<th>Left Sham</th>
<th>Mid Torque</th>
<th>Mid Sham</th>
<th>Right Torque</th>
<th>Right Sham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertebral height</td>
<td>6.46</td>
<td>5.60</td>
<td>6.79</td>
<td>5.71</td>
<td>6.39</td>
<td>5.51</td>
</tr>
<tr>
<td>Vertebral width</td>
<td>0.57</td>
<td>0.54</td>
<td>1.98</td>
<td>1.98</td>
<td>0.47</td>
<td>0.73</td>
</tr>
<tr>
<td>Disc space</td>
<td>1.11</td>
<td>0.67</td>
<td>0.47</td>
<td>0.55</td>
<td>1.15</td>
<td>0.74</td>
</tr>
<tr>
<td>Growth plate thickness</td>
<td>0.19</td>
<td>0.09</td>
<td>0.19</td>
<td>0.04</td>
<td>0.26</td>
<td>0.14</td>
</tr>
</tbody>
</table>

DISCUSSION:
The in-vivo torque device related study indicates that there is relaxation in the torque which needs to be considered in the examination of the effect of torque on growth. The relaxation leads to a 20% loss in the initial torque level. A reduced width and remarkably increased thickness in the growth plate and dramatically widened disc space as affected by the torque device has been found during the growth of the caudal vertebral bodies, which may lead to an abnormal alignment. This study has limited animal samples in a short-term follow up.

REFERENCES: