

A Biomechanical Study of Scaphoid Headless Screws

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ABSTRACT
Scaphoid fractures, are the most common fracture of the carpus [1]. Headless screws are favored for internal fixation in the treatment of displaced or unstable fractures. Compression plays the most important role in fracture stability, maintaining gap reduction and also accelerating the healing of cancellous bone [2]. This study compares the generated compression force and fastening torque and the effect of pre-drilling on them, during insertion of five frequently used headless compression screws. In this study solid rigid polyurethane foam was used as substitution to human cancellous bone to achieve more consistent statistical results. Pre-drilling did not have a significant effect on the average maximum generated compression, although it significantly increased the fastening torque. Mini-Acutrak 2 generated the maximum compression and showed the most reliability and sustainability of the generated compression and no risk of losing compression due to over-fastening was observed. Twinfix had the second highest generated compression, 31% more than Kompressor Mini. However, it showed a higher risk of losing compression.



EXPERIMENTAL SETUP

- Solid rigid polyurethane foam (Sawbones®, 0.16 g/cm³) was used instead of human cancellous bone
- 5 frequently used headless compression screws (5 screws from each type)
- Compression and fastening torque were recorded at each quarter of a turn
- Effect of pre-drilling on compression and fastening torque
- 50 pairs of Sawbones sample (10 samples for each screw type)

RESULTS

Mini-Acutrak 2 (Acumed®)

- Max. Compression of 45.4 N
- No significant effect of pre-drilling on compression force
- No over-fastening effect

Twinfix (Stryker®)

- Sudden increase of Compression force to 30.7 N
- No significant effect of pre-drilling on Max. compression force
- High risk of compression loss up to 42%

Kompressor Mini

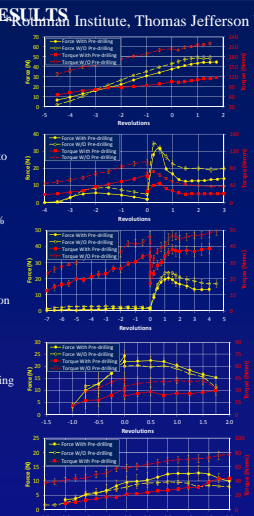
- A profile similar to Twinfix
- Max. compression of 20.8 N
- Torque can be misleading for the surgeon

HCS 3.0mm (Synthes®)

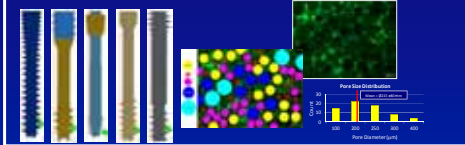
- Max. compression of 17.3 N
- No significant effect due to no pre-drilling on compression

Herbert-Whipple (Zimmer®)

- Max. compression of 13.4 N
- Self-cutting did not work well without pre-drilling



Effect of Porosity



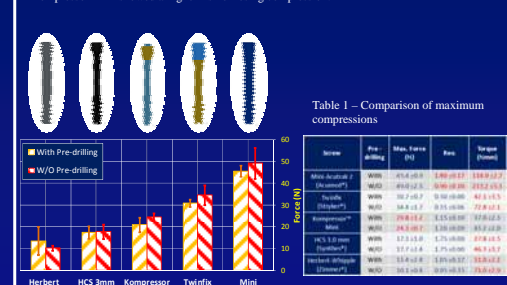
DISCUSSION

Pre-drilling Method:

- No pre-drilling did not have a significant effect on the average maximum achievable compression force.
- Without pre-drilling, fastening torque significantly increased in all the screws except Kompressor Mini.
- The self-drilling design of all screws worked perfectly except Herbert-Whipple.
- Herbert-Whipple needed an extra axial load of 20 N to advance in the foam without pre-drilling.

Compression Force and Effect of Over-Fastening:

- Mini-Acutrak 2 generated the maximum compression and showed the most reliability and sustainability of the generated compression.
- Twinfix had the second highest generated compression, 31% more than Kompressor Mini which might be the result of its larger thread size.
- Kompressor Mini showed a higher risk of losing compression.



ACKNOWLEDGEMENTS
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- [2] Hausmann JT, Mayr W, Unger E, Benesch T, Vecsei V, Gabler C "Interfragmentary compression forces of scaphoid screws in a sawbone cylinder model", Injury, 2007