SPINAL ROD GRIPPING CAPACITY: HOW DO 5.5/6.0 MM DUAL DIAMETER SCREWS COMPARE?

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SUMMARY:

Pedicle screws that accept 5.5 or 6.0mm rods have Axial and Torsional rod Gripping Capacity equal to, or better than, screws that only accept 5.5mm rods, regardless of rod material.

INTRODUCTION:

The security of fixation at the rod-screw junction is important in pedicle screw spinal instrumentation systems. The loss of correction and risk of non-union secondary to delayed rod-screw slippage is a known problem in spine surgery. Newer systems have screws that accept either a 5.5 or 6.0 mm rod. Theoretically these dual diameter screws may compromise rod gripping, particularly when the smaller diameter rod is used within a screw head capable of accepting a larger rod. The purpose of this study was to compare axial gripping capacity (screw slip along the rod, AGC) and torsional gripping capacity (slip around the rod, TGC) of a variety of spinal implant manufactures, evaluating systems that accept only 5.5 mm rods (single diameter, S-D) and those that accept both 5.5 and 6.0 mm rods (dual diameter, D-D) for cobalt chromium (CoCr) and titanium alloy (Ti) rods.

PURPOSE:

To evaluate pedicle screw slippage resistance (axial and torsional gripping capacities (AGC, TGC)) from five suppliers, comparing systems using 5.5mm rods (S-D) to systems accepting both 5.5 and 6.0mm rods (D-D) using both cobalt chromium (CoCr) and titanium alloy (Ti) rods.

METHODS:

D-D polyaxial pedicle screws from three suppliers (accepting 5.5mm, and 6.0mm, Ti and CoCr rods) and S-D screws from two suppliers (accepting 5.5mm Ti and CoCr rods, Table) were secured to rods with set screws per manufacturer instructions and tested using ASTM:F1798-08 on an MTS MiniBionix machine.

Table: Implant specifications from five different companies that were included in slip testing.

Company	A	B	C	D	E
System Type	S-D	S-D	D-D	D-D	D-D
Rod Diameter (mm)	5.5	5.5	5.5 & 6.0	5.5 & 6.0	5.5 & 6.0
Screw Diameter (mm)	5.0	5.5	5.5	6.5	5.0
Screw Length (mm)	30	40	45	25	30-45
Screw Shaft Material	Ti	Ti	Ti	Ti	Ti
Set Screw Material	Ti	Ti	Ti	Ti	Ti
Tightening Torque (Nm)	9	10.2	10.2	10.2	13

Axial loading of each construct (n=6 for each rod material and diameter) was in-line with the rod at 15mm/min (Figure 1A). A 10 mm cavity was drilled into the base plate to allow the rod to travel within the screw assembly. AGC was the maximum load within the initial 1.5mm of displacement.

Torsional load was applied to the rod at 25º/min with the screw secured within a slot in a block attached to the load cell (Figure 1B). TGC was the maximum torque within the initial 10º of rotation.

Figure 1A

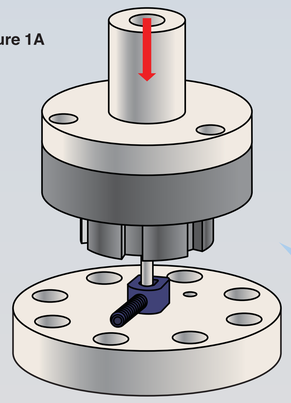
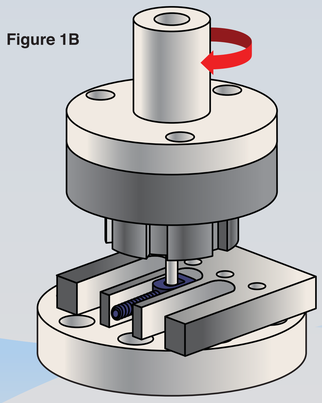


Figure 1B



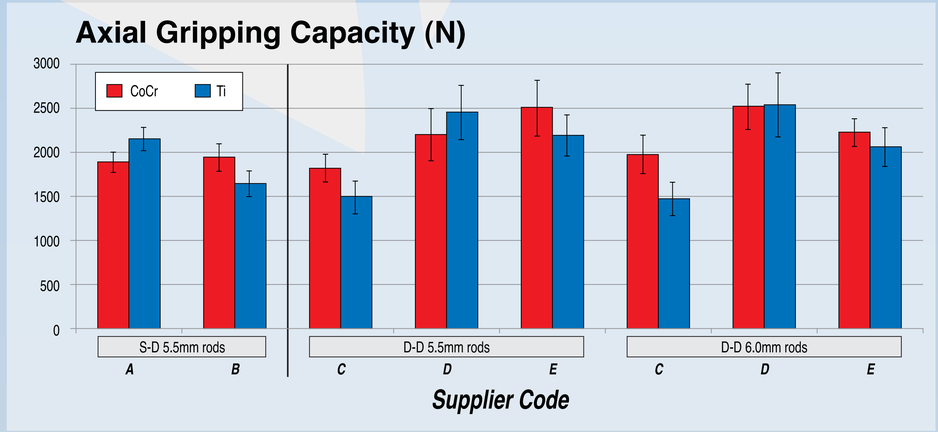
AGC and TGC were compared between D-D and S-D systems, suppliers, rod diameters and materials using univariate analysis (ANOVA or Mann Whitney U test), followed by classification and regression tree (CART) analysis. A sub-analysis was performed of 5.5mm rods only comparing AGC and TGC between D-D and S-D systems, α=0.05.

RESULTS:

Mean AGC and TGC for D-D were 111% and 122% that of S-D, respectively. 5.5mm rods within D-D screws were no weaker than 5.5 mm rods in S-D screws for AGC (dual > single, p=0.043) and TGC (p=0.066).

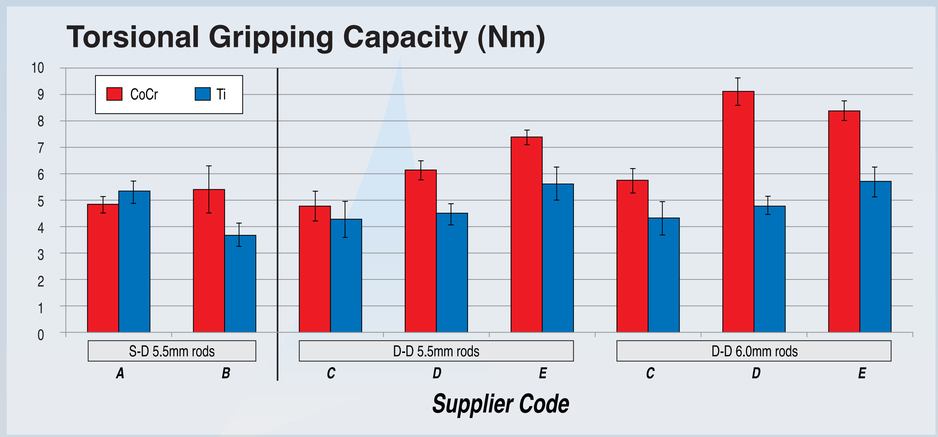
AGC was different between suppliers (p<0.001)(Figure 2A). D-D had greater AGC than S-D (p=0.01). No rod diameter (p=0.227) or material (p=0.131) effect emerged. CART identified Supplier as the most significant predictor for greater AGC.

Figure 2A



TGC was different between suppliers (p<0.001)(Figure 2B). D-D had greater TGC than S-D (p=0.008). Rod diameter (6.0>5.5mm, p=0.002) and material (CoCr>Ti, p<0.001) were significant predictors of higher TGC. CART determined Supplier and CoCr material as significant predictors of increased TGC.

Figure 2B



CONCLUSION:

Using 5.5mm rods, D-D had a similar axial and torsional gripping capacity as S-D. 6.0mm CoCr rods in D-D screws had the greatest slippage resistance. These data suggest that D-D systems should be at least as resistant to screw slippage as S-D systems. Interestingly, gripping capacity varied ~30-70% when considering rod material (CoCr vs. Ti) and supplier (example: TGC of supplier B's 5.5mm Ti rod was less than one half that of supplier D's 6.0mm CoCr rod).

SIGNIFICANCE:

Despite variability amongst suppliers, comparable rod gripping is demonstrated between newer D-D and traditional S-D pedicle screw systems, arguing against the theoretical concern for delayed loosening or loss of correction with D-D systems.

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