

RESEARCH ARTICLE

Exploring the mechanical strength, antimicrobial performance, and bioactivity of 3D-printed silicon nitride-PEEK composites in cervical spinal cages

Supplementary File

Table S1. Printing parameters used in this study to 3D-print cervical spinal cages

	PEEK	Si <sub>3</sub> N <sub>4</sub> -PEEK
Nozzle diameter (mm)	0.4	
Extrusion multiplier	1.01	0.96-1.2
Extruder width (mm)	0.45	
Layer height (mm)	0.18	
Bed temperature (°C)	250	
Nozzle temperature (°C)	420	425
Chamber temperature (°C)	200	
Z-axis movement speed (mm/min)	500	
Interior fill percentage (%)	100	

Table S2. Representative weight measurements of cages printed for study groups

Material	Design	Weight (g)
PEEK	Solid	1.14
PEEK	Solid	1.15
PEEK	Solid	1.17
PEEK	Porous	0.96
PEEK	Porous	0.92
PEEK	Porous	0.95
PEEK	Porous window	0.9
PEEK	Porous window	0.91
PEEK	Porous window	0.92
Si <sub>3</sub> N <sub>4</sub> -PEEK	Solid	1.38
Si <sub>3</sub> N <sub>4</sub> -PEEK	Solid	1.36
Si <sub>3</sub> N <sub>4</sub> -PEEK	Solid	1.42
Si <sub>3</sub> N <sub>4</sub> -PEEK	Solid	1.44
Si <sub>3</sub> N <sub>4</sub> -PEEK	Solid	1.27
Si <sub>3</sub> N <sub>4</sub> -PEEK	Solid	1.36
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous	1.29
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous	1.3
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous	1.31

(Continued...)

Table S2. Continued...

Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous	1.12
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous	1.3
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous	1.14
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous window	1.08
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous window	1.13
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous window	1.13
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous window	1.13
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous window	1.03
Si <sub>3</sub> N <sub>4</sub> -PEEK	Porous window	1.12

Table S3. Cage testing conditions for different tests conducted in this study

Design and material/ mechanical test	Solid		Porous		Porous window	
	PEEK	Si <sub>3</sub> N <sub>4</sub> -PEEK	PEEK	Si <sub>3</sub> N <sub>4</sub> -PEEK	PEEK	Si <sub>3</sub> N <sub>4</sub> -PEEK
Compression	5th, 50th, 75th*		5th, 50th, 75th*		5th, 50th*	
Compression shear	5th, 50th, 75th*		5th, 50th, 75th*		5th, 50th*	5th, 50th, 75th*
Torsion	until failure					

\*Percentiles were based on Peck et al. study.<sup>1</sup>

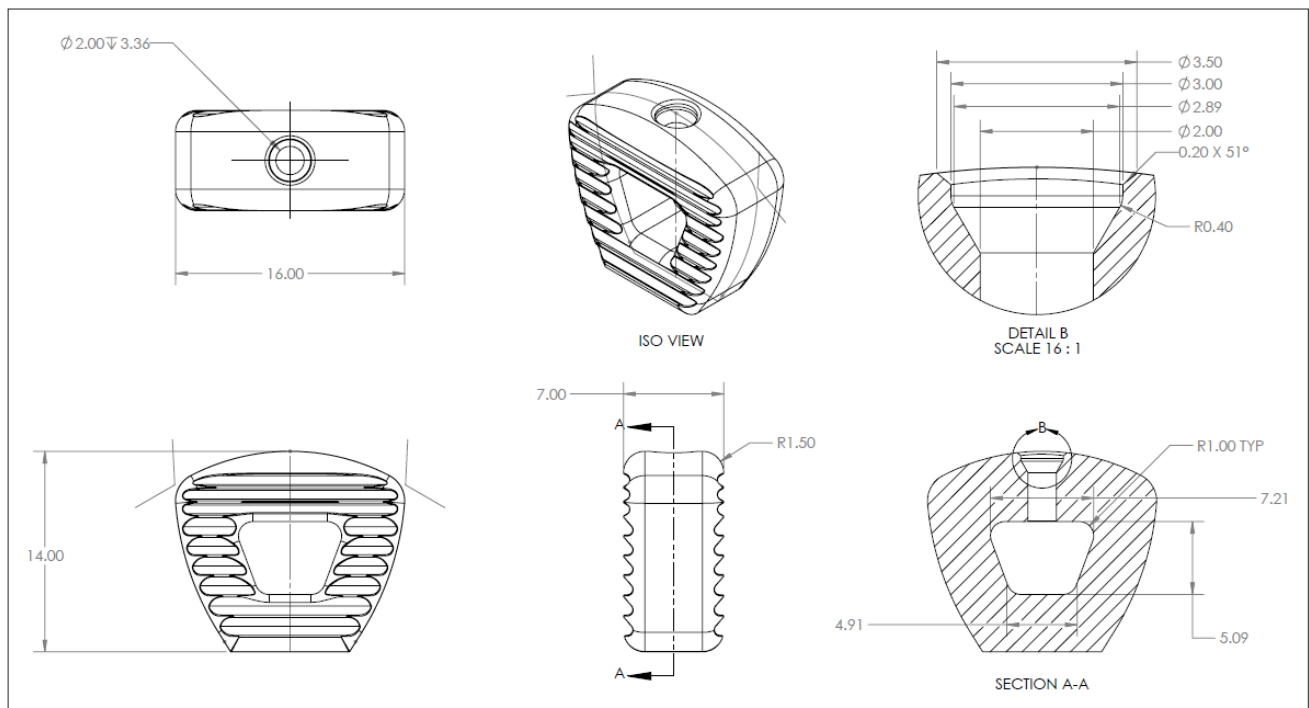
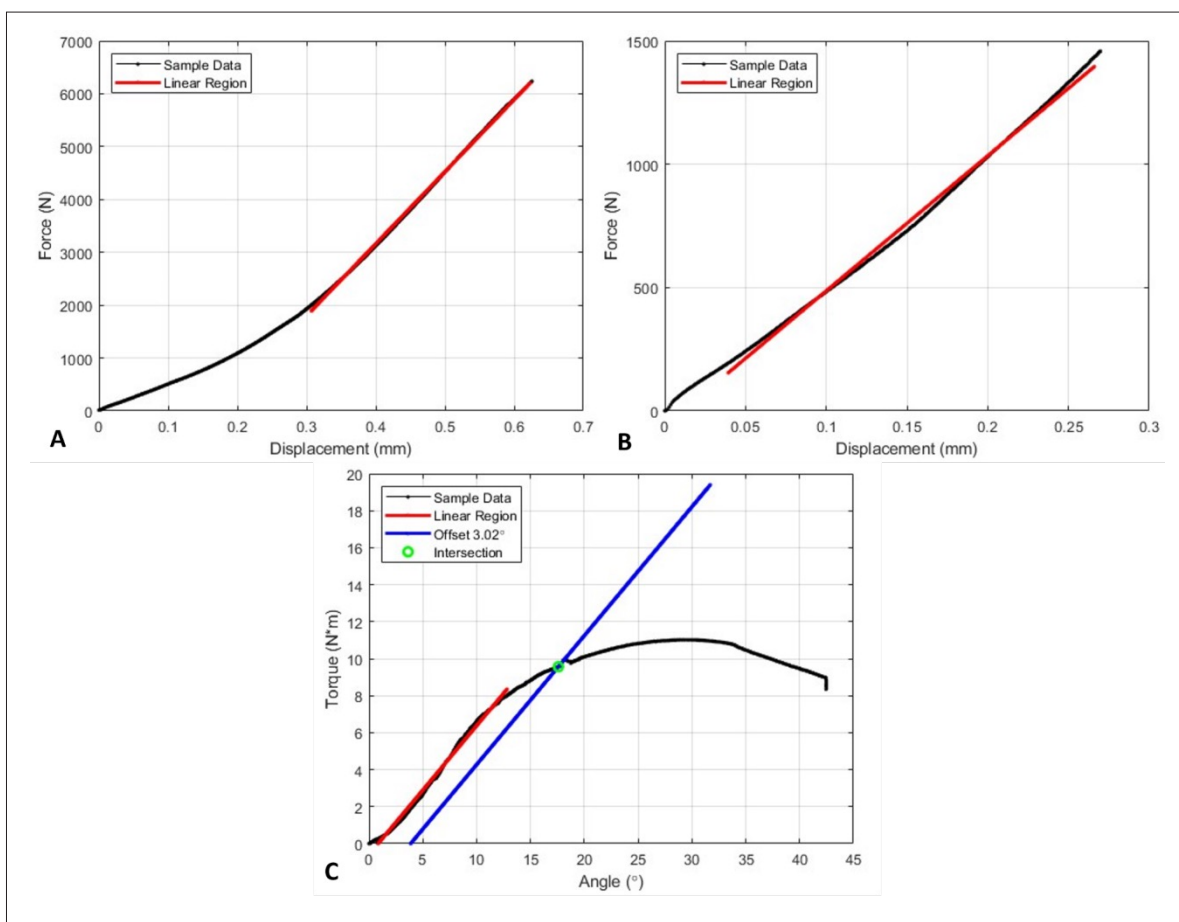
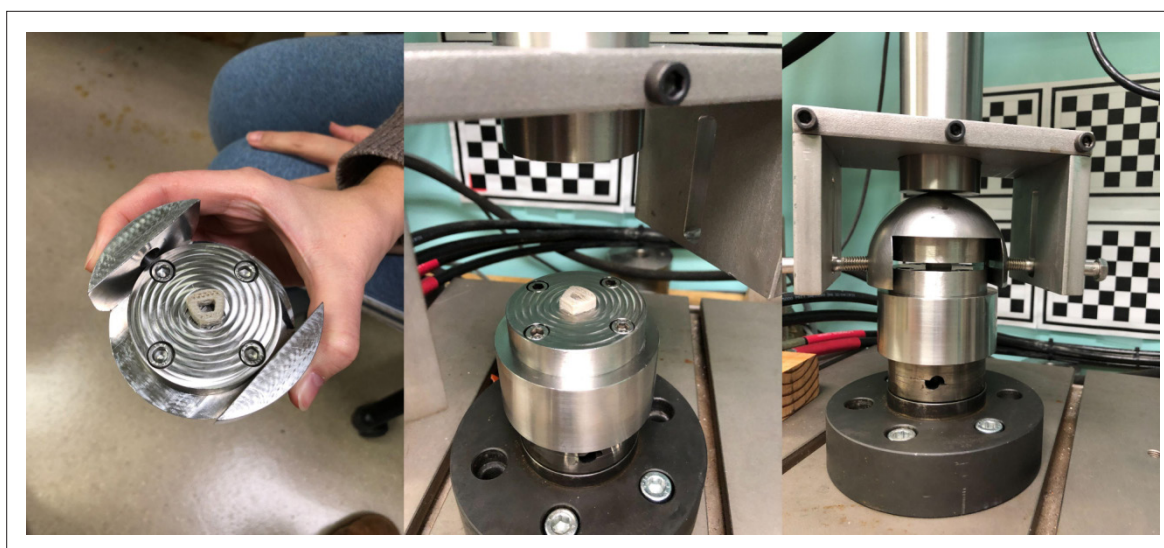


Figure S1. Dimensions of the solid cage design used in this study.



**Figure S2.** Representative force–displacement for compression (a) and shear (b) tests and torque–degree (c) curves of the samples (linear region was used to calculate stiffness, and intersection was used to determine the yield torque).



**Figure S3.** Torsion and compression (without the metal bracket) test set up according to ASTM F2077.<sup>2</sup>

## References

1. Peck JH, Sing DC, Nagaraja S, Peck DG, Lotz JC, Dmitriev AE. Mechanical performance of cervical intervertebral body fusion devices: a systematic analysis of data submitted to the Food and Drug Administration. *J Biomech.* 2017;54:26-32. doi: 10.1016/j.jbiomech.2017.01.032
2. ASTM International. *Standard Test Methods for Intervertebral Body Fusion Devices*. PA, USA: ASTM; 2022. doi: 10.1520/F2077-22