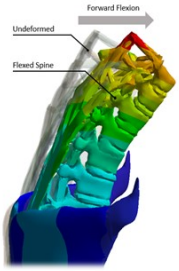
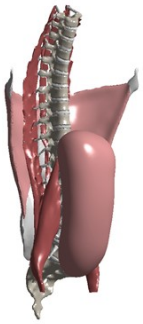
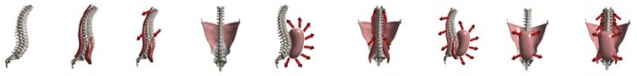
INTRODUCTION The spine possesses numerous degrees of freedom, thus making it an unstable structure. However, the actions of muscles inclusive of their intramuscular pressure (IMP), intra-abdominal pressure (IAP), and passive response of the thoracolumbar fascia (TLF) are believed to stabilize the spine via coordinative engagement. OBJECTIVE The primary objective of this research was to exploit a validated and representative finite elements (FE) model of the spine to evaluate the relative contribution of spinal muscles, IMP, IAP, and TLF to maintain equilibrium spinal stability. METHODS A fully validated FE spine model has been leveraged to execute the present study. The developed model was based on MRI-scans, spanning a total of 273 soft tissues. It includes accurate continuum models of all thoracic and lumbar vertebrae, intervertebral discs (IVDs), major spinal muscles enclosing their IMP (modelled as fluid-structure continuum), TLF, and a fluid-filled model of the IAP. Equilibrium spinal stability was evaluated based on the ability of select tissues to maintain spine's initial position following an applied external perturbation. To fulfill this, a previously validated spinal perturbation of 350N flexion was applied at T1. Case-scenarios of activating each tissue on its own, as well as in combinations, were investigated. For each case, in efforts of quantifying equilibrium stability, a percentage stability contribution (%) was evaluated using planar vertebral displacements relative to the baseline (case 0). Muscles activations were based on validated EMG muscle forces while IAP was introduced as an increasing pressure, with a maximum of 67 mmHg, in the abdominal cavity. RESULTS Applying the 350N perturbation on the model inclusive of only the vertebrae and IVDs was considered the most unstable position. Thereafter, activating the IAP, muscles, and TLF contributed individually to 24%, 53.8%, and 77% equilibrium stabilities, respectively (Fig 1). In addition, tissue combinations resulted between 60% and 93% stability, with the 93% being the case of coordinative activation of all tissues to their maximum physiological capability (Fig 1). Lastly, results showed a 46% drop in IMP (Fig 1) in response to the engagement of the TLF, suggesting its role in stabilizing and preventing excessive muscle pressurization. DISCUSSION The research put forth concluded that spinal muscles, IMP, TLF, and IAP are major spinal stabilizers, with a 93% combined equilibrium stability contribution. The TLF showed to be capable of storing excessive loads as a potential relief mechanism to protect the spine. This was supported by the observed TLF resultant forces summing up to around 244N acting opposite to applied perturbation. In conclusion, the results of this study may assist to better understand the notion of spinal equilibrium stability as literature is still pressing for more representative spine models capable of executing stability assessment scenarios.



Cases	VBs Displacements (cm)					IVDs Pressure (MPa)					IMP (mmHg)				Stability Contribution
	L_1	L_2	L_3	L_4	L_5	IVD_1	IVD_2	IVD_3	IVD_4	IVD_5	P	L	M	I	
0	6.1	4.9	3.4	2	1	0.497	0.502	0.514	0.523	0.538	-	-	-	-	-
1	5.8	4.5	3.1	1.8	0.8	0.49	0.496	0.506	0.513	0.528	-	-	-	-	8%
2	2.9	2.3	1.6	0.9	0.4	0.28	0.29	0.304	0.318	0.337	258	372	94	12	53%
3	1.4	1.13	0.88	0.58	0.3	0.238	0.244	0.258	0.272	0.29	-	-	-	-	75%
4	4.6	3.7	2.5	1.5	0.7	0.321	0.348	0.353	0.376	0.418	-	-	-	-	25%
5	0.6	0.48	0.34	0.22	0.11	0.145	0.158	0.17	0.192	0.223	37	146	32	7	89%
6	1.9	1.55	1.1	0.65	0.25	0.2	0.22	0.258	0.268	0.279	132	287	31	10	69%
7	1.24	1.03	0.76	0.5	0.27	0.206	0.22	0.237	0.246	0.26	-	-	-	-	78%
8	0.47	0.37	0.26	0.16	0.08	0.084	0.103	0.12	0.137	0.158	21	128	26	6	93%

L_1, L_2, L_3, L_4, and L_5 represent the results for the first, second, third, fourth, and fifth lumbar vertebral bodies respectively. IVD_1, IVD_2, IVD_3, IVD_4, and IVD_5 represent the first, second, third, fourth, and fifth lumbar intervertebral disc respectively. P, L, M, and I represent the psoas major, longissimus, multifidus, and intertransversarius muscles respectively.





Case 0 Case 1 Case 2 Case 3 Case 4 Case 5 Case 6 Case 7 Case 8