



**Titre:** Biomechanical effects of lumbar fusion surgery on adjacent segments using musculoskeletal models of the intact, degenerated and fused spine  
Title:

**Auteurs:** Mahdi Ebrahimkhani, Navid Arjmand, & Aboufazi Shirazi-Adl  
Authors:

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**Supplementary Table S1** - Prescribed kinematics (thorax, pelvis and lumbar rotations in degrees) onto the undeformed FE model to construct the upright standing posture under gravity based on posture optimization outputs (positive values indicate forward flexion relative to the undeformed state). Surgically induced alterations in L4-L5 lordosis, relative to preoperative supine lordosis, for different fused states are reported. In undeformed (supine) configuration, intervertebral angles are 3.0°, 3.4°, 3.4°, 8.5° and 21.2° at L1-L2 to L5-S1, respectively, all based on CT images of a 65 years-old male cadaver<sup>26</sup>. Some select postures are depicted in Supplementary Figure S1.

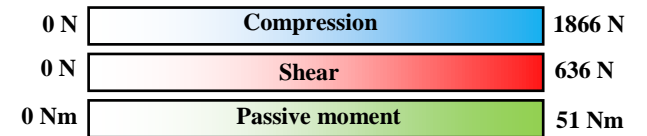
	<b>Upright standing</b>				
	<b>Intact</b>	<b>Degenerated</b>	<b>Fused normal-lordosis</b>	<b>Fused hypo-lordosis</b>	<b>Fused hyper-lordosis</b>
<b>T12</b>	4.9	5.6	4.9	5.5	2.5
<b>L1</b>	1.0	1.5	1.0	1.7	-1.5
<b>L2</b>	-2.9	-2.6	-2.9	-2.0	-5.5
<b>L3</b>	-5.8	-5.9	-5.8	-4.5	-8.6
<b>L4</b>	-7.6	-7.9	-8.2	-8.2	-8.1
<b>L5</b>	-8.8	-8.5	-10.0	-12.0	-6.9
<b>S1</b>	-10.0	-10.2	-10.0	-12.0	-6.9
<b>Alteration in L4-L5 Lordosis after fusion</b>	-	-	<b>-1.1</b>	<b>-6.1</b>	<b>4.9</b>

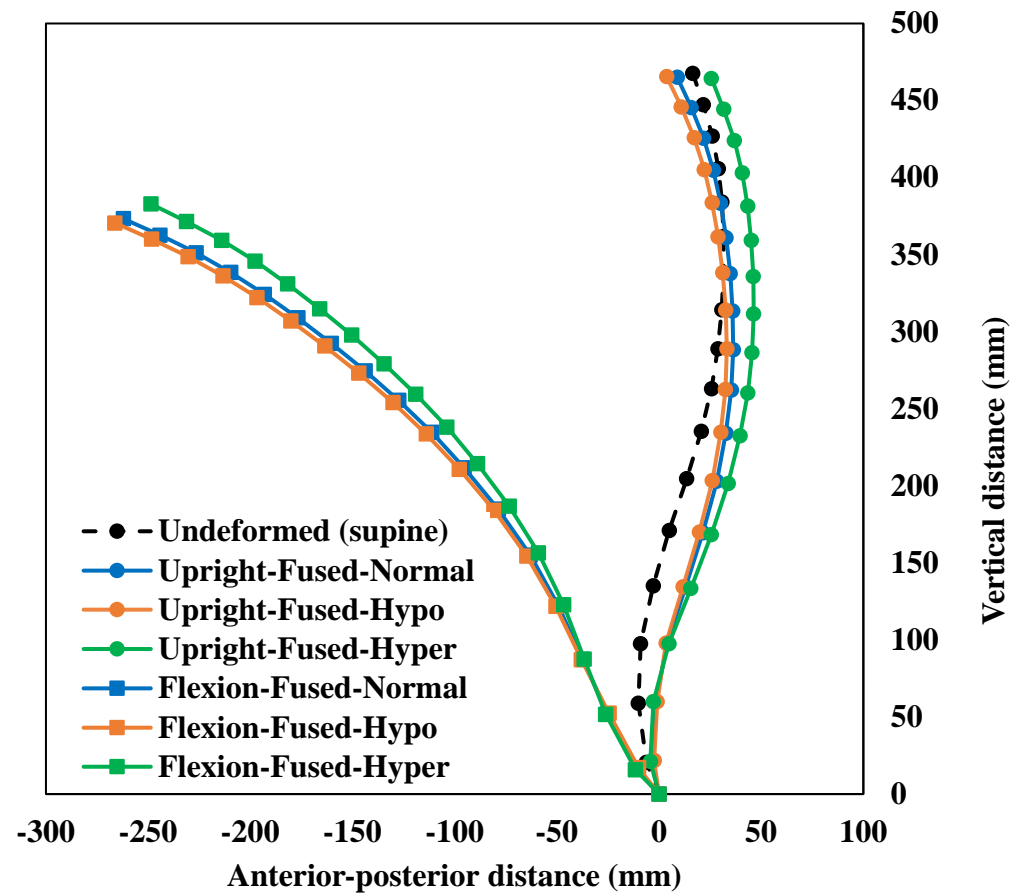
**Supplementary Table S2** - Prescribed kinematics (thorax, pelvis and lumbar rotations in degrees) into the FE model in upright standing to arrive to the flexed postures for intact, degenerated and fused conditions in two scenarios (fixed and altered lumbopelvic rhythm, LPR). Segmental contribution in total lumbar flexion for intact, degenerated and fused models are reported in Figure 4. Some select postures are depicted in Supplementary Figure S1.

	Flexion 20°				Flexion 40°				Flexion 60°				Flexion 80°			
	Intact	Degenerated	Fused LPR-fixed	Fused LPR-altered	Intact	Degenerated	Fused LPR-fixed	Fused LPR-altered	Intact	Degenerated	Fused LPR-fixed	Fused LPR-altered	Intact	Degenerated	Fused LPR-fixed	Fused LPR-altered
T12	20.0	20.0	20.0	20.0	40.0	40.0	40.0	40.0	60.0	60.0	60.0	60.0	80.0	80.0	80.0	80.0
L1	18.5	17.6	18.5	18.8	36.8	34.9	36.8	37.5	55.0	51.9	55.0	56.1	74.1	71.0	74.0	75.3
L2	16.5	15.4	16.4	17.2	32.6	30.2	32.4	34.1	48.5	44.7	48.2	50.8	66.3	62.4	66.0	69.0
L3	14.7	13.5	14.1	15.3	28.7	26.1	27.4	30.1	42.4	38.2	40.4	44.6	59.1	54.8	56.6	61.6
L4	12.3	11.3	10.6	12.6	23.7	21.5	20.1	24.4	34.6	30.9	29.1	35.7	49.8	46.0	43.1	51.0
L5	9.5	10.3			17.7	19.5			25.3	27.7			38.6	42.2		
S1	6.9	7.9	6.9	9.7	12.1	14.3	12.1	18.1	16.7	19.6	16.7	26.0	28.3	32.5	28.3	39.4

**Supplementary Table S3** - Compression force (N), shear force (N) and passive moment (Nm) at upper (L3-L4) and lower (L5-S1) adjacent disc mid-planes for the preoperative (intact and degenerated) as well as postoperative fused states in upright and flexed postures. Please see the legends below the table where color highlights are defined.

		Intact				Degenerated				Fused																												
		Flexion				Flexion				Upright			Flexion - fixed lumbopelvic rhythm												Flexion - altered lumbopelvic rhythm													
										Normal lordosis	Hypo lordosis	Hyper lordosis	Normal-lordosis				Hypo-lordosis				Hyper-lordosis				Normal-lordosis			Hypo-lordosis			Hyper-lordosis							
		20	40	60	80	20	40	60	80				20	40	60	80	20	40	60	80	20	40	60	80	20	40	60	80	20	40	60	80						
L3-L4	Compression	401	855	1244	1340	1353	395	911	1385	1620	1642	406	458	332	816	1043	915	855	891	1182	1066	1006	730	955	847	818	858	1208	1231	1202	923	1309	1387	1358	774	1123	1156	1156
	Shear	34	51	124	195	270	36	32	68	102	164	33	21	52	46	109	167	228	59	124	181	244	22	82	146	208	54	125	188	246	69	144	205	265	30	96	159	219
	Moment	2	7	13	25	32	3	7	13	24	31	2	1	2	9	22	41	51	7	17	36	46	9	22	41	51	8	16	30	38	6	12	25	33	8	16	30	39
L5-S1	Compression	434	1001	1430	1598	1724	426	1031	1510	1757	1866	440	489	354	939	1248	1244	1297	990	1318	1312	1371	845	1159	1174	1255	1009	1443	1585	1656	1058	1501	1657	1734	917	1355	1509	1607
	Shear	132	335	453	451	465	129	354	481	474	485	134	135	124	337	442	440	471	330	435	433	462	334	448	450	494	368	530	570	605	359	515	559	592	367	542	589	636
	Moment	2	9	17	28	34	3	9	17	28	34	2	1	2	11	24	42	51	10	23	40	49	11	25	42	51	9	19	32	39	8	17	30	37	9	19	32	39





**Supplementary Figure S1:** Spinal posture (vertebral positions) in undeformed, fused upright, and fused 40° flexion tasks (altered lumbopelvic rhythm) under different normal, hypo-, and hyper-lordosis conditions.