



Fig. E-1

The superior view of a right torso with the upper arm in the abduction (0°), scapular plane abduction (40°), and flexion (90°) planes.

TABLE E-1 Means for Sternoclavicular Retraction Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-23.4	-24.3	-27.4	-30.4	-19.0	-19.0
20	-23.1	-25.2	-28.8	-31.1	-19.8	-19.6
25	-23.9	-25.7	-29.8	-32.5	-20.1	-20.3
30	-24.6	-26.3	-31.3	-33.7	-20.4	-20.7
35	-25.4	-26.9	-32.5	-34.6	-20.8	-21.1
40	-26.1	-27.5	-33.5	-35.3	-21.3	-21.5
45	-26.9	-28.2	-34.7	-36.0	-21.6	-22.0
50	-27.6	-28.8	-35.7	-36.7	-21.9	-22.4
55	-28.4	-29.4	-36.5	-37.3	-22.3	-22.9
60	-29.0	-30.0	-37.3	-37.8	-22.7	-23.5
65	-29.6	-30.6	-37.9	-38.4	-23.1	-24.0
70	-30.2	-31.2	-38.5	-39.0	-23.4	-24.5
75	-30.6	-31.7	-39.1	-39.5	-23.8	-25.2
80	-31.1	-32.2	-39.6	-40.0	-24.1	-25.9
85	-31.6	-32.6	-40.1	-40.6	-24.5	-26.5
90	-32.0	-33.0	-40.6	-41.1	-24.8	-27.3
95	-32.4	-33.4	-41.5	-42.0	-25.3	-28.1
100	-32.8	-33.8	-42.0	-42.5	-25.9	-28.8
105	-33.2	-34.2	-42.6	-43.0	-26.6	-29.4
110	-33.8	-34.7	-43.0	-43.6	-27.6	-30.1
115	-34.4	-35.4	-43.4	-44.2	-29.6	-31.8
120	-36.4	-37.4	-44.0	-44.8	-31.7	-33.7
Peak	-38.8		-45.2		-34.7	

Negative values indicate a retracted position.

TABLE E-2 Means for Sternoclavicular Elevation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-10.6	-11.7	-13.0	-14.5	-10.8	-10.4
20	-10.7	-11.4	-13.1	-14.5	-9.8	-10.3
25	-11.0	-11.4	-13.6	-14.4	-9.9	-10.2
30	-11.5	-11.5	-14.3	-14.3	-10.1	-10.2
35	-12.2	-11.6	-14.7	-14.2	-10.3	-10.4
40	-12.7	-11.8	-15.2	-14.3	-10.5	-10.6
45	-13.2	-11.9	-15.7	-14.6	-10.8	-10.9
50	-13.6	-12.1	-16.1	-14.9	-11.2	-11.3
55	-14.0	-12.2	-16.5	-15.1	-11.6	-11.6
60	-14.4	-12.3	-16.8	-15.3	-12.0	-11.8
65	-14.7	-12.4	-17.1	-15.7	-12.2	-12.1
70	-15.0	-12.6	-17.3	-16.0	-12.5	-12.4
75	-15.2	-12.8	-17.5	-16.3	-12.7	-12.7
80	-15.4	-12.9	-17.7	-16.5	-13.0	-13.0
85	-15.5	-13.1	-17.9	-16.8	-13.2	-13.4
90	-15.5	-13.4	-18.1	-17.2	-13.5	-13.8
95	-15.7	-13.8	-19.1	-18.1	-13.7	-14.0
100	-15.8	-14.3	-19.1	-18.2	-14.0	-14.3
105	-15.8	-14.7	-19.2	-18.5	-14.1	-14.6
110	-15.8	-15.2	-19.3	-18.8	-14.2	-14.9
115	-15.8	-15.5	-19.4	-19.2	-15.1	-15.6
120	-16.9	-17.1	-19.5	-19.3	-14.5	-14.9
Peak	-17.6		-19.5		-15.4	

Negative values indicate an elevated position.

TABLE E-3 Means for Sternoclavicular Posterior Rotation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	0.7	2.9	1.3	3.4	-1.3	0.0
20	1.0	3.9	1.3	3.8	-0.9	0.4
25	1.4	4.2	1.9	4.8	-0.6	0.6
30	1.9	4.4	3.1	6.2	0.0	1.1
35	2.6	4.7	4.0	7.2	0.9	1.7
40	3.6	5.2	4.9	8.1	1.9	2.4
45	4.7	5.9	5.9	8.8	2.8	3.4
50	5.8	6.6	6.9	9.6	4.0	4.3
55	7.0	7.4	7.7	10.4	5.3	5.4
60	8.2	8.6	8.6	11.2	6.6	6.6
65	9.4	9.7	9.6	12.3	7.8	7.8
70	10.5	10.9	10.7	13.4	9.0	9.2
75	11.6	12.3	11.8	14.4	10.2	10.6
80	12.8	13.5	13.0	15.5	11.5	12.2
85	14.0	14.9	14.4	16.8	12.8	13.7
90	15.2	16.2	15.8	18.2	14.1	15.3
95	16.5	17.6	16.6	19.2	15.5	16.9
100	17.9	19.0	18.2	20.5	17.1	18.4
105	19.5	20.4	19.9	21.8	19.0	20.0
110	21.2	21.8	21.5	23.1	21.1	21.7
115	22.9	23.6	23.1	24.6	22.8	23.4
120	24.3	24.8	24.8	26.1	25.0	25.4
Peak	32.3		30.9		30.1	

Negative values indicate an anteriorly rotated position.

TABLE E-4 Means for Acromioclavicular Internal Rotation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	57.4	58.2	55.6	56.9	58.5	59.8
20	58.1	59.4	56.5	57.9	59.8	61.3
25	58.8	60.0	57.4	58.9	60.4	62.4
30	59.2	60.6	58.2	59.6	61.0	63.1
35	59.6	61.0	58.9	60.2	61.6	63.7
40	60.0	61.6	59.3	60.7	62.1	64.2
45	60.3	62.1	59.8	61.0	62.6	64.7
50	60.7	62.5	60.2	61.3	62.9	65.1
55	61.0	62.9	60.4	61.6	63.3	65.5
60	61.4	63.4	60.6	61.8	63.7	65.9
65	61.6	63.7	60.8	62.1	64.0	66.1
70	61.9	64.0	60.9	62.3	64.3	66.3
75	62.1	64.3	61.1	62.4	64.6	66.6
80	62.4	64.5	61.3	62.6	64.9	66.7
85	62.6	64.6	61.4	62.8	65.2	66.8
90	62.9	64.6	61.7	62.8	65.4	67.0
95	63.1	64.7	61.2	62.3	65.7	67.1
100	63.3	64.8	61.4	62.4	65.9	67.1
105	63.6	64.8	61.7	62.4	66.2	67.1
110	63.9	64.9	61.9	62.4	66.4	67.0
115	64.1	64.9	62.1	62.4	65.9	66.4
120	63.5	64.1	62.2	62.5	66.2	66.5
Peak	64.3		63.4		68.5	

TABLE E-5 Means for Acromioclavicular Upward Rotation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-4.4	-5.8	-3.3	-5.0	-7.7	-6.9
20	-5.8	-6.3	-4.4	-6.6	-8.9	-7.6
25	-7.2	-6.9	-5.3	-7.4	-9.8	-8.5
30	-8.5	-7.7	-6.5	-7.9	-10.7	-9.3
35	-9.6	-8.5	-7.4	-8.3	-11.4	-10.1
40	-10.4	-9.2	-8.3	-8.7	-12.1	-11.0
45	-11.1	-9.9	-9.3	-9.2	-12.6	-11.7
50	-11.7	-10.4	-10.1	-9.8	-13.2	-12.4
55	-12.3	-11.1	-11.1	-10.4	-13.6	-13.0
60	-12.7	-11.6	-12.0	-11.0	-14.0	-13.4
65	-13.2	-12.0	-12.8	-11.7	-14.4	-13.8
70	-13.7	-12.5	-13.4	-12.3	-14.6	-14.2
75	-14.0	-12.9	-14.0	-12.9	-14.9	-14.5
80	-14.4	-13.2	-14.5	-13.6	-15.1	-14.8
85	-14.7	-13.6	-15.0	-14.1	-15.2	-15.2
90	-14.9	-13.9	-15.4	-14.4	-15.4	-15.3
95	-15.1	-14.3	-16.3	-15.4	-15.5	-15.4
100	-15.2	-14.6	-16.6	-15.8	-15.5	-15.6
105	-15.3	-14.9	-16.9	-16.1	-15.2	-15.6
110	-15.2	-15.3	-17.1	-16.5	-14.9	-15.5
115	-15.1	-15.4	-17.2	-16.7	-15.0	-15.6
120	-15.5	-16.0	-17.1	-16.6	-15.4	-16.1
Peak	-15.8		-16.8		-15.4	

Negative values indicate an upwardly rotated position.

TABLE E-6 Means for Acromioclavicular Posterior Tilting Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-4.7	-3.9	-3.9	-2.0	-2.3	-2.9
20	-4.2	-3.4	-1.6	0.2	-2.9	-2.2
25	-3.0	-2.6	-0.7	1.4	-2.1	-1.1
30	-2.0	-1.7	0.7	2.0	-1.3	-0.4
35	-0.9	-0.8	1.6	2.5	-0.5	0.6
40	0.0	0.1	2.5	3.1	0.3	1.5
45	0.8	0.8	3.4	3.8	1.1	2.2
50	1.6	1.5	4.3	4.5	1.8	3.0
55	2.4	2.1	5.3	5.1	2.7	3.7
60	3.1	2.7	6.1	5.9	3.4	4.4
65	3.7	3.3	6.7	6.6	4.1	5.0
70	4.4	4.0	7.4	7.3	4.7	5.7
75	4.8	4.5	8.0	8.0	5.3	6.3
80	5.5	5.0	8.6	8.8	5.9	7.0
85	5.9	5.5	9.2	9.4	6.5	7.8
90	6.4	6.0	9.7	10.1	7.2	8.4
95	6.8	6.7	12.0	12.5	7.8	9.1
100	7.2	7.5	12.5	13.1	8.4	9.7
105	7.7	8.2	13.1	13.7	8.9	10.3
110	8.1	9.1	13.7	14.4	9.4	10.8
115	8.5	9.9	14.2	15.1	11.4	12.7
120	10.6	12.4	14.6	15.5	11.8	13.1
Peak	13.8		15.3		16.2	

Negative numbers indicate an anteriorly tilted position.

TABLE E-7 Means for Scapulothoracic Internal Rotation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	37.0	37.1	31.3	30.4	42.8	43.6
20	38.1	37.5	31.0	30.8	43.2	44.5
25	38.3	37.6	31.3	30.5	43.8	45.1
30	38.5	37.8	31.2	30.3	44.3	45.5
35	38.6	37.9	31.2	30.1	44.8	46.0
40	38.7	38.0	31.0	30.1	45.2	46.4
45	38.7	38.1	30.9	30.0	45.6	46.8
50	38.7	38.2	30.8	30.0	46.1	47.1
55	38.7	38.2	30.6	30.0	46.5	47.4
60	38.8	38.3	30.5	30.0	46.7	47.5
65	38.8	38.3	30.5	30.0	47.0	47.6
70	38.9	38.3	30.5	30.1	47.2	47.6
75	38.9	38.3	30.6	30.1	47.4	47.6
80	39.0	38.3	30.6	30.1	47.5	47.4
85	39.0	38.1	30.6	30.1	47.7	47.2
90	39.0	38.1	30.8	30.2	47.8	47.0
95	39.1	38.1	30.5	29.7	47.9	46.7
100	39.1	38.2	30.5	29.7	47.7	46.3
105	39.1	38.3	30.6	29.7	47.4	46.0
110	38.9	38.4	30.8	29.6	46.8	45.4
115	38.6	38.2	30.8	29.6	45.2	43.9
120	37.2	36.9	30.6	29.4	43.5	42.1
Peak	35.8		30.3		39.7	

TABLE E-8 Means for Scapulothoracic Upward Rotation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-10.3	-13.6	-10.9	-14.5	-11.7	-11.9
20	-11.9	-14.6	-12.0	-16.5	-12.6	-12.7
25	-13.6	-15.4	-13.5	-17.7	-13.8	-13.5
30	-15.5	-16.3	-15.6	-19.3	-15.1	-14.7
35	-17.3	-17.4	-17.5	-20.5	-16.6	-16.0
40	-19.1	-18.6	-19.2	-21.7	-18.1	-17.5
45	-20.9	-19.9	-21.1	-23.1	-19.6	-19.0
50	-22.7	-21.2	-22.9	-24.5	-21.3	-20.7
55	-24.3	-22.5	-24.7	-25.9	-22.9	-22.2
60	-26.0	-24.0	-26.5	-27.3	-24.4	-23.7
65	-27.5	-25.6	-28.2	-29.1	-25.9	-25.4
70	-29.0	-27.2	-29.9	-30.7	-27.3	-27.1
75	-30.5	-28.8	-31.5	-32.3	-28.7	-28.9
80	-31.8	-30.3	-33.1	-34.0	-30.1	-30.7
85	-33.1	-32.0	-34.8	-35.7	-31.4	-32.5
90	-34.4	-33.6	-36.5	-37.3	-32.9	-34.4
95	-35.7	-35.3	-38.3	-39.4	-34.3	-36.1
100	-37.1	-37.1	-40.0	-41.0	-35.9	-37.6
105	-38.6	-38.8	-41.7	-42.5	-37.4	-39.1
110	-40.1	-40.6	-43.4	-44.2	-39.1	-40.7
115	-41.6	-42.4	-44.9	-45.8	-41.0	-42.5
120	-43.5	-44.6	-46.4	-47.1	-43.3	-44.5
Peak	-51.1		-52.0		-47.7	

Negative values indicate an upwardly rotated position.



TABLE E-9 Means for Scapulothoracic Posterior Tilting Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-13.0	-12.4	-13.7	-12.2	-12.2	-11.8
20	-12.7	-11.3	-11.9	-10.3	-11.9	-11.0
25	-11.8	-10.6	-11.3	-8.7	-11.2	-9.9
30	-11.2	-9.8	-10.2	-7.6	-10.4	-9.1
35	-10.5	-9.1	-9.5	-6.8	-9.6	-8.2
40	-9.8	-8.3	-8.8	-6.1	-8.7	-7.4
45	-9.0	-7.5	-8.1	-5.4	-8.0	-6.7
50	-8.3	-6.8	-7.4	-4.8	-7.2	-6.1
55	-7.5	-6.1	-6.7	-4.3	-6.5	-5.4
60	-6.8	-5.3	-6.1	-3.6	-5.7	-4.7
65	-6.1	-4.5	-5.5	-2.9	-5.0	-4.1
70	-5.5	-3.7	-4.8	-2.2	-4.3	-3.3
75	-4.9	-3.0	-4.2	-1.5	-3.6	-2.6
80	-4.2	-2.3	-3.5	-0.8	-2.8	-1.9
85	-3.6	-1.6	-2.8	-0.1	-2.1	-1.1
90	-2.8	-0.9	-2.1	0.5	-1.4	-0.4
95	-2.2	-0.2	-0.6	2.3	-0.6	0.4
100	-1.5	0.5	0.2	3.0	0.2	1.2
105	-0.7	1.2	1.1	3.7	1.1	2.0
110	0.2	1.9	2.1	4.5	2.1	2.7
115	1.3	2.8	2.9	5.1	4.0	4.4
120	2.7	4.2	3.8	5.8	5.4	6.1
Peak	8.1		7.2		8.2	

Negative numbers indicate an anteriorly tilted position.

TABLE E-10 Means for Glenohumeral Elevation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-2.8	2.4	3.7	5.9	-1.1	-1.2
20	-6.6	-3.8	-0.7	1.7	-5.6	-5.7
25	-10.8	-8.8	-4.8	-2.3	-9.0	-10.0
30	-14.1	-13.3	-8.6	-6.3	-12.4	-13.6
35	-17.6	-17.4	-12.0	-10.3	-15.6	-16.9
40	-20.8	-21.4	-15.5	-14.2	-19.1	-20.2
45	-24.1	-25.2	-18.9	-18.3	-22.5	-23.7
50	-27.4	-28.9	-22.5	-22.2	-26.1	-27.0
55	-30.8	-32.6	-26.0	-26.0	-29.9	-30.6
60	-34.3	-36.1	-29.7	-30.1	-33.7	-34.3
65	-37.8	-39.6	-33.6	-33.8	-37.6	-37.9
70	-41.2	-43.0	-37.4	-37.6	-41.6	-41.6
75	-44.9	-46.4	-41.4	-41.4	-45.8	-45.2
80	-48.6	-49.8	-45.4	-45.3	-50.0	-48.8
85	-52.3	-53.2	-49.2	-49.1	-54.1	-52.3
90	-56.0	-56.5	-53.1	-52.7	-58.2	-56.0
95	-59.8	-59.7	-56.9	-56.2	-62.1	-59.6
100	-63.5	-63.0	-60.6	-59.8	-65.9	-63.3
105	-66.9	-66.3	-64.1	-63.5	-69.4	-67.0
110	-70.3	-69.5	-67.7	-66.8	-72.8	-70.7
115	-73.8	-72.6	-71.1	-70.1	-75.6	-73.7
120	-76.8	-75.3	-74.3	-73.5	-77.7	-76.0
Peak	-86.4		-83.4		-84.1	

Negative values indicate an elevated position.

TABLE E-11 Means for Glenohumeral External Rotation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	-35.0	-41.5	-51.1	-54.3	-15.6	-15.0
20	-43.2	-44.1	-58.0	-58.9	-18.2	-17.6
25	-47.1	-45.7	-59.6	-64.3	-20.5	-21.8
30	-49.8	-47.0	-62.7	-66.9	-23.1	-24.9
35	-51.7	-48.1	-63.6	-68.0	-25.6	-27.8
40	-53.3	-49.1	-64.2	-68.7	-28.2	-30.4
45	-54.7	-50.1	-64.4	-69.2	-30.5	-32.8
50	-55.6	-51.0	-64.2	-69.2	-32.9	-35.1
55	-56.3	-51.8	-63.7	-68.7	-35.2	-37.4
60	-57.0	-52.7	-63.2	-68.2	-37.7	-39.5
65	-57.6	-53.4	-62.5	-67.3	-40.0	-41.6
70	-58.2	-54.1	-61.8	-66.3	-42.4	-44.0
75	-58.7	-54.7	-60.8	-65.1	-45.0	-46.4
80	-59.2	-55.3	-59.9	-63.7	-47.5	-48.7
85	-59.7	-56.0	-58.9	-62.4	-50.0	-50.8
90	-60.1	-56.6	-58.1	-61.0	-52.4	-53.1
95	-60.5	-57.3	-58.6	-61.1	-54.7	-55.2
100	-60.8	-57.9	-57.9	-60.0	-57.0	-57.3
105	-61.0	-58.5	-57.3	-59.1	-59.1	-59.3
110	-61.2	-59.3	-57.0	-58.4	-61.1	-61.1
115	-61.3	-60.2	-57.1	-58.2	-63.4	-63.4
120	-62.0	-61.0	-57.5	-58.5	-63.8	-63.7
Peak	-64.2		-60.6		-66.8	

Negative values indicate an externally rotated position.

TABLE E-12 Means for Glenohumeral Plane of Elevation Across Different Planes of Motion (*deg*)

Humerothoracic Elevation	Scapular Plane Abduction		Abduction		Flexion	
	Raising	Lowering	Raising	Lowering	Raising	Lowering
15	5.4	3.7	0.9	0.6	13.9	11.3
20	5.4	4.1	-3.5	-4.0	17.7	13.6
25	5.7	4.5	-5.3	-6.6	20.4	16.5
30	5.9	4.6	-7.3	-8.4	22.4	18.8
35	6.0	4.8	-9.2	-10.1	24.1	20.5
40	6.0	4.9	-11.0	-11.7	25.6	22.0
45	6.1	5.1	-12.6	-13.0	27.0	23.4
50	6.1	5.4	-14.0	-14.2	28.1	24.6
55	6.1	5.6	-15.2	-15.2	29.0	25.7
60	6.2	5.7	-16.2	-16.1	29.7	26.6
65	6.1	5.8	-17.0	-16.8	30.2	27.3
70	6.1	5.8	-17.6	-17.3	30.6	27.8
75	5.9	5.9	-18.0	-17.6	30.8	28.1
80	5.8	5.9	-18.2	-17.7	30.7	28.2
85	5.8	6.2	-18.2	-17.4	30.4	28.2
90	5.6	6.2	-17.9	-17.0	29.7	27.9
95	5.5	6.2	-17.2	-15.8	29.0	27.4
100	5.2	6.2	-16.2	-14.7	28.1	26.5
105	4.9	6.0	-15.0	-13.3	26.8	25.5
110	4.9	5.9	-13.4	-11.8	25.3	24.3
115	5.0	5.8	-11.5	-9.9	24.0	23.1
120	4.7	5.4	-8.8	-7.6	21.4	20.7
Peak	6.5		-0.2		16.0	

Negative numbers indicate a position posterior to the scapular plane.