

Glenoid Retroversion = $(90 - \alpha)$ degrees

Humeral head translation = $(AB/AC) \times 100$ percent

Classification	Radiographic Features
Type I	< 5 degree difference in retroversion
Type II	> 5 degree difference in retroversion
Type III	Posterior humeral head subluxation, <35% anterior to scapular spine axis
Type IV	Presence of false glenoid
Type V	Flattening of humeral head, progressive/ complete humeral head dislocation
Type VI	Infantile posterior dislocation
Type VII	Proximal humeral growth arrest

Fig. E-1

Waters radiographic classification of glenohumeral dysplasia and schematic diagram depicting the technique of determining glenoid retroversion and humeral head subluxation on the basis of axial CT or MRI.

TABLE I Hospital for Sick Children Active Movement Scale*	
	Score
Gravity eliminated	
No contraction	0
Contraction, no motion	1
<50% range of motion	2
>50% range of motion	3
Full motion	4
Against gravity	
<50% range of motion	5
>50% range of motion	6
Full motion	7

*Scores are given for each of the following joint movements: shoulder flexion, shoulder abduction, shoulder adduction, shoulder internal rotation, shoulder external rotation, elbow flexion, elbow extension, forearm pronation, forearm supination, wrist flexion, wrist extension, finger flexion, finger extension, thumb flexion, and thumb extension.

Fig. 1

Schematic representation of the modified Mallet Classification for assessing upper trunk function in patients with brachial plexus birth palsy. Grade I represents no function, and Grade V represents normal function. Grades II, III, and IV are depicted for each category.

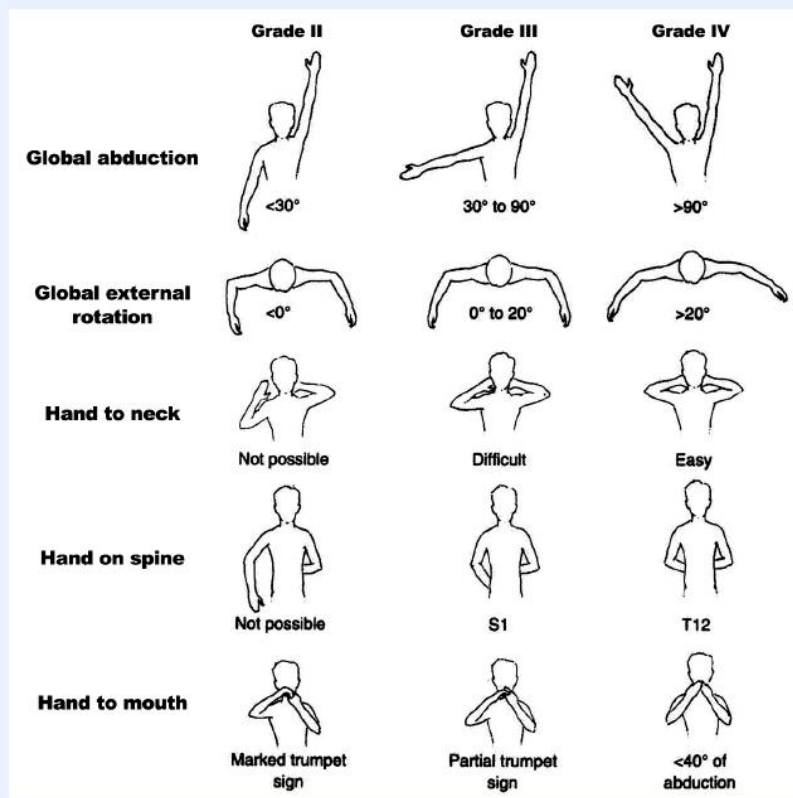


Fig. E-2

Active Movement Scale (top) and modified Mallet classification for assessment of upper trunk function in patients with brachial plexus birth palsy (bottom). (Reprinted from: Bae DS, Waters PM, Zurakowski D. Reliability of three classification systems measuring active motion in brachial plexus birth palsy. J Bone Joint Surg Am. 2003 Sep;85[9]:1733-8.)

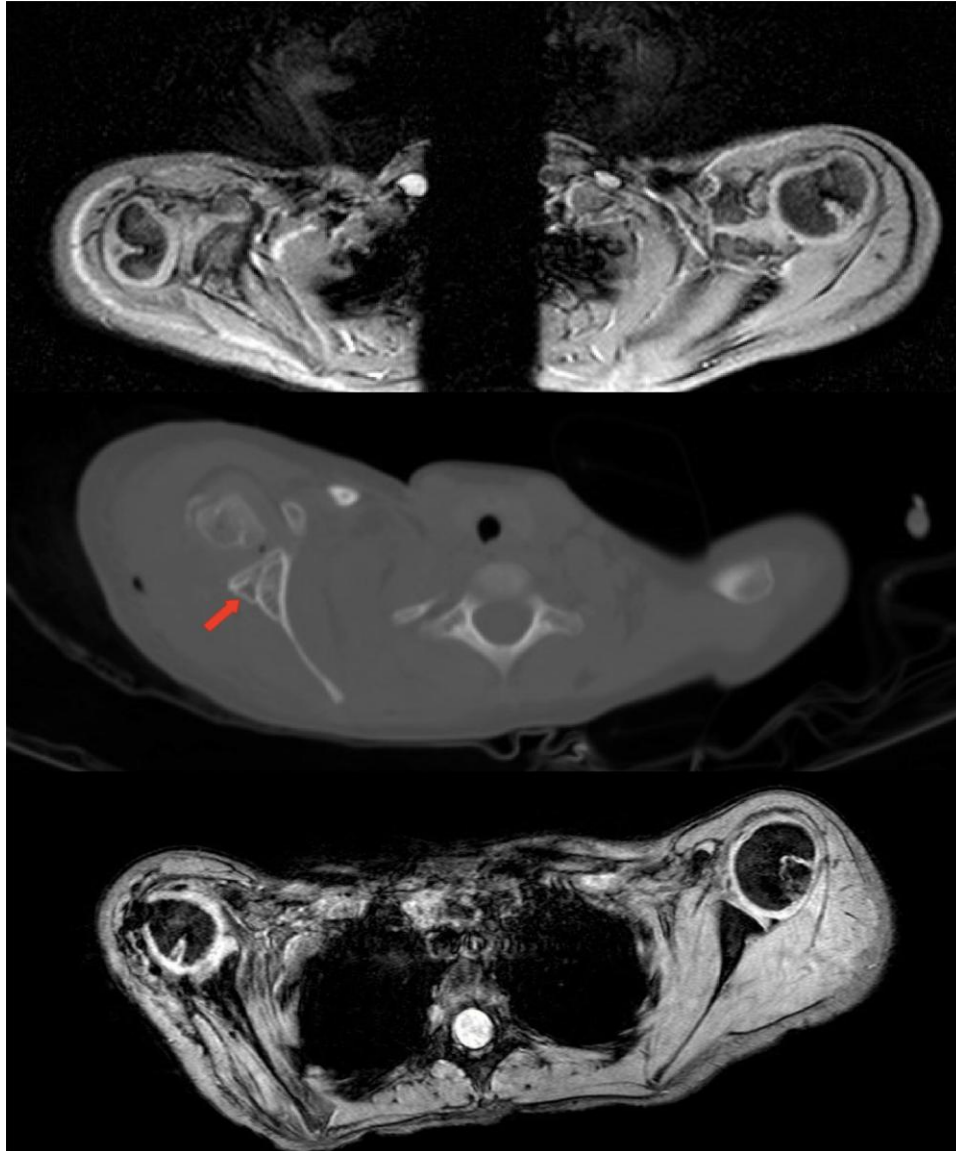


Fig. E-3
Preoperative (top), immediate postoperative (middle), and one-year postoperative (bottom) axial images showing inadvertent glenoplasty—i.e., cracking and reshaping of subchondral bone. The arrow points to the graft insertion site.

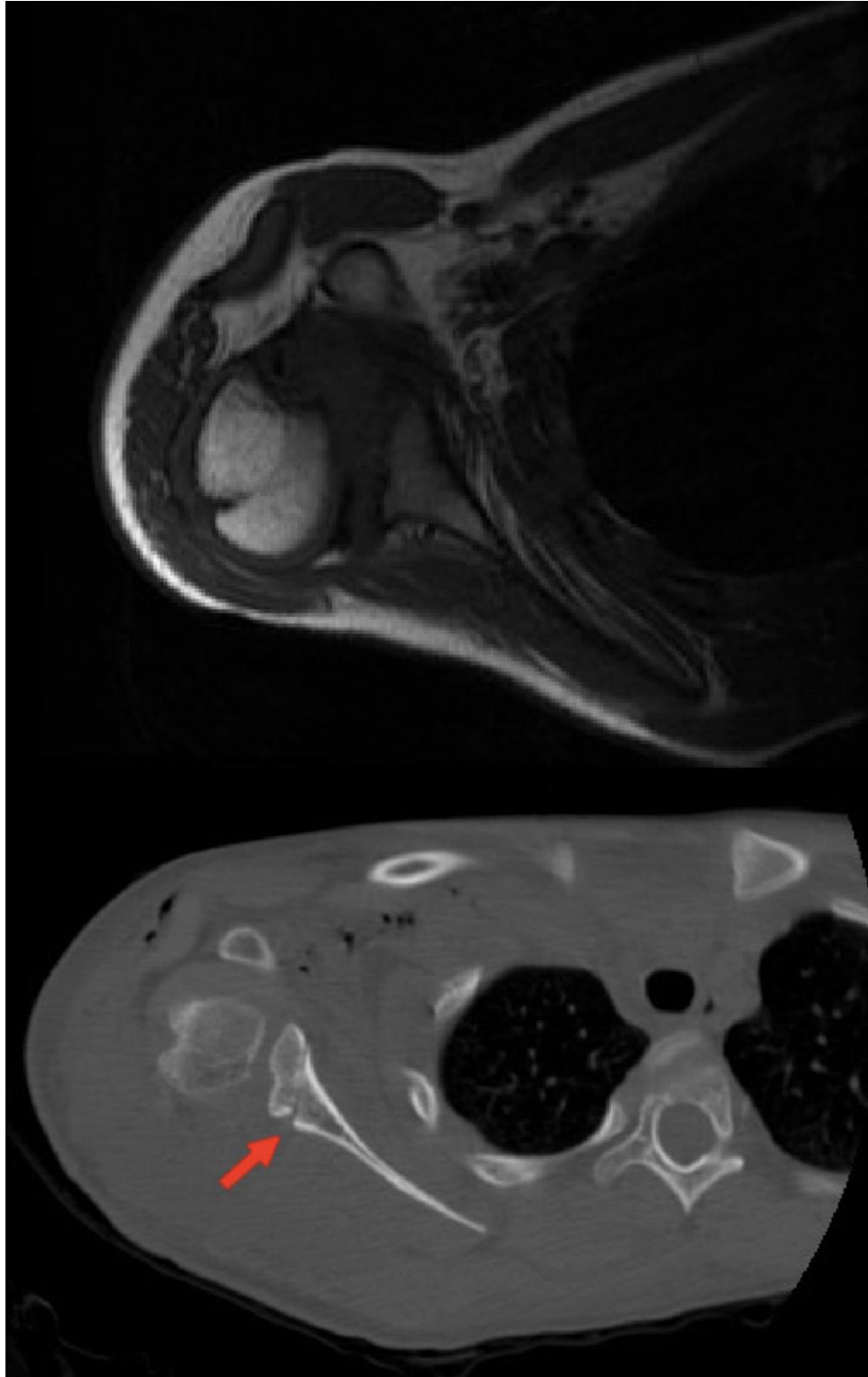


Fig. E-4
Preoperative and immediate postoperative axial images showing scapular neck osteotomy without anteversion because of graft collapse (arrow) in the immediate postoperative period.

TABLE E-1 Preoperative Data*

Case	Age (yr)	Mallet Score (points)						AMS (points)			Range of Motion (deg)								Glenoid Retroversion (deg)	%HHACS	Waters Type	
		Abd	ER	HTN	HTM	HTB	Composite	Abd	ER	IR	Abd Contract.	Active Abd	Passive Abd	Active ER 0°	Passive ER 0°	Active ER 90°	Passive ER 90°	Active IR				Passive IR
1	9.0	4	1	2	2	4	13	5	0	7	50	90	180	-90	-45	0	40	90	90	24.0	15.0	IV
2	2.5	4	2	2	3	2	13	7	2	7					0		90			32.5	0.0	IV
3	3.9	4	1	2	2	2	12	6	0	7	0	100	180	-90	40	0	90	90	90	12.7	16.0	III
4	5.7	4	1	2	2	2	11	7	0	7	0	180	180	-90	0	0	70	90	90	25.0	14.0	IV
5	4.3	4	2	2	2	3	13	6	2	7				-20	10					60.3	0.0	V
6	4.1	4	1	2	2	2	11	7	0	7	40	140	180	-90	80	0	90	90	90	32.0	16.0	IV
7	12.4	3	2	1	2	2	10	5	2	2	0	80	180	-90	0	0	80	90	90	52.8	0.0	V
8	12.3	4	1	2	2	5	14	7	0	7	30	90	180	-90	-20	0	45	90	90	12.9	29.4	III
9	3.1	2	1	1	1	2	7	2	0	7	0	30	160	-90	-45	0	60	90	90	20.0	23.0	III
10	9.2	4	1	2	2	3	12	7	0	7	45	160	180	-90	-45	0	45	90	90	32.2	0.0	V
11	6.8	4	1	2	2	3	12	7	0	7	0	180	180	-90	20	0	90	90	90	69.0	0.0	IV
12	3.9	3	1	3	3	2	12	6	0	7	40	90	180	-90	-45	0	80	90	90	35.5	0.0	IV
13	3.0	3	1	2	2	2	10	3	0	7	0	90	120	-90	0	0	80	90	90	24.2	33.6	III
14	7.9	4	2	2	2	3	13	6	2	7	50	140	180	-45	0	30	90	90	90	38.5	0.0	V
15	9.2	3	1	2	3	2	11	6	2	7	0	90	120	-90	0	0	90	90	90	28.8	13.4	IV
16	2.1	2	1	1	1	3	8	2	0	7	0	45	90	-90	-70	0	0	90	90	30.0	21.6	IV
17	6.2	3	1	2	2	4	12	7	0	7	0	100	160	-90	-45	0	0	90	90	14.7	17.6	IV
18	2.5	4	2	3	4	3	16	7	2	7	0	150	180	0	90	0	90	90	90	61.0	0.0	V
19	5.5	4	1	2	2	3	12	7	0	7	0	100	180	-90	0	0	80	90	90	25.6	16.8	V
20	3.0	3	2	2	2	3	12	5	2	7	30	90	160	-70	0	0	70	90	90	21.0	19.2	V
21	6.6	4	1	2	2	2	11	6	0	7	30									36.0	0.0	V
22	8.0	5	1	2	3	2	13	7	0	7	40	180	180	-90	0	0	90	90	90	40.6	0.0	V
23	11.0	3	2	2	4	5	13	5	3	7	0	65	115	-70	170	-20	0	90	90	24.0	0.0	V

24	6.0	2	1	1	2	2	8	2	0	7	0	20	75	0	0	0	30	90	90	30.0	0.0	IV
25	7.0	3	1	2	2	2	10	5	0	7	0	75	150	-90	-10	0	5	90	90	22.6	28.7	IV
26	9.0	3	3	2	2	3	13	5	2	7	0	30	180	-30	-20	30	170	90	90	25.8	0.0	IV
27	16.2	3	1	2	2	2	10	6	0	7	45	80	110	-90	-20	0	60	90	90	28.0	0.0	IV
28	10.9	4	1	2	2	2	11	7	0	7	45	170	180	-90	0	0	45	90	90	35.3	0.0	IV
29	6.7	3	2	2	2	2	11	6	2	7	0	100	180	-45	70	5	90	90	90	18.4	0.0	III
30	13.9	2	1	2	2	2	9	6	0	7	40	80	140	-90	-60	0	30	90	90	54.0	0.0	V
31	6.9	4	2	2	2	2	12	7	0	7	0	160	180	0	0	0	90	90	90	27.2	0.0	IV
32	15.2	4	2	1	1	4	12	7	2	7	10	100	180	-70	0	20	70	90	90	13.5	22.8	III
Mean	7.3	3.4	1.4	1.9	2.2	2.7	11.5	5.8	0.7	6.8	17.2†	103.8†	159.3†	-71†	0.5†	2.3†	64.5†	90.0	90.0	31.5	9.0	

*AMS = Active Movement Scale, Abd = abduction, ER = external rotation, HTN = hand to neck, HTM = hand to mouth, HTB = hand to back, IR = internal rotation, %HHACS = percentage of the humeral head anterior to the midscapular line. †Calculation of mean included only patients with both preoperative and postoperative measurements.

TABLE E-2 Postoperative Data*

Case	Mallet Score (points)						AMS (points)			Range of Motion (deg)									Glenoid Retroversion (deg)	%HHACS	Waters Type
	Abd	ER	HTN	HTM	HTB	Composite	Abd	ER	IR	Abd Contract.	Active Abd	Passive Abd	Active ER 0°	Passive ER 0°	Active ER 90°	Passive ER 90°	Active IR	Passive IR			
1	4	3	4	3	2	16	7	3	7	45	160	180	10	30	70	90	90	90	15.6	47.2	II
2	4	4	4	3	2	17	7	7	7	20	120	160	20	60	70	90	30	40	-4.0	52.6	I
3	4	4	4	4	2	18	7	6	7										2.6	50.5	I
4	4	5	4	4	2	19	7	7	7	60	180	180	45	45	90	90	15	15	14.9	47.2	II
5	5	3	2	3	2	15	7	3	7	0	180	180	20	75	20	80	90	90	24.5	39.7	III
6	4	4	5	4	1	18	7	7	3	40	180	180	75	75	90	90	10	30	1.3	52.0	I
7	3	3	3	4	2	15	5	7	7	20	80	125	10	10	45	60	80	80	-9.8	49.7	I
8	5	3	4	4	3	19	7	7	7	50	170	170	5	5	45	75	90	90	2.2	52.0	I
9	3	4	2	2	2	13	3	6	6	0	80	125	45	80	70	90	0	20	-1.4	49.6	I
10	4	3	4	4	2	21	7	6	7	25	165	180	0	30	40	75	90	90	27.0	46.2	II
11	4	4	4	4	3	19	7	7	7	15	110	160	10	35	70	70	90	90	-2.5	44.2	II
12	4	1	2	2	2	11	6	0	7	0	150	180	-90	30	0	90	90	90	11.9	40.1	III
13	4	4	4	2	3	17	6	6	3	20	120	180	30	75	45	80	30	45	2.1	51.1	I
14	4	4	4	4	2	18	7	6	7	30	170	180	20	45	90	90	90	90	16.0	42.9	I
15	4	3	4	3	2	16	7	6	7		150	170	45	90	10	45	10	45	0.0	41.4	II
16	3	2	2	3	2	12	3	3	6	0	80	140	0	10	10	45	40	60	-12.0	56.0	I
17	4	2	2	2	2	12	6	3	7	45	120	160	-60	0	0	75	90	90	0.9	48.0	I
18	5	4	4	4	2	19	7	7	7	45	180	180	20	70	80	90	95	60	28.5	46.6	II
19	4	3	4	4	2	17	6	3	7	20	120	160	10	40	40	60	60	60	-7.0	50.0	I

20	3	3	2	3	2	13	6	6	7		95	145	10	60	40	80	90	90	-16.6	82.5	I
21	3	2	2	2	2	11	6	2	7	0	85	180	-40	30	10	80	90	90	16.9	25.5	IV
22	4	3	3	4	2	16	7	3	7	40	160	180	0	30	10	20	90	90	21.8	0.0	IV
23	3	2	2	4	2	11	2	2	2	10	60	75	0	35	40	70	50	60	26.5	39.8	II
24	3	3	3	2	2	13	3	3	6	0	70	95	0	45	30	75	40	50	-18.2	33.2	III
25	3	3	2	2	2	12	6	6	7	0	75	120	10	30	20	45	40	45	-0.7	34.0	III
26	4	2	3	2	2	13	6	3	7	30	150	180	-20	20	45	90	90	90	0.0	36.7	II
27	4	3	2	3	2	14	6	6	3	40	130	140	0	30	50	60	50	50	-3.0	56.5	I
28	4	3	3	4	2	16	6	3	7	20	150	170	10	45	50	70	90	90	-2.0	46.7	I
29	4	3	3	3	2	15	6	3	7	55	110	160	30	70	45	110	90	90	-1.8	42.1	I
30	3	3	2	3	2	13	6	3	7	15	80	110	10	20	10	20	70	80	33.2	13.6	IV
31	4	4	4	3	2	17	6	7	3	0	145	160	50	75	70	90	45	45	10.0	41.8	II
32	4	4	4	4	2	18	7	3	7	10	160	160	20	40	30	70	90	90	-0.9	45.5	I
Mean	3.8	3.2	3.2	3.2	2.1	15.4	6.0	4.7	6.3	23.5†	128.6†	155.2†	10.9†	43.5†	44.1†	72.6†	64.5†	68.4†	5.5	43.9	

*AMS = Active Movement Scale, Abd = abduction, ER = external rotation, HTN = hand to neck, HTM = hand to mouth, HTB = hand to back, IR = internal rotation, %HHACS = percentage of the humeral head anterior to the midscapular line. †Calculation of mean included only patients with both preoperative and postoperative measurements.

TABLE E-3 Comparison of Combined Glenoid Osteotomy and Tendon Transfer Outcomes with Previously Reported Outcomes Following Humeral Osteotomy*

Authors	No. of Patients	Mean Age (yr)	Mean Follow-up (yr)	Mallet Score (Change from Preop.) (points)							ER (Change from Preop.)	
				Abd	ER	HTN	HTM	HTB	Composite Standard	Composite Modified Including IR Score	Passive	Active
Current study: glenoid osteotomy	32	7.2	20.4 mo	3.8 (increased 0.4)	3.2 (increased 1.8)	3.2 (increased 1.3)	3.2 (increased 1.0)	2.1 (decreased 0.6)	13.4 (increased 4.5)	15.4 (increased 4.0)	44° in neutral (increased 43°)/73° at 90° (increased 8°)	11° in neutral (increased 82°)/44° at 90° (increased 42°)
Abzug et al. ¹⁸ (2010): humeral osteotomy	23	10.1	2.2	3.7 (increased 0.2)	3.3 (increased 0.9)	3.1 (increased 0.6)	3.6 (increased 1.0)	2.4 (decreased 0.4)	13.7 (increased 2.7)	16.1 (increased 2.3)	Increased 43.2°	N/A
Waters and Bae ¹⁹ (2006): humeral osteotomy	27	7.6	3.7	4 (increased 1)	4 (increased 2)	4 (increased 1)	4 (increased 1)	3 (increased 1)	N/A	18 (increased 5)	Increased 64°	N/A
Waters and Peljovich ¹⁰ (1999): humeral osteotomy	16	8.4	3.1	3.8 (increased 0.8)	3.8 (increased 1.7)	3.9 (increased 1.8)	3.6 (increased 1.3)	N/A	15.1 (increased 5.6)	N/A	7.7° at 90° (increased 31.5°)	N/A
Waters (1999) ³³ : humeral osteotomy	7	2.4	9.1	3.9 (increased 1)	3.9 (increased 1.9)	4.0 (increased 1.7)	4.0 (increased 1.7)	N/A	15.8 (increased 6.3)	N/A	16° at 90° (increased 30°)	N/A

*Abd = abduction, ER = external rotation, HTN = hand to neck, HTM = hand to mouth, HTB = hand to back, IR = internal rotation, and N/A = not available.