RESULTS

The pre-operative, immediate post-operative and final radiologic results and scoring are shown in table (40).

* The final end results (radiologic and functional) are shown in table (41).

* Tables (42-65) and figures (64-74) show the analysis and the correlation between some results' variables.

* Recorded complications are collected in table (66).

Table (40): Radiological results and scoring.

Case No.	Side	Volar tilt °			Ulnar tilt °			Radial shift mm			Dorsal shift mm			Rad. height mm			Artic. Step mm			IRUJ incong.			Radiol. Score	Op. Tech.
		Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.		
1	R	17			20			18			18			12										PCP
	L	-30	18	15	10	23	20	23	18	18	17	13	13	5	12	10	0	0	0	Mod	0	0	E.	
2	R	5			20			15			10			8										
	L	0	0	0	-10	10	10	30	17	17	18	12	12	-4	3	3	?	2	2	Sev.	Mod	Mod	F	EXF.
3	R	-35	8	8	30	25	24	16	21	21	26	18	18	14	15	14	0	0	0	Mod	0	0	E.	PCP
	L	11			25			20			18			16										
4	R	-50	-5	-7	12	20	19	20	20	20	19	17	17	7	12	11	1	0	0	0	0	0	G.	PCP
	L	10			23			19			16			13										
5	R	-10	20	10	20	24	25	15	17	16	19	16	16	14	13	12	0	0	0	Mild	Mild	Mild	G.	PCP
	L	14			24			17			16			15										
6	R	-12	15	10	10	16	10	18	17	21	17	11	9	3	8	0	0	0	0	Mild	0	0	F	PCP
	L	10			18			16			14			10										
7	R	-30	10	10	9	13	10	23	17	17	20	15	15	4	9	6	0	0	0	Mod	Mild	Mild	G	PCP
	L	13			14			16			15			10										
8	R	19			20			18			16			17										PCP
	L	-35	22	18	23	22	20	21	18	18	26	15	15	17	17	14	2	0	0	Mild	Mild	Mild	G	
9	R	0	11	8	25	25	23	17	13	14	14	13	13	12	14	12	0	0	0	Mod	0	Mod	G	PCP
	L	-18	18	8	25	25	21	16	15	15	18	13	14	11	12	11	0	0	0	0	0	0	E	PCP
10	R	15			18			11			16			10										PCP
	L	-5	12	11	8	16	15	13	12	12	19	16	17	3	7	6	2	0	0	Mild	0	0	G	
11	R	20			22			20			18			14										PCP
	L	-11	20	20	21	23	22	20	20	20	20	18	18	12	13	13	1	0	0	Mild	0	0	E	
12	R	12			30			14			13			13										Ex.F.
	L	-15	10	10	12	32	28	25	16	17	11	13	12	5	13	13	0	0	0	Mild	Mild	Mild	E	
13	R	11			20			17			16			11										PCP
	L	-22	13	12	11	19	19	20	17	17	21	11	11	6	8	8	1	0	0	Mild	Mild	Mild	G.	

Table (40): Cont.

Case No.	Side	Volar tilt °			Ulnar tilt °			Radial shift mm			Dorsal shift mm			Rad. height mm			Artic. Step mm			IRUJ incong.			Radio. Score	Op. Tech.
		Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.		
14	R	12			26			18			15			15										PCP
	L	-40	10	8	12	25	10	25	19	21	21	15	16	7	13	4	0	0	0	Sev.	0	Mild	P	
15	R	10			24			18			13			15										
	L	-10	7	0	20	22	20	17	19	15	19	13	12	10	14	13	0	0	0	Mild	0	0	G	Ex.F.
16	R	14			24			13			11			16										
	L	-20	12	11	16	23	22	17	15	15	13	11	11	9	13	10	0	0	0	Mild	0	Mild	F	PCP
17	R	11			24			14			10			15										
	L	-30	10	10	7	23	23	20	14	14	18	11	11	2	15	13	?	0	0	Mod	0	0	E	Ex. F.
18	R	18			30			16			14			17										
	L	13	15	14	20	28	25	17	16	16	9	12	12	8	15	14	0	0	0	Mod	0	Mild	G	PCP
19	R	0	0	0	20	20	20	15	14	14	12	11	11	10	11	11	1	0	0	Mild	0	0	E	PCP
	L	10			22			14			11			12										
20	R	13			22			17			10			11										
	L	-10	10	10	18	22	20	15	17	17	12	10	10	8	10	10	0	0	0	Mild	0	0	E	PCP
21	R	15			20			15			12			13										
	L	-30	10	0	3	20	10	21	16	20	13	12	13	1	9	7	?	0	2	Sev.	0	Sev.	F	Ex. F.
22	R	0	20	6	10	18	3	13	15	20	21	16	20	4	10	6	0	0	0	Sev.	Mild	Mod	P.	PCP
	L	20			20			15			16			12										
23	R	-12	0	-10	5	16	8	20	15	18	18	12	12	2	11	3	?	0	1	Sev.	0	Mild	F	Ex. F.
	L	10			17			14			12			13										
24	R	-25	12	12	0	18	18	20	16	16	15	12	12	3	9	9	3	0	0	Mild	0	0	E.	PCP
	L	12			19			16			11			11										
25	R	-10	12	12	11	25	24	17	14	14	16	13	13	0	12	12	0	0	0	Mod	0	0	E.	PCP
	L	12			26			14			12			13										
26	R	-25	10	10	20	28	26	15	12	12	15	10	10	6	12	10	?	0	0	Mod	0	0	E.	Ex. F.
	L	11			30			12			10			13										

Table (40): Cont.

Case No.	Side	Volar tilt °			Ulnar tilt °			Radial shift mm			Dorsal shift mm			Rad. height mm			Artic. Step mm			IRUJ incong.			Radiol. Score	Op. Tech.
		Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.		
27	R	11			28			14			12			16										
	L	-40	10	10	22	26	25	16	15	15	22	12	12	11	16	16	0	0	0	Mild	0	0	E	PCP
28	R	-8	12	10	17	20	20	21	17	17	15	14	14	7	10	10	1	0	0	Mild	0	0	E	PCP
	L	10			22			17			14			11										
29	R	15			26			19			15			18										
	L	-25	13	13	12	26	25	26	19	19	19	15	15	4	17	16	0	0	0	Sev.	0	0	E	PCP
30	R	10			28			13			11			12										
	L	-30	10	10	15	28	26	15	13	13	20	11	11	6	12	11	?	0	0	Sev.	0	0	E	Ex. F.
31	R	-30	15	13	20	30	28	21	20	20	22	15	15	11	16	15	?	0	0	Sev.	0	Mild	G	Ex. F
	L	18			30			20			15			18										
32	R	20			28			18			11			15										
	L	-10	21	20	20	28	28	14	18	18	16	11	11	14	15	15	0	0	0	Mod	0	0	E	PCP
33	R	-25	12	12	7	11	8	20	14	14	17	12	12	4	9	7	0	0	0	Mod	Mild	Mild	G	PCP
	L	15			12			13			12			11										
34	R	-8	20	4	9	16	2	14	17	20	20	15	19	5	10	6	0	0	0	Sev	Mild	Mild	P.	PCP
	L	18			16			16			15			12										
35	R	20			30			15			15			16										PCP
	L	15	17	16	18	26	25	16	15	14	8	13	13	10	16	15	0	0	0	Mod	Mild	Mild	G.	
36	R	14			21			13			10			17										
	L	-28	13	13	5	20	20	17	13	13	15	10	10	3	16	15	?	0	0	Mod	0	0	E	EX. F
37	R	15			25			15			11			14										
	L	-35	16	16	17	23	22	18	15	15	19	11	11	7	13	13	0	0	0	Mild	0	0	E	PCP
38	R	22			21			17			12			16										
	L	-18	20	20	15	21	21	21	17	17	19	12	12	10	16	15	0	0	0	Mod	0	0	E	PCP
39	R	14			20			17			15			15										
	L	-14	15	12	9	20	20	22	18	18	20	15	15	7	12	12	1	0	0	Mild	0	0	G	PCP

Table (40): Cont.

Case No.	Side	Volar tilt °			Ulnar tilt °			Radial shift mm			Dorsal shift mm			Rad. height mm			Artic. Step mm			IRUJ incong.			Radiol. Score	Op. Tech.
		Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.		
40	R	11			23			14			9			14										
	L	-27	11	11	12	23	22	16	14	14	15	9	9	6	14	13	?	0	0	Sev.	0	0	E	Ex. F.
41	R	14			25			18			15			13										
	L	-35	12	10	13	22	11	22	18	20	19	15	17	4	12	4	0	0	0	Sev.	Mild	Mild	P.	PCP
42	R	-18	15	15	7	19	17	20	16	16	17	12	12	3	11	10	0	0	0	Mod	0	0	E.	PCP
	L	15			19			16			12			11										
43	R	-10	13	13	12	22	20	23	18	18	16	13	13	5	14	14	3	0	0	Mod	0	0	E.	PCP
	L	14			22			18			13			14										
44	R	16			24			17			14			16										
	L	-15	10	8	18	24	20	19	17	18	18	14	14	7	15	14	0	0	0	Mild	0	0	G	Ex. F
45	R	0	12	12	8	16	16	17	13	13	12	9	9	4	10	9	2	0	0	Mild	Mild	Mild	E	PCP
	L	14			16			13			9			10										
46	R	-20	12	12	17	25	25	16	13	13	11	9	9	5	14	12	?	0	0	Mod	0	0	E.	Ex. F.
	L	13			27			13			9			14										
47	R	19			21			16			10			11										
	L	-15	18	16	10	20	17	21	16	16	13	10	10	3	10	5	0	0	0	Mild	Mild	Mild	F	PCP
48	R	19			23			18			14			11										
	L	-30	17	17	10	23	23	22	18	18	20	14	14	3	11	10	0	0	0	Sev.	Mild	Mild	E	PCP
49	R	20			22			15			10			17										
	L	-18	20	12	7	19	9	19	15	15	16	10	10	4	15	10	?	0	0	Mild	Mild	Mild	F	Ex. F.
50	R	18			12			19			15			11										
	L	-20	18	16	5	12	11	20	19	19	20	15	15	3	10	10	0	0	0	Mild	0	0	E	PCP
51	R	20			26			16			12			15										
	L	-35	18	18	11	25	24	20	16	16	14	12	12	3	15	14	0	0	0	Mild	0	0	E	Ex. F.
52	R	-30	12	10	7	15	12	20	16	16	18	14	14	0	10	5	2	0	0	Mild	0	Mild	F	PCP
	L	16			20			16			14			13										

Table (40): Cont.

Case No.	Side _	Volar tilt °			Ulnar tilt °			Radial shift mm			Dorsal shift mm			Rad. height mm			Artic. Step mm			IRUJ incong.			Radiol. Score	Op. Tech.
		Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.	Pre	Post	Fin.		
53	R	15			18			15			13			12										
	L	-12	16	16	9	18	16	19	15	15	22	13	13	3	12	8	1	0	0	Mild	0	0	G	PCP
54	R.	-25	11	10	7	22	22	20	18	18	22	15	15	6	13	12	0	0	0	Mild	0	0	E	PCP
	L	10			24			18			15			13										
55	R	20			17			19			14			11										PCP
	L	-30	18	18	9	16	15	24	19	19	20	14	14	5	11	10	2	0	0	Mild	0	0	E	
56	R	16			14			19			15			15										
	L	-10	5	5	0	14	8	23	19	19	15	15	15	6	13	12	?	0	0	Mild	0	0	G	Ex.F.
57	R	20			16			17			14			15										PCP
	L	-40	20	20	10	16	15	19	17	17	18	14	14	2	14	12	1	0	0	Mod	Mild	Mild	G	
58	R	0	10	10	6	14	14	18	18	18	21	15	15	1	13	12	0	0	0	Mild	0	0	E	PCP
	L	12			15			18			15			14										
59	R	-15	15	13	10	15	14	18	17	17	18	14	14	6	15	14	0	0	0	Mild	Mild	Mild	G	PCP
	L	16			16			17			14			17										
60	R	-40	10	8	2	13	12	24	20	20	20	15	15	0	10	9	?	0	0	Mod	Mild	Mild	F	Ex. F.
	L	18			22			19			15			16										
61	R	-40	0	0	6	12	10	23	20	20	18	15	15	3	10	9	2	0	0	Mild	0	0	G	PCP
	L	12			15			20			14			11										
62	R	-38	0	0	0	10	8	24	15	15	17	10	10	0	6	4	?	1	1	Sev.	Mild	Mild	P.	Ex. F.
	L	15			25			14			10			16										

– = Side injured is underlined
E = Excellent
- = reversed volar tilt
G = Good
Mod. = Moderate
F= Fair
Sev. = Severe
P = Poor

Table (41): Final results.

Case No.	Sex	Age (y)	Inj. Limb (domit)	Fryk. Class.	Melone class.	ttt. (W)	Follow up (m.)	*Motion (degrees) Wrist Dorsf. / Palmf.	Wrist Rad. D. /UL. D.	Forearm Pron./sup	Grip (points)	Pain (points)	Deform. (points)	Radiographic findings Rad. Short (mm)	Tilt ° Volar -	Tilt ° Ulnar	Incongruity R.C.J.	Incongruity RUJ	Final rating	Operative technique
1	M	38	(L)	VIII	IIB	6	24	R 75/80	30/40	80/90					17	20				
								L 60/70	20/20	80/60	10	24	3	2	15	20	0	0	G	PCP
2	F	28	L	VII	V	6	20	R 80/85	25/40	90/90					5	20				
								L 50/55	10/25	60/80	6	15	1	5	0	10	Mild	Mod.	P	Ex.F.
3	M	34	(R)	IV	IIB	6	17	R 70/75	25/40	80/85	10	24	3	2	8	24	0	0	E	PCP
								L 80/80	25/40	80/85					11	25				
4	M	40	(R)	VIII	III	6	16	R 45/55	10/25	70/70	10	24	3	2	-7	19	0	0	F	PCP
								L 60/70	20/40	75/80					10	23				
5	M	37	(R)	VII	IIB	6	15	R 85/55	30/15	80/85	10	24	3	3	10	25	0	Mild	G	PCP
								L 90/80	30/40	80/85					14	24				
6	F	65	(R)	VIII	IIB	6	24	R 70/50	30/20	65/85	6	30	3	10	10	10	0	0	F	PCP
								L 70/55	35/20	80/85					10	18				
7	M	45	(R)	VIII	III	6	21	R 65/45	25/35	80/75	6	30	3	4	10	10	0	Mild	F	PCP
								L 75/70	25/35	85/85					13	14				
8	M	33	L	VIII	IIB	6	11	R 60/40	20/40	80/80					19	20				
								L 50/25	10/20	40/50	10	24	3	3	18	20	0	Mild	G	PCP
9	F	52	(R)	VI	-	6	20	R 50/45	20/30	60/70	6	24	1	1	8	23	0	Mod	F	PCP
			L	VI	-	6	20	L 50/50	25/30	65/80	6	24	3	2	8	21	0	0	G	PCP
10	M	42	L	VIII	III	6	24	R 60/40	10/40	80/80					15	18				
								L 60/35	10/30	80/60	10	30	3	4	11	15	0	0	G	PCP
11	M	29	L	VII	IIB	6	24	R 75/60	30/20	80/60					20	22				
								L 70/60	25/25	80/55	12	30	3	1	20	22	0	0	E	PCP
12	F	66	L	II	-	8	20	R 65/45	20/35	80/80					12	30				
								L 60/45	20/35	80/ 80	6	24	3	0	10	28	0	Mild	G	Ex.f.
13	F	52	L	VII	IIB	6	10	R 70/60	25/30	80/75					11	20				
								L 70/45	25/20	75/70	10	24	3	3	12	19	0	Mild	G	PCP

Table (41): Cont.

Case No.	Sex	Age (y)	Inj. Limb (domit)	Fryk. Class.	Melone class.	ttt. (W)	Follow up (m.)	*Motion (degrees) Wrist Dorsf. / Palmf.	Wrist Rad. D. /UL. D.	Forearm Pron./sup.	Grip (points)	Pain (points)	Deform. (points)	Radiographic findings Rad. Short (mm)	Tilt ° Volar -	Tilt ° Ulnar	Incongruity R.C.J.	Incongruity RUJ	Final rating	Operative technique
14	M	80	L	VIII	III	6	20	R 50/60	15/20	75/65					12	26				
								L 40/25	10/5	70/55	0	15	3	11	8	10	0	Mild	P	PCP
15	F	70	L	I	-	7	16	R 70/65	15/35	75/90					10	24				
								L 65/55	15/30	70/80	6	24	3	2	0	20	0	0	G	Ex.f
16	F	70	L	VIII	IIB	6	11	R 70/70	30/35	75/85					14	24				
								L 60/45	25/30	65/65	0	24	3	6	11	20	0	Mild	F	PCP
17	F	36	L	VII	V	6	23	R 60/40	30/40	80/80					11	24				
								L 60/40	20/25	80/75	12	24	3	2	10	23	0	0	E	Ex. F
18	M	24	L	VIII	IIA	6	15	R 75/70	30/25	75/70					18	30				
								L 55/50	20/25	75/70	12	24	3	3	24	25	0	Mild	G	PCP
19	F	22	(R)	III	I	6	9	R 70/65	25/30	80/80	12	30	3	1	0	20	0	0	E	PCP
								L 70/65	25/30	80/80					10	22				
20	F	41	L	VIII	IIB	6	17	R 80/75	15/25	90/75					13	22				
								L 80/75	15/25	90/75	10	24	3	1	10	20	0	0	E	PCP
21	F	49	L	VIII	V	6	24	R 50/60	30/40	80/80					15	20				
								L 30/30	20/25	80/25	6	15	1	6	0	10	Mod	Sev.	P	Ex. F
22	F	80	(R)	VIII	IIB	6	22	R 15/30	15/45	40/40	0	15	1	6	6	3	0	Mod	P	PCP
								L 45/45	30/45	80/80					20	20				
23	F	75	(R)	VIII	III	7	13	R 30/30	20/25	80/25	6	15	3	3	-10	8	Mild	Mild	P	Ex. F
								L 50/60	30/40	80/80					10	17				
24	F	41	(R)	VIII	IIB	6	19	R 75/45	25/25	75/70	10	30	3	2	12	18	0	0	E	PCP
								L 75/45	25/30	75/75					12	19				
25	F	65	(R)	VI	-	6	8	R 60/40	25/30	70/80	10	24	3	1	12	24	0	0	G	PCP
								L 60/50	30/40	75/85					12	26				
26	F	60	(R)	VIII	IV	6	23	R 80/70	20/35	85/85	6	24	3	3	10	26	0	0	G	Ex.F
								L 80/90	25/35	90/90					11	30				

Table (41): Cont.

Case No.	Sex	Age (y)	Inj. Limb (domit)	Fryk. Class.	Melone class.	ttt. (W)	Follow up (m.)	*Motion (degrees) Wrist Dorsf. / Palmf.	Wrist Rad. D. /UL. D.	Forearm Pron./sup.	Grip (points)	Pain (points)	Deform. (points)	Radiographic findings Rad. Short (mm)	Tilt ° Volar -	Tilt ° Ulnar	Incongruity R.C.J.	Incongruity RUJ	Final rating	Operative technique
27	F	50	L	VIII	IIB	6	8	R 75/60	25/25	70/70					11	28				
								L 75/60	25/25	70/65	10	30	3	0	10	25	0	0	E	PCP
28	M	37	R	VIII	IIB	6	14	R 70/65	25/30	80/80	12	30	3	1	10	20	0	0	E	PCP
								L 75/65	25/30	80/80					10	22				
29	M	60	L	VII	IIB	6	21	R 50/55	5/40	80/80					15	26				
								L 45/45	5/30	65/80	10	24	3	2	13	25	0	0	G	PCP
30	F	18	L	VII	IIB	6	9	R 70/80	15/25	75/85					10	28				
								L 70/75	15/20	75/80	12	30	3	1	10	25	0	0	E	Ex. F
31	M	26	(R)	VII	IV	6	16	R 70/55	20/25	80/85	10	30	3	3	13	28	0	Mild	E	Ex. F
								L 70/80	30/30	80/90					18	30				
32	M	60	L	VIII	IV	6	23	R 50/45	5/40	80/80					20	28				
								L 45/45	5/35	80/60	6	24	3	0	20	28	0	0	G	PCP
33	M	49	(R)	VIII	III	6	11	R 60/70	20/20	80/80	6	30	3	4	12	8	0	Mild	F	PCP
								L 80/85	30/40	80/80					15	12				
34	F	73	(R)	VIII	IIB	6	18	R 50/55	15/10	70/70	6	24	3	6	4	2	0	Mild	P	PCP
								L 70/75	30/45	80/85					18	16				
35	M	27	L	VIII	IIA	6	10	R 80/85	25/40	90/90					20	30				
								L 75/80	20/25	80/90	10	24	3	1	16	25	0	Mild	G	PCP
36	F	38	L	VII	V	6	15	R 70/80	20/40	80/80					14	21				
								L 70/75	15/35	80/80	10	24	3	2	13	20	0	0	E	Ex. F
37	F	56	L	VIII	IIB	6	12	R 80/75	15/25	85/75					15	25				
								L 80/75	15/25	85/75	10	30	3	1	16	22	0	0	E	PCP
38	M	51	(R)	VI	-	6	24	R 45/45	10/30	80/90	12	30	3		22	21	0	0	E	PCP
								L 50/45	10/35	85/90				1	20	21				
39	F	49	L	VII	IIB	6	17	R 70/80	30/30	85/90					14	20				
								L 65/70	25/20	80/80	6	24	3	3	12	20	0	0	E	PCP

Table (41): Cont.

Case No.	Sex	Age (y)	Inj. Limb (domit)	Fryk. Class.	Melone class.	ttt. (W)	Follow up (m.)	*Motion (degrees) Wrist Dorsf. / Palmf.	Wrist Rad. D. /UL. D.	Forearm Pron./sup.	Grip (points)	Pain (points)	Deform. (points)	Radiographic findings Rad. Short (mm)	Tilt ° Volar -	Tilt ° Ulnar	Incongruity R.C.J.	Incongruity RUJ	Final rating	Operative technique
40	M	21	L	VII	IIB	6	20	R 75/80	30/40	80/90					11	23				
								L 60/70	20/25	80/90	10	30	3	1	11	22	0	0	E	Ex. F
41	M	63	L	VIII	III	6	11	R 20/30	15/40	40/40					14	25				
								L 50/60	30/45	85/90	0	15	3	9	10	11	0	Mild	P	PCP
42	F	67	(R)	VI	-	6	22	R 70/75	25/40	80/85	10	24	3	1	15	17	0	0	G	PCP
								L 80/80	25/40	80/85					15	19				
43	M	30	(R)	VIII	IIB	6	24	R 60/60	20/30	70/75	12	30	3	0	13	20	0	0	E	PCP
								L 60/60	20/40	75/80					14	22				
44	F	51	L	VI	-	6	10	R 80/60	10/40	80/85					16	24				
								L 70/55	10/30	80/70	10	24	3	2	8	20	0	0	G	Ex. F
45	F	26	(R)	III	I	6	18	R 70/60	25/25	80/80	12	24	3	1	12	16	0	Mild	G	PCP
								L 75/60	30/30	85/85					14	16				
46	M	55	(R)	VIII	IV	6	19	R 60/40	20/30	80/75	10	30	3	2	12	25	0	0	E	Ex. F
								L 60/40	30/40	80/80					13	27				
47	F	62	L	VIII	IIB	6	8	R 80/85	25/40	85/85					19	21				
								L 50/50	5/20	60/70	6	24	3	6	16	17	0	Mild	F	PCP
48	M	41	L	VII	IIB	6	17	R 75/80	30/40	90/90					19	23				
								L 65/70	25/30	80/85	10	30	3	1	17	23	0	Mild	E	PCP
49	F	40	L	VIII	V	6	12	R 70/60	35/20	80/85					20	22				
								L 55/50	30/10	65/80	10	24	3	7	12	9	0	Mild	F	Ex. F
50	M	33	L	VIII	IIB	6	18	R 70/80	25/40	90/90					18	12				
								L 70/75	20/35	90/90	12	30	3	1	16	11	0	0	E	PCP
51	F	69	L	VI	-	7	13	R 65/45	20/30	80/80					20	26				
								L 60/45	20/25	80/80	6	15	3	1	18	24	0	0	F	Ex. F
52	F	45	(R)	VIII	IIB	6	12	R 30/25	20/25	60/40	6	30	3	8	10	12	0	Mild	F	PCP
								L 55/60	30/45	80/85					16	20				

Table (41): Cont.

Case No.	Sex	Age (y)	Inj. Limb (domit)	Fryk. Class.	Melone class.	ttt. (W)	Follow up (m.)	*Motion (degrees) Wrist Dorsf. / Palmf.	Wrist Rad. D. /UL. D.	Forearm Pron./sup.	Grip (points)	Pain (points)	Deform. (points)	Radiographic findings Rad. Short (mm)	Tilt ° Volar -	Tilt ° Ulnar	Incongruity R.C.J.	Incongruity RUJ	Final rating	Operative technique
53	M	48	L	VIII	III	6	16	R 60/70	25/40	80/80					15	18				
								L 45/55	15/20	70/65	6	30	3	4	16	16	0	0	G	PCP
54	M	31	(R)	IV	IIB	6	21	R 75/60	25/20	90/85	12	30	3	1	10	22				
								L 75/60	25/25	90/85					10	24	0	0	E	PCP
55	M	47	L	VII	IIB	6	15	R 70/80	15/25	75/85					20	17				
								L 70/75	15/20	75/80	10	30	3	1	18	15	0	0	E	PCP
56	F	36	L	VII	V	6	10	R 70/80	30/30	80/90					16	14				
								L 70/60	20/25	80/85	6	30	3	3	5	8	0	0	F	Ex. F
57	M	24	L	VIII	IIB	6	17	R 80/60	10/40	80/85					20	16				
								L 70/55	10/30	80/70	10	24	3	3	20	15	0	Mild	G	PCP
58	F	43	(R)	VI	-	6	14	R 70/60	25/30	90/90	10	30	3	2	10	14	0	0	E	PCP
								L 75/60	30/30	90/90					12	15				
59	M	30	(R)	VII	IIB	6	24	R 85/55	30/15	80/85	10	24	3	3	13	14	0	Mild	G	PCP
								L 90/80	30/40	80/90					16	16				
60	F	66	(R)	VIII	III	7	8	R 70/50	30/20	65/80	6	24	3	7	8	12	0	Mild	F	Ex. F
								L 70/55	35/20	80/85					18	22				
61	M	45	(R)	VIII	III	6	16	R 70/45	25/20	75/70	10	24	3	2	0	10	0	0	F	PCP
								L 70/60	25/30	80/80					12	15				
62	M	67	(R)	VIII	IV	7	13	R 40/25	10/5	60/50	0	15	1	12	0	8	Mild	Mild	P	Ex. F
								L 55/65	20/25	80/80					15	25				

* Side injured is underlined
E = Excellent
- = reversed volar tilt.
G = Good
domit. = dominant
F = Fair
Mod = Moderate
P = poor
Ex. F= External fixation
PCP= Percutaneous pinning

Table (42): Final end results scoring in relation to different age groups.

Age group "years"	No. of fractures	Excellent		Good		Fair		Poor	
		No.	%	No.	%	No.	%	No.	%
18-29	10	5	50	4	40	0	0.0	1	10
30-39	12	7	58.3	4	33.3	1	8.4	0	0.0
40-49	15	6	40	2	13.3	6	40	1	6.7
50-59	8	4	50	3	37.5	1	12.5	0	0.0
60-69	12	0	0.0	6	50.0	4	33.3	2	16.7
70-80	6	0	0.0	1	16.7	1	16.7	4	66.6
Total	63	22		20		13		8	

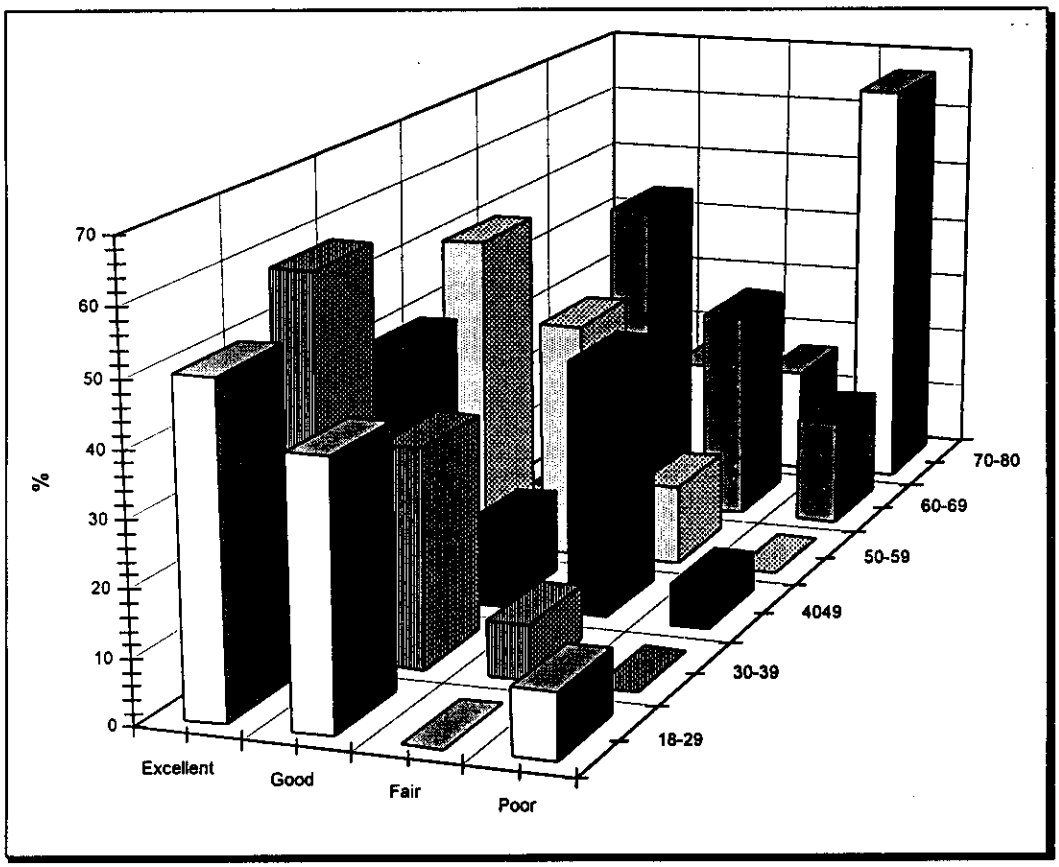


Fig. (64): Final end results in relation to age.

Table (42) shows that the best results (91.6% excellent and good) were obtained in the group aging between 30 and 39 years old. And the worset (83.3% fair and poor) were in patients aging from 70 to 80 years.

*Measures of the five radiologic parameters described by ***Van Der Linden and Ericson (1981)*** were directly obtained from the P-A & lateral radiographs of the affected and sound wrist joints, table (43).

Table (43): Measurements and mean values of 5 radiologic parameters.

Side	Volar tilt O		Ulnar tilt O		Radial shift mm		Dorsal shift mm		Radial height mm	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Injured: Pre-op.	- 40-15	-20	-10-25	11.9	13-30	19.3	9-26	17.3	- 4-17	5.7
Final	- 10-20	10.2	3-28	17.4	12-21	16.6	9-18	13.2	0-16	10.4
Sound	5-22	14.4	12-30	21.1	11-20	16.2	10-18	13.3	8-18	13.3

Table (43) shows that: the **mean volar tilt** was pre-operatively -20°, at final assessment: 10.2° and that of the sound side was: 14.4°.

- The **mean ulnar tilt** pre-operatively was 11.9°, at final assessment it measured 17.4° and the mean of the sound side was 21.1°.
- The **mean radial height** pre-operatively was 5.7 mm, at final assessment it was 10.4 mm, and the mean of the unaffected wrist was 13.3 mm.
- All these measures show significant statistical improvement, see tables (44-48) and no statistical difference was detected between the immediate post reduction and the final end results obtained.

VOLAR TILT

Anova: single factor.

Groups	Count	Sum	Average	Variance	Stand. Dev.
Pre	63	-1251	-19.857	190.995	13.820
Post	63	787	12.492	34.189	5.847
Fin.	63	655	10.396	37.856	6.152
Normal	63	876	13.904	28.087	5.299

ANOVA

Source of variation	SS	Df	MS	F	P-value	F. crit
Between groups	49145.218	3	16381.739	225.079	1.763 E-70	2.641
Within groups	18049.968	248	72.782			
Total	67195.186	251				

* LSD 0.05 = 2.979 **LSD**

Groups	Average	Pre	Post	Final	Normal
Pre	-19.857		-32.349	-30.253	-33.761
Post	12.492			2.095	-3.507
Final	10.396				-3.507
Normal	13.904				

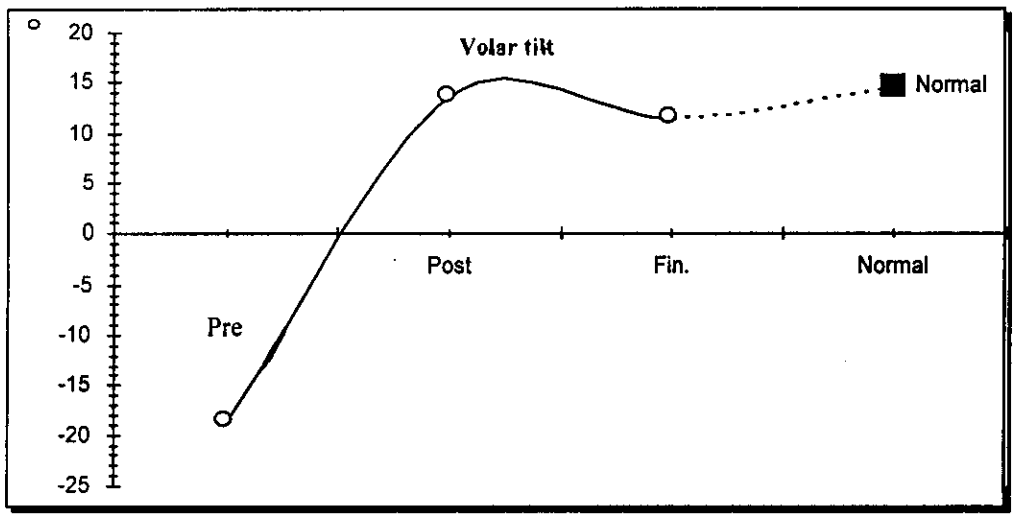


Table (44): Statistical analysis of volar tilt measurements.

ULNAR TILT

Anova: Single factor

Groups	Count	Sum	Average	Variance	Stand. Dev.
Pre	63	759	12.047	52.981	7.278
Post	63	1291	20.492	26.512	5.148
Fin.	63	1126	17.873	42.402	6.511
Normal	63	1371	21.761	20.958	4.578

ANOVA

Source of variation	SS	Df	MS	F	P-value	F. crit
Between groups	3515.503	3	1171.834	32.811	6.766 E-18	2.641
Within groups	8857.015	248	35.7137			
Total	12372.519	251				

* LSD 0.05 = 2.086 **LSD**

Groups	Average	Pre	Post	Final	Normal
Pre	12.047		-8.444	-5.825	-9.714
Post	20.492			2.619	-3.888
Final	17.873				-3.888
Normal	21.761				

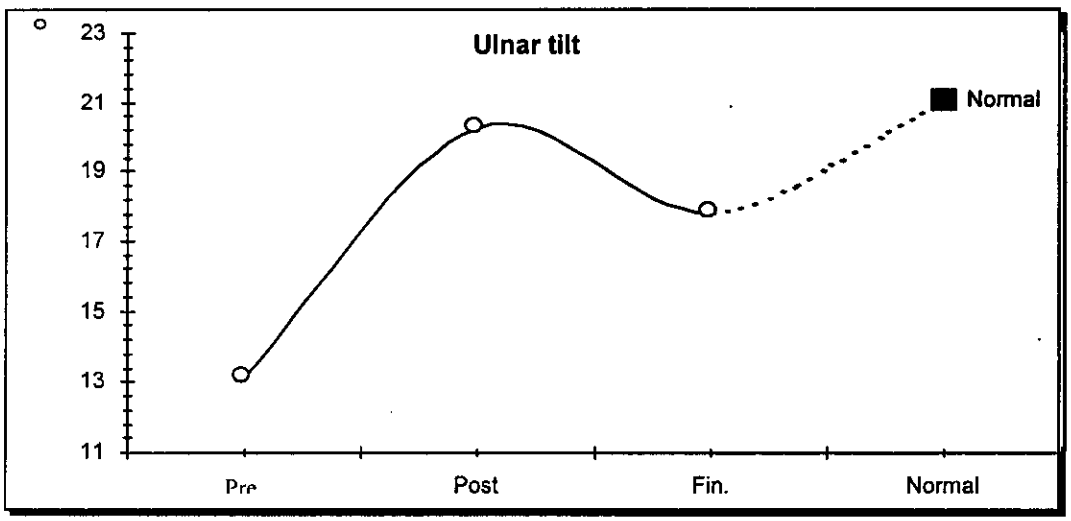


Table (45): Statistical analysis of ulnar tilt measurements.

RADIAL SHIFT

Anova: Single factor

Groups	Count	Sum	Average	Variance	Stand. Dev.
Pre	63	1217	19.317	11.962	3.458
Post	63	1038	16.476	4.834	2.198
Fin.	63	1048	16.634	8.751	2.9583
Normal	63	1018	16.158	4.909	2.215

ANOVA

Source of variation	SS	Df	MS	F	P-value	F. crit
Between groups	403.186	3	134.395	17.650	2.040 E-10	2.641
Within groups	1888.380	248	7.614			
Total	2291.567	251				

* LSD 0.05 = 0.963 **LSD**

Groups	Average	Pre	Post	Final	Normal
Pre	19.317		2.841	2.682	3.158
Post	16.476			-0.158	0.476
Final	16.634				0.476
Normal	16.158				

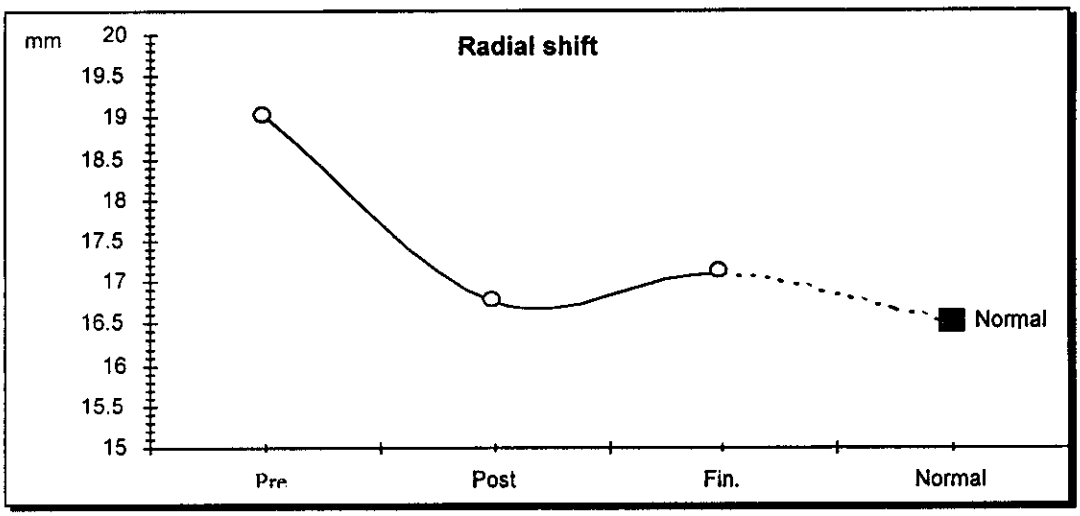


Table (46): Statistical analysis of radial shift measurements.

DORSAL SHIFT

Anova: Single factor

Groups	Count	Sum	Average	Variance	Stand. Dev.
Pre	63	1099	17.444	13.250	3.640
Post	63	821	13.031	4.837	2.199
Fin.	63	831	13.190	6.576	2.564
Normal	63	833	13.222	5.498	2.344

ANOVA

Source of variation	SS	Df	MS	F	P-value	F. crit
Between groups	873.460	3	291.153	38.610	1.643 E-20	2.641
Within groups	1870.095	248	7.540			
Total	2743.555	251				

* LSD 0.05 = 0.958 **LSD**

Groups	Average	Pre	Post	Final	Normal
Pre	17.444		4.412	4.253	4.222
Post	13.031			-0.158	-0.031
Final	13.190				-0.031
Normal	13.222				

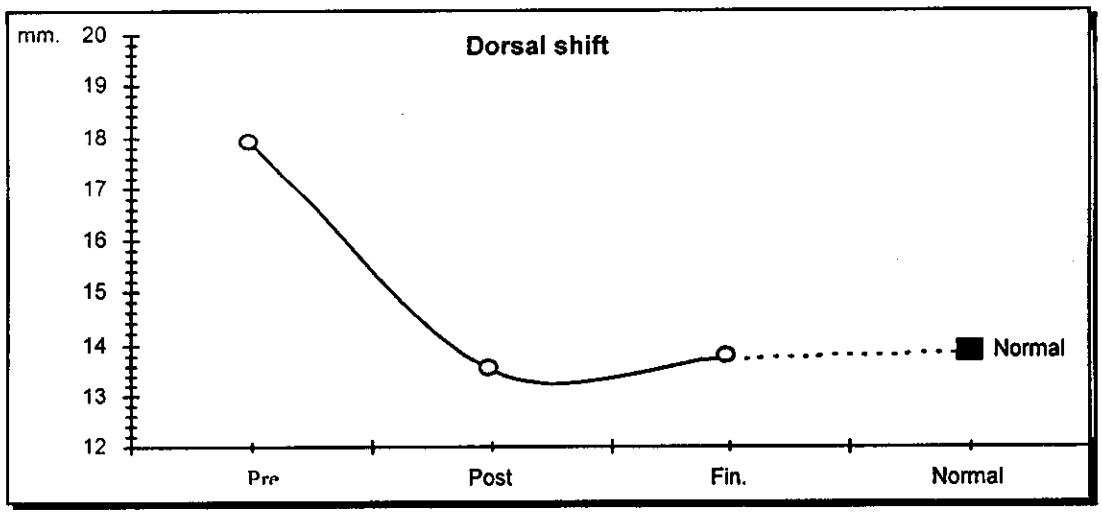


Table (47): Statistical analysis of dorsal shift measures.

RADIAL HEIGHT

Anova: Single factor

Groups	Count	Sum	Average	Variance	Stand. Dev.
Pre	63	360	5.714	16.400	4.049
Post	63	766	12.158	7.877	2.806
Fin.	63	653	10.365	13.622	3.690
Normal	63	849	13.476	5.576	2.361

ANOVA

Source of variation	SS	Df	MS	F	P-value	F. crit
Between groups	2174.126	3	724.708	66.674	1.197 E-31	2.641
Within groups	2695.587	248	10.869			
Total	4869.714	251				

* LSD 0.05 = 1.151 **LSD**

Groups	Average	Pre	Post	Final	Normal
Pre	5.714		-6.444	-4.650	-7.761
Post	12.158			1.793	-3.111
Final	10.365				-3.111
Normal	13.476				

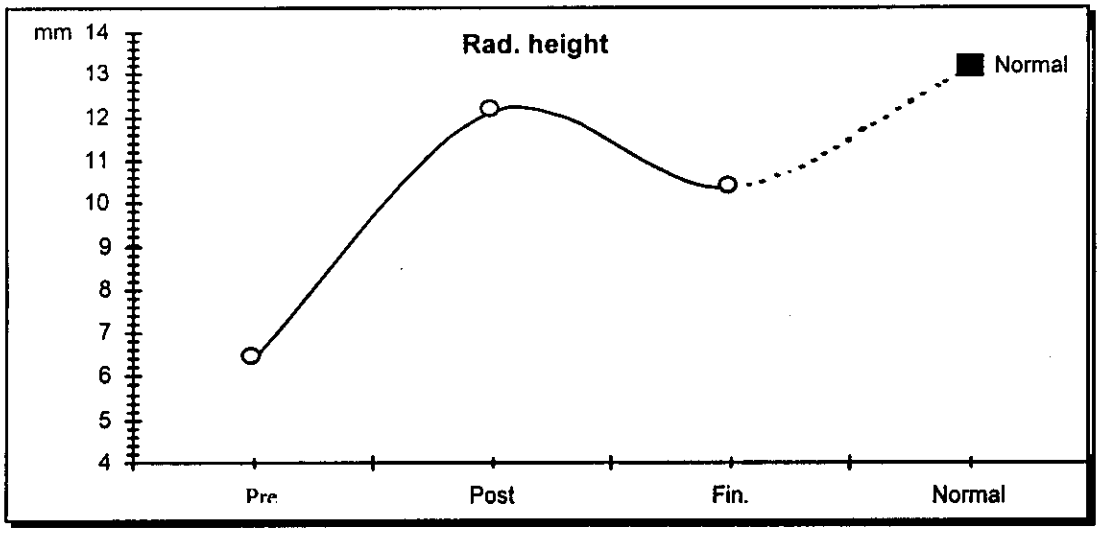


Table (48): Statistical analysis of radial height measurements.

Table (49): Final end results of volar tilt, and its grading according to Sarmiento and Latta's modification of lidstram classification (1981).

Degree of dorsal angulation	Grade	No. of fractures	%
Less than 0°	Excellent	55	87.31
0°	Excellent	6	9.52
1-10°	Good	2	3.17
11-14°	Fair	0	0.00
≥ 15°	Poor	0	0.00
Total		63	100.00

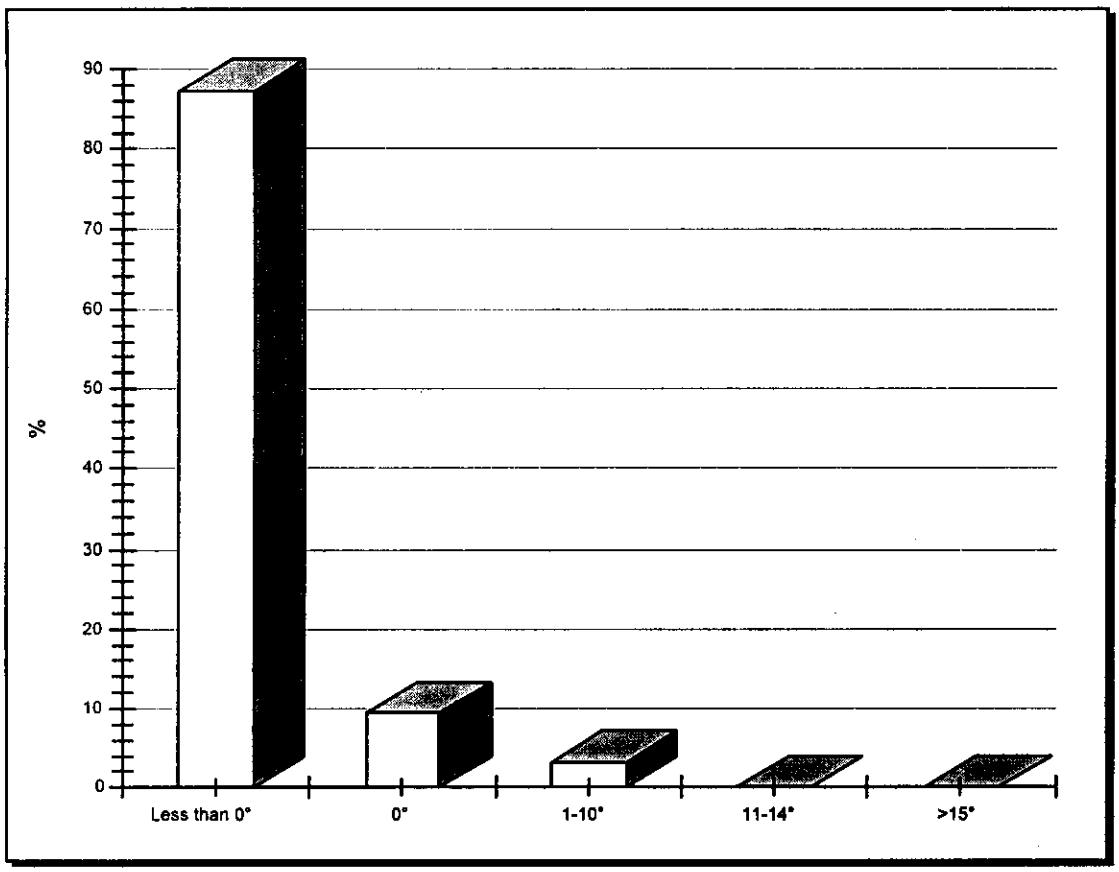


Fig. (65): Histogram of final radiologic results of volar tilt.

Table (49) shows that 96.8% of studied cases showed excellent volar tilting at time of final assessment.

Table (50): Ulnar tilt final grading according to Sarmineto & Latta's modification of lidstram classification (1981).

Ulnar tilt	Grade	No. of fractures	%
≤ 4°	Excellent	48	76.19
5 - 9°	Good	7	11.11
10 - 14°	Fair	5	7.94
≥ 15°	Poor	3	4.76
Total		63	100.00

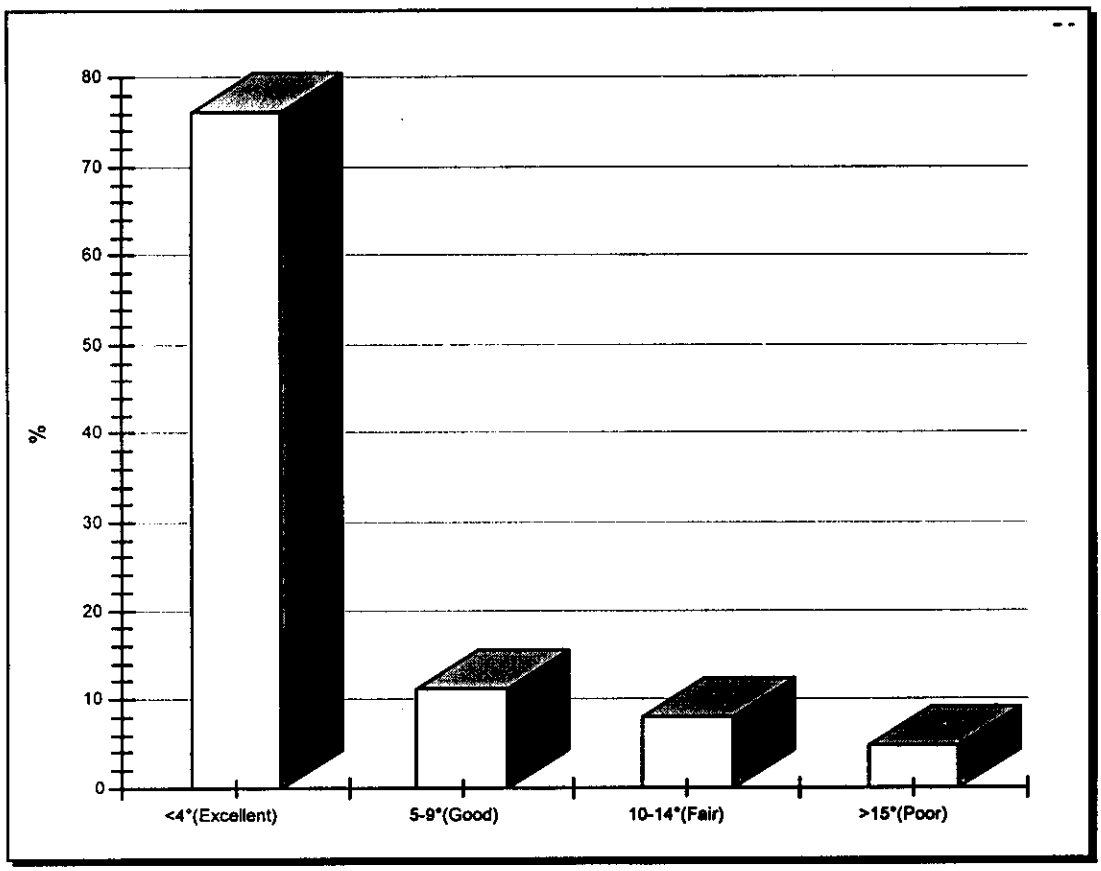


Fig. (66): Histogram of final radiologic measures of ulnar tilt.

Table (50) shows that 87.30% of cases showed excellent or good ulnar tilting at the time of final assessment.

Table (51): Radial shortening grading according to Sarmiento & Latta's modification of Lidstram classification (1981).

Radial shortening	Grade	No. of fractures	%
< 3 mm	Excellent	35	55.56
3-6 mm	Good	21	33.33
7 – 11 mm	Fair	6	9.52
≥ 12 mm	Poor	1	1.59
Total		63	100.00

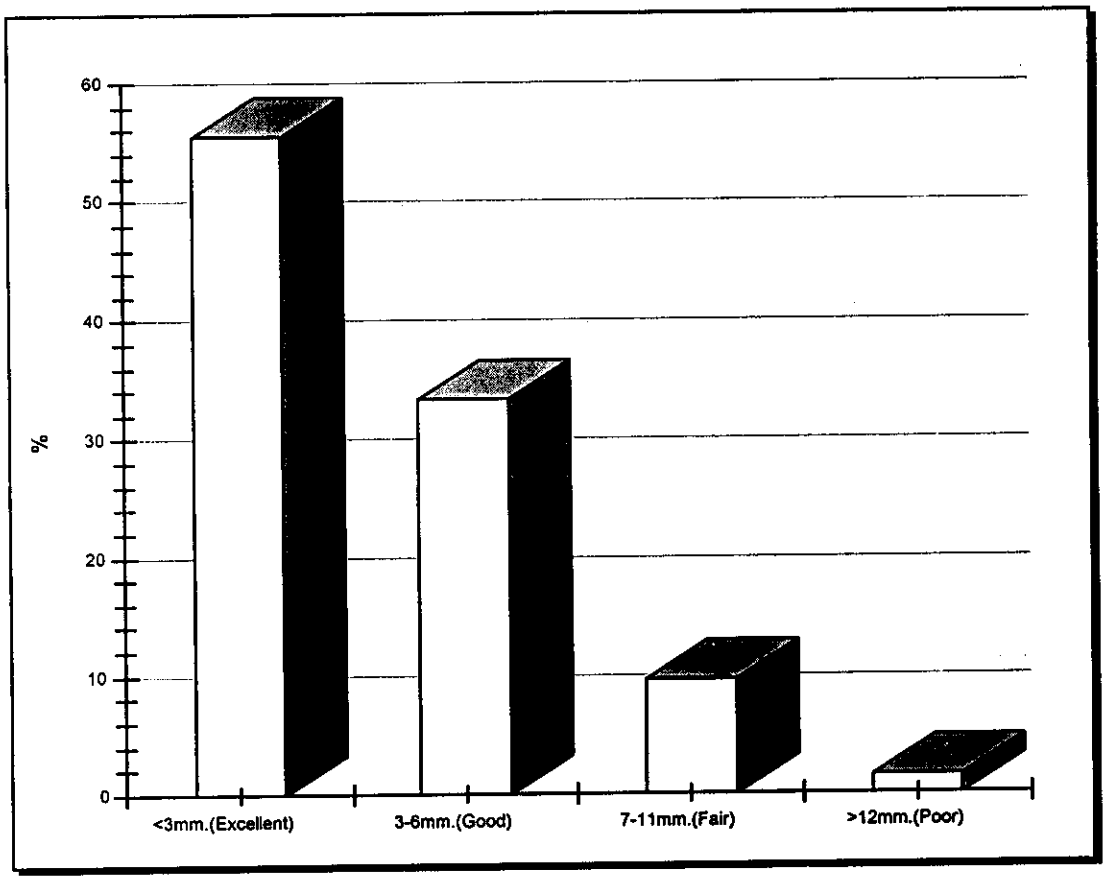


Fig. (67): Histogram of final radiologic results of radial height.

Table (51) shows that 88.8% of cases showed excellent or good radial height obtained.

Statistical analysis of the radiologic results obtained by percutaneous pinning and external fixation showed that the ulnar tilt and radial height did not show any significant statistical difference between the two methods of treatment used. While, volar tilt, radial and dorsal shift were significantly different as volar tilt was improved better with P.C.P. while dorsal and radial shift were controlled better with external fixators, (Tables 52-56).

VOLAR TILT

Preoperative: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	18.543	-23.411
Variance	212.564	123.882
Standard deviation	14.579	11.130
Observations	45	18
Pooled variance	189.303	
Df	61	
t-state	1.246	
P (T<=t) one-tail	0.108	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.217	
t Critical two-tail	1.999	

Final: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	11.586	7.176
Variance	29.358	49.029
Standard deviation	5.418	7.002
Observations	45	18
Pooled variance	34.518	
Df	61	
t-state	2.644	
P (T<=t) one-tail	0.005	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.010	
t Critical two-tail	1.999	

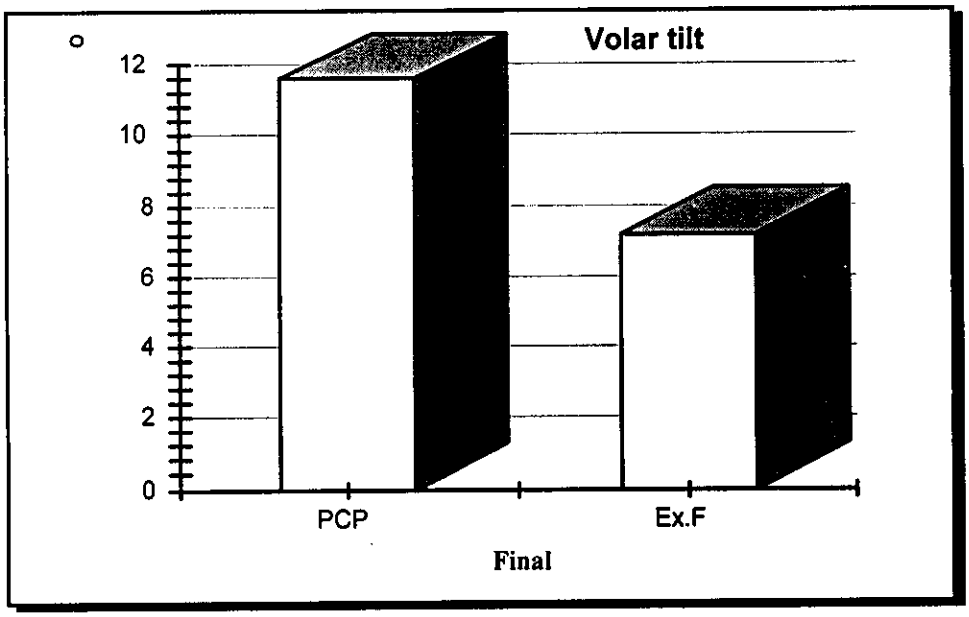


Table (52): Volar tilt with PCP and Ex. fixation.

ULNAR TILT

Preoperative: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	13.130	9.117
Variance	40.382	79.235
Standard deviation	6.354	8.901
Observations	45	18
Pooled variance	50.573	
Df	61	
t-state	1.988	
P (T<=t) one-tail	0.025	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.051	
t Critical two-tail	1.999	

Final: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	17.804	18.058
Variance	36.027	62.933
Standard deviation	6.002	7.933
Observations	45	18
Pooled variance	43.084	
Df	61	
t-state	-0.136	
P (T<=t) one-tail	0.445	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.891	
t Critical two-tail	1.999	

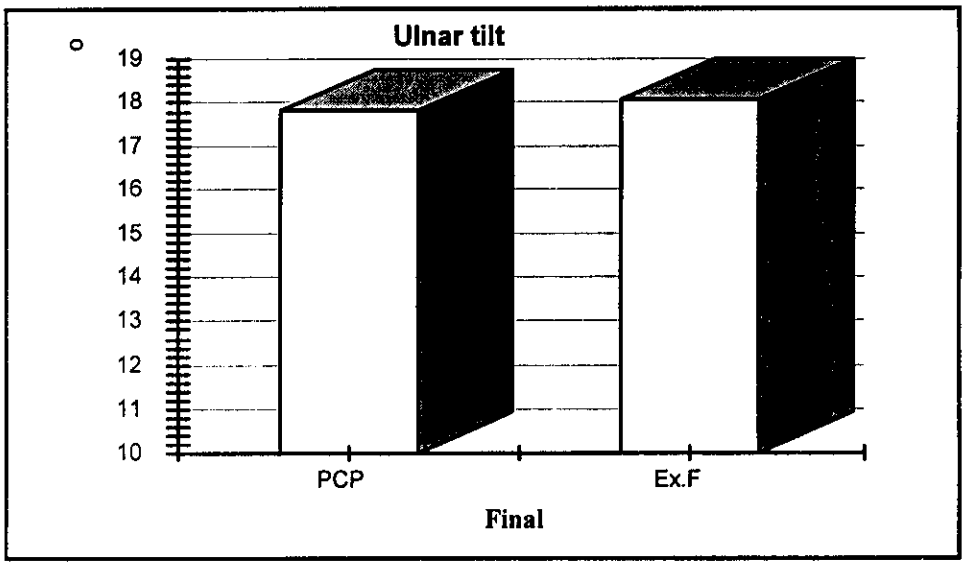


Table (53): Ulnar tilt with PCP and Ex. Fix.

RADIAL SHIFT

Preoperative: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	19	20.176
Variance	10.133	16.779
Standard deviation	2.183	4.096
Observations	45	18
Pooled variance	11.876	
Df	61	
t-state	-1.202	
P (T<=t) one-tail	0.116	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.233	
t Critical two-tail	1.999	

Final: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	17.108	15.362
Variance	5.210	16.867
Standard deviation	2.282	4.107
Observations	45	18
Pooled variance	8.267	
Df	61	
t-state	2.151	
P (T<=t) one-tail	0.017	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.035	
t Critical two-tail	1.999	

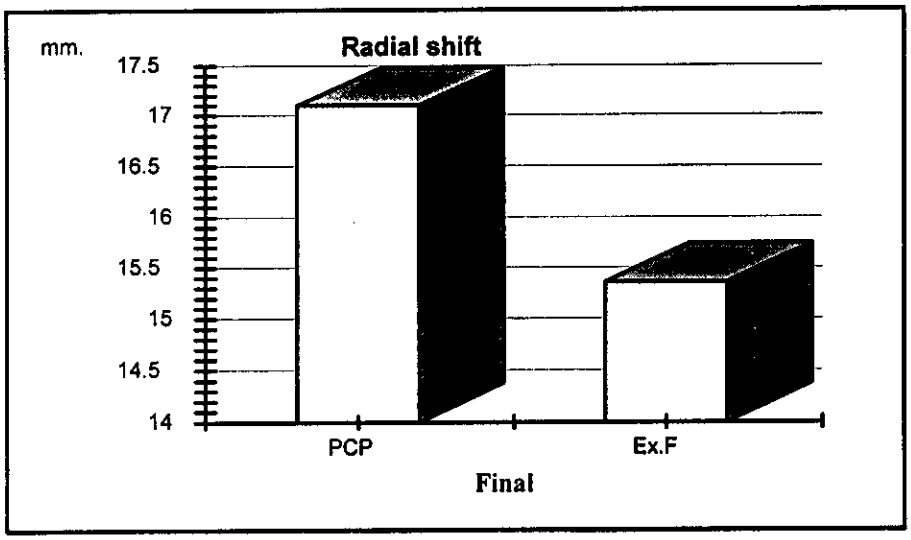


Table (54): Radial shift with PCP and Ex. fixation.

DORSAL SHIFT

Preoperative: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	17.869	16.294
Variance	14.115	9.720
Standard deviation	3.757	3.117
Observations	45	18
Pooled variance	12.963	
Df	61	
t-state	1.541	
P (T<=t) one-tail	0.064	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.128	
t Critical two-tail	1.999	

Final: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	13.760	11.647
Variance	6.452	3.867
Standard deviation	2.540	1.966
Observations	45	18
Pooled variance	5.774	
Df	61	
t-state	2.099	
P (T<=t) one-tail	0.001	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.002	
t Critical two-tail	1.999	

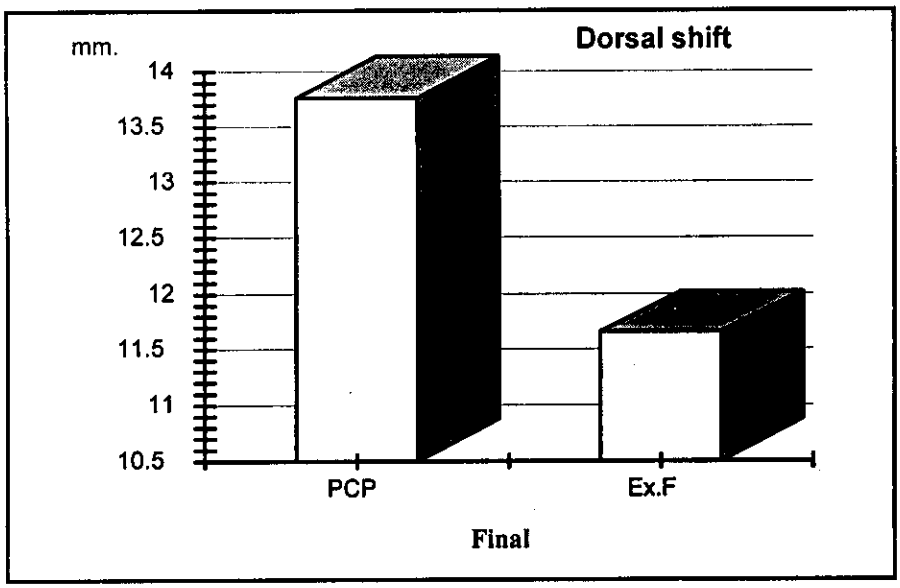


Table (55): Dorsal shift with PCP and Ex. fixation.

RADIAL HEIGHT

Preoperative: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	6.391	3.882
Variance	16.021	13.610
Observations	45	18
Pooled variance	15.388	
Mean Difference	0	
Df	61	
t-state	2.253	
P (T<=t) one-tail	0.013	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.027	
t Critical two-tail	1.999	

Final: T-test: two-sample assuming equal variances.

	PCP	Ex. F
Mean	10.347	10.411
Variance	13.165	15.757
Observations	45	18
Pooled variance	13.845	
Mean Difference	0	
Df	61	
t-state	- 0.060	
P (T<=t) one-tail	0.475	
t Critical one-tail	1.670	
P (T < =1) two-tail	0.951	
t Critical two-tail	1.999	

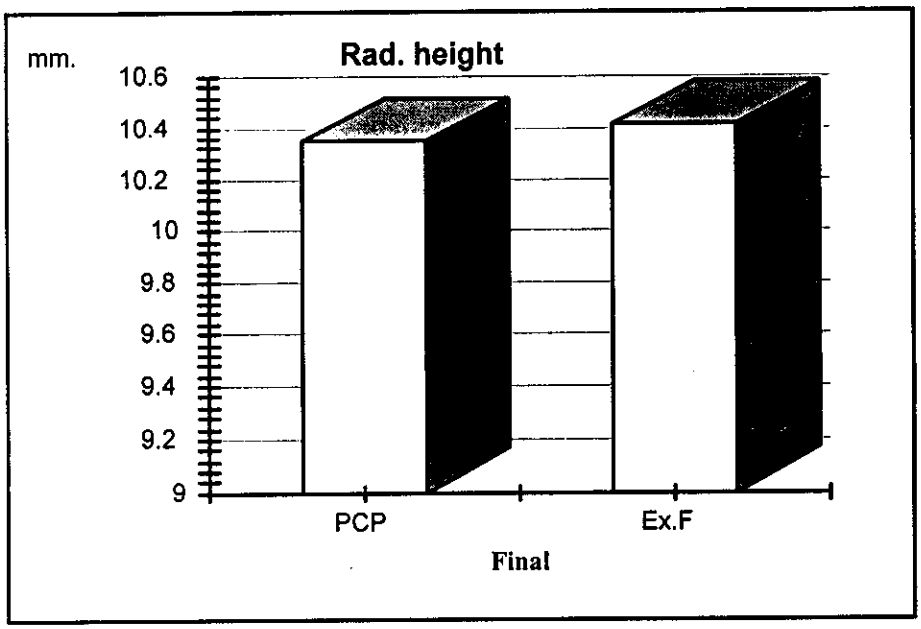


Table (56): Rad. height with PCP and Ex. fixation.

The final radiological scoring according to ***Sarmiento and Latta's*** modification of Lidstrom classification **(1981)** is shown in table (57) and Fig. (68). The excellent and good results obtained with PCP were 82.22% while those obtained with external fixation were 66.66%.

Table (57): Final radiologic scoring.

Radiologic score	P.C.P.		Ex. Fixation		Total techniques	
	No.	%	No.	%	No.	%
Excellent	22	48.89	8	44.44	30	47.62
Good	15	33.33	4	22.22	19	30.16
Fair	4	8.89	5	27.78	9	14.28
Poor	4	8.89	1	5.56	5	7.94
Total	45	100.00	18	100.00	63	100.00

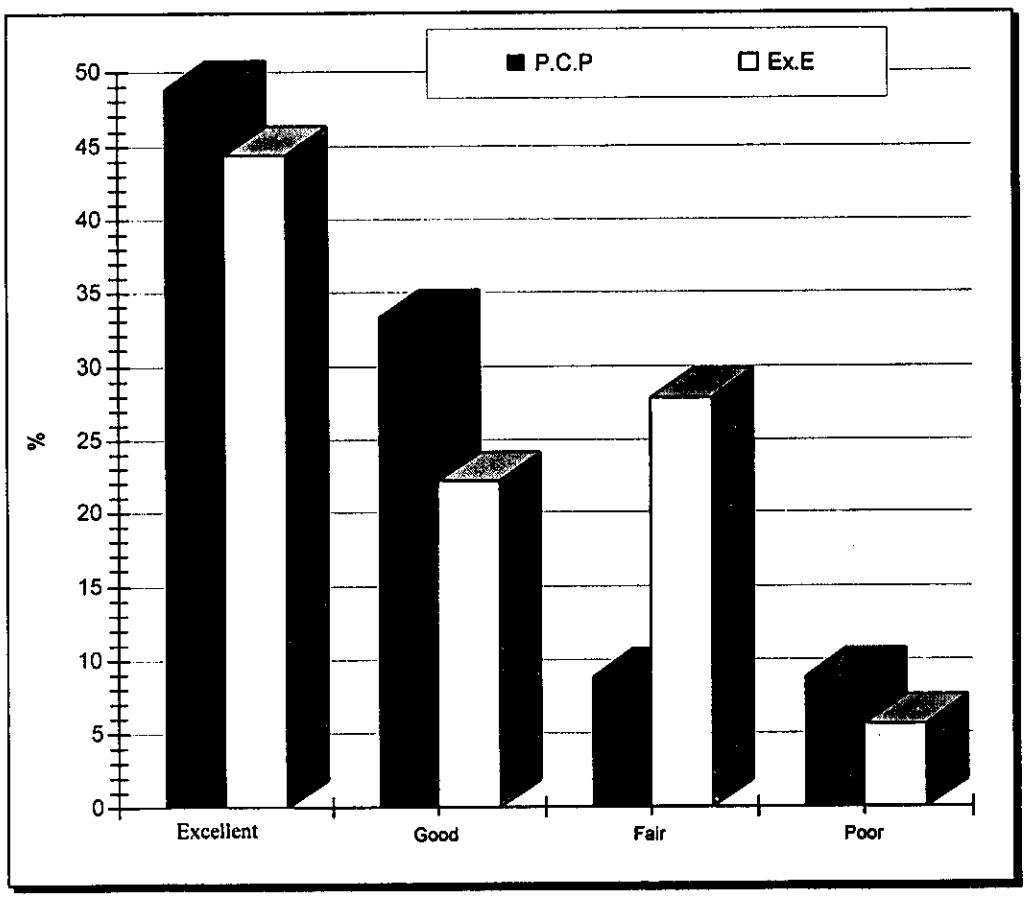


Fig. (68): Final radiological scoring.

* Radio-carpal joint congruity was measured and scaled according to the scale of ***Knirk and Jupiter (1986).*** Table (58) and Fig. (69) show that 93.65% of fractures showed a step of less than 1 mm at time of final assessment.

Table (58): Grading of RCJ incongruity pre and post-operatively.

Grade	Pre-operative		Final	
	No.	%	No.	%
O: Step < 1mm	34	53.97	59	93.65
I: Step 1-2 mm	8	12.70	4	6.35
II: Step 2-3 mm	5	7.94	0	0.00
III: Step > 3mm	2	3.17	0	0.00
Impacted or rotated	14	22.22	0	0.00
Total	63	100.00	63	100.00

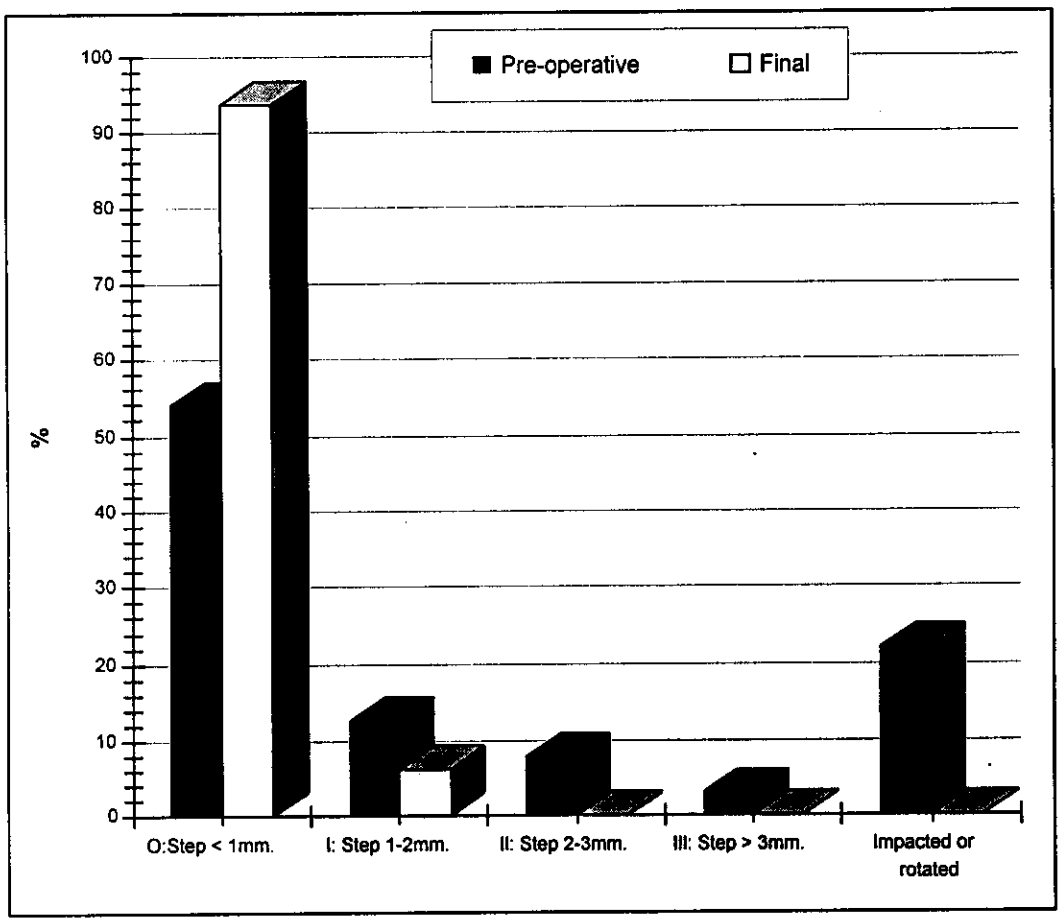


Fig. (69): Graph for RCJ incongraity pre and post-operatively.

* Inferior radio-ulnar joint incongruity was estimated on the light of ***Metz and Gilula (1993)*** discreption, table (59) and Fig. (70).

Table (59): IRUJ incongruity pre and post-operatively.

Grade	Pre-operative		Final	
	No.	%	No.	%
Congruient	2	3.17	36	57.14
Mild incongruity	30	47.62	23	36.51
Mod. Incongruity	18	28.57	3	4.76
Sever incongruity	13	20.64	1	1.59
Total	63	100.00	63	100.00

* Mild incongruity = sublaxation. Moderate & severe incong. = dislocation.

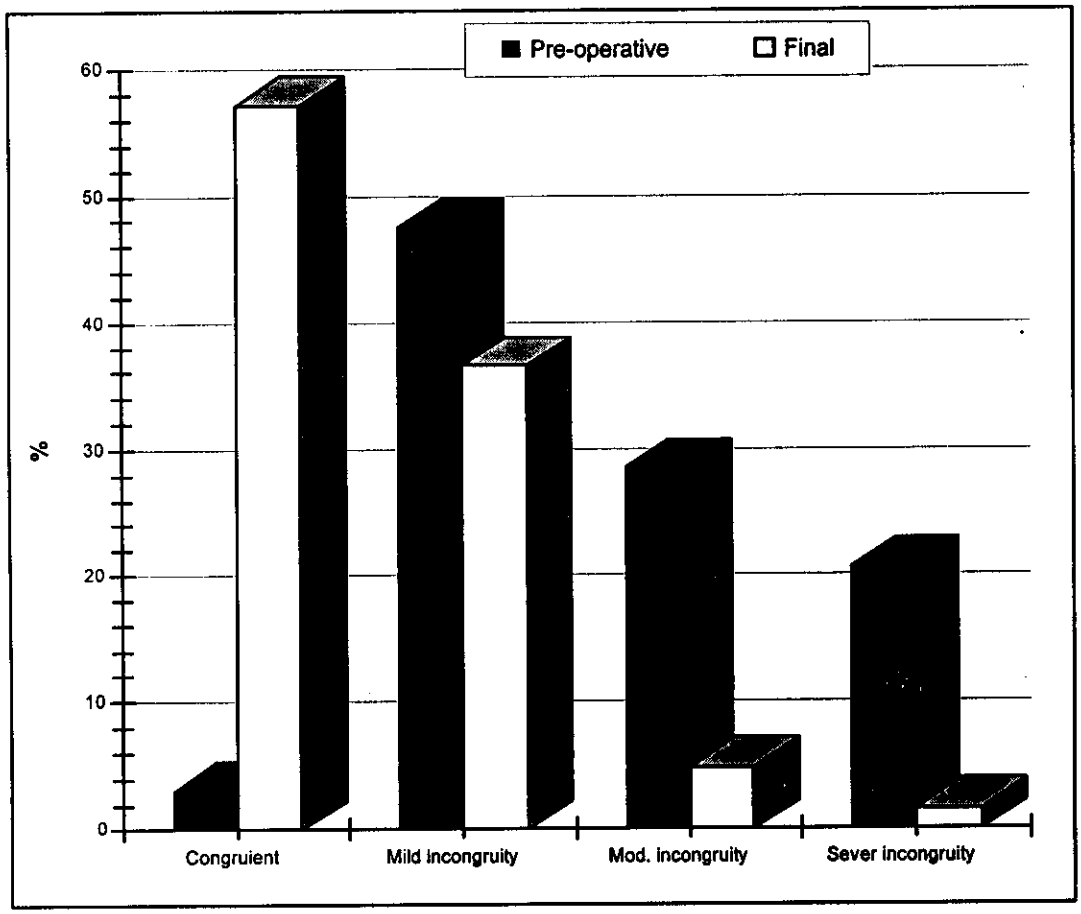


Fig. (70): Graph for IRUJ incongruity pre and post-operatively.

Wrist and forearm movements regained:

The mean values of the wrist and forearm movements (at the time of final assessment) of the healthy and injured sides are shown in table (60) and Fig. (71). All these measures showed significant statistical improvement.

Table (60): Mean of final results of wrist and forearm movements.

Movement	Sound side		P.C.P.		Ex. Fixation		All cases	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Doris-flex	45-90	68.79	45-85	67.67	30-80	60.72	30-85	63.97
Palmar-flex	30-90	65.56	25-80	58.55	30-75	51.66	25-80	55.1
Rad. Dev.	5-35	24.11	5-30	20	10-30	17.5	5-30	18.75
Ulnar dev.	20-45	34.60	5-45	27	10-35	25	5-45	26
Pronation	70-90	80.97	40-90	73.44	60-85	75.55	40-90	74.49
Supination	60-90	82.74	40-90	73.55	25-90	73.05	25-90	73.3

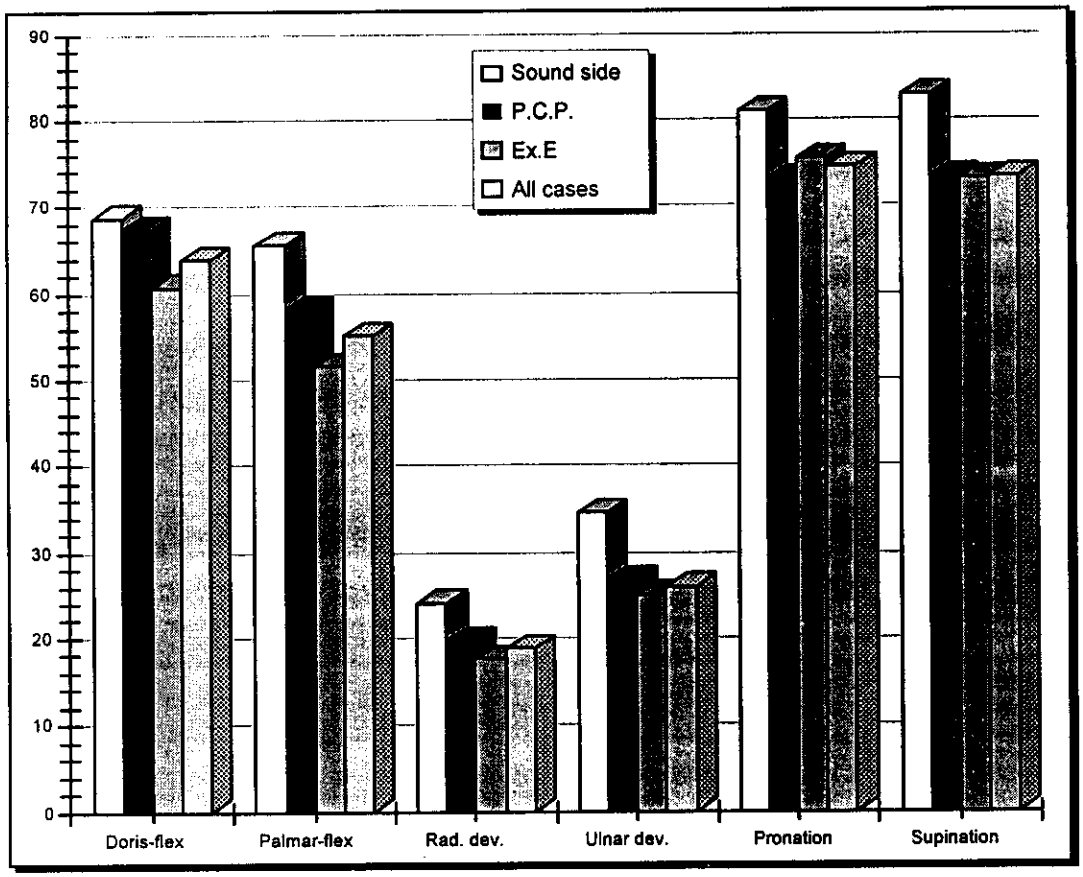


Fig. (71): Diagram of final forearm and wrist movements regained.

The final total wrist joint and forearm functional limitations obtained are show in table (61). Nearly 88% of cases showed normal or less than 30% loss of range of total wrist and forearm movements.

Table (61): Wrist and forearm motion final total scoring.

Final range obtained	No.	%
Normal range	21	33.33
< 30% loss of range of movements.	34	53.97
Minimal functional loss.	4	6.35
Less than minimal	4	6.35
Total	63	100.0

Grip strength score analysis at the final assessment is shown in table (62), which shows that 60% of cases showed normal or less than 15% loss of grip strength at time of final assessment.

Table (62): Final total grip scoring.

Grip strength	No.	%
Normal	11	17.46
≤ 15% loss	27	42.86
16-30% loss	20	31.75
> 30% loss	5	7.93
Total	63	100.00

Residual pain and subjective functional limitations and handcapping as suggested by the patients are shown in table (63) and Fig. (72).

Table (63): Pain/functional limitations final scoring.

Pain/function	No.	%
Non/normal	19	30.16
Mild occasional/slight limitation	33	52.38
Moderate, needs analgesics/ some limitation	11	17.46
Severe/weak with loss	0	00.00
Total	63	100.0

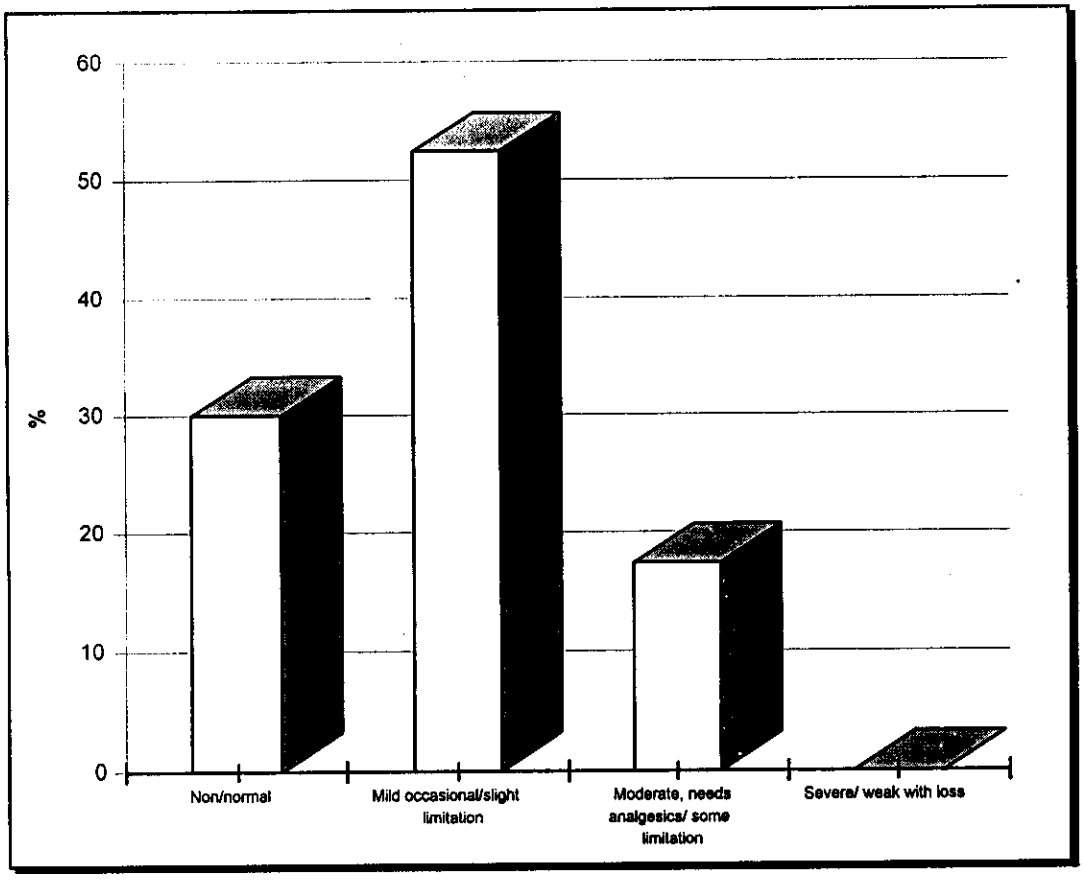


Fig. (72): Graph for final pain/functional limitations.

Final **residual deformity** is shown in table (64). The vast majority of patients (92%) showed no deformity.

Table (64): Total residual deformity scoring.

Deformity	No.	%
None	58	92.06
Slight	5	7.94
Obvious	0	00.00
Total	63	100.0

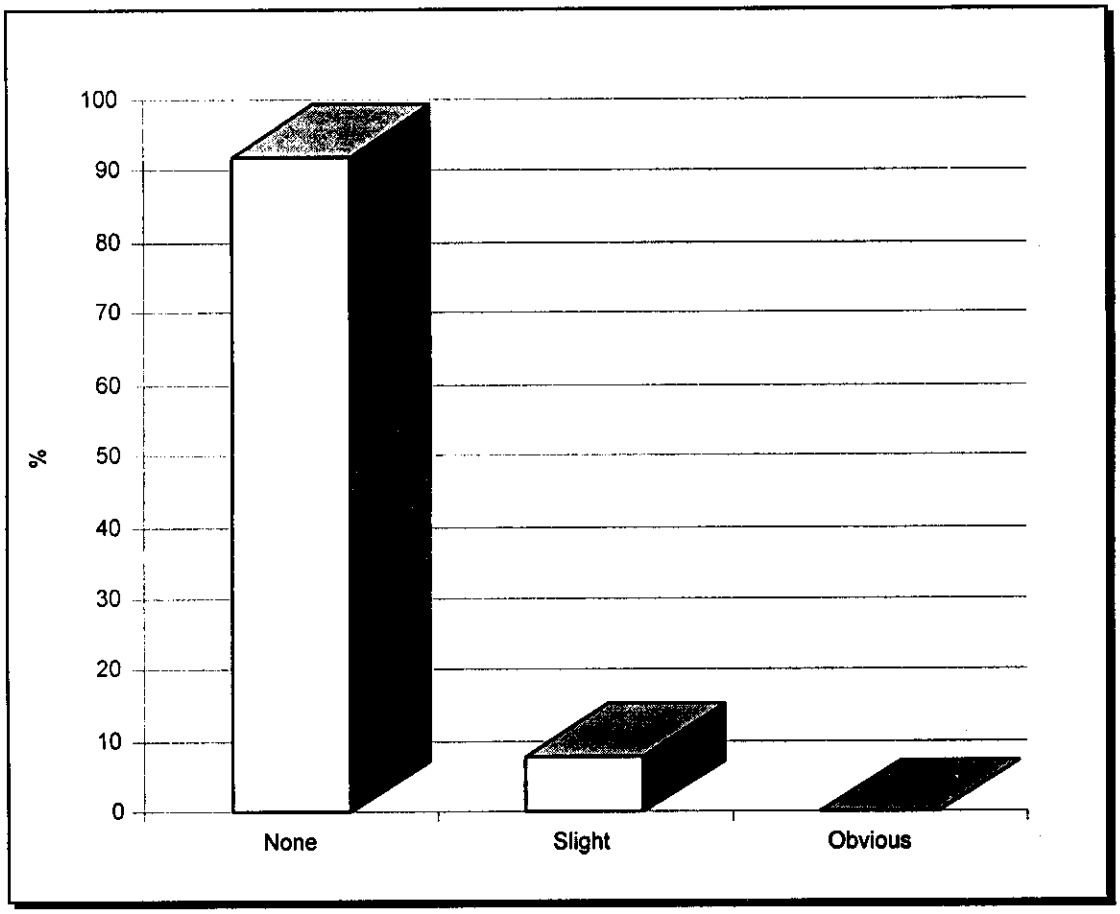


Fig. (73): Diagram of final residual deformity.

Final end results obtained with per-cutaneous pining, external fixation and both techniques are shown in table (65).

Table (65): Final end results.

Final score	P.C.P.		Ex. Fixation		Total	
	No.	%	No.	%	No.	%
Excellent	16	35.56	6	33.34	22	34.92
Good	16	35.56	4	22.22	20	31.75
Fair	8	17.78	4	22.22	12	19.05
Poor	5	11.10	4	22.22	9	14.28
Total	45	100.00	18	100.00	63	100.00

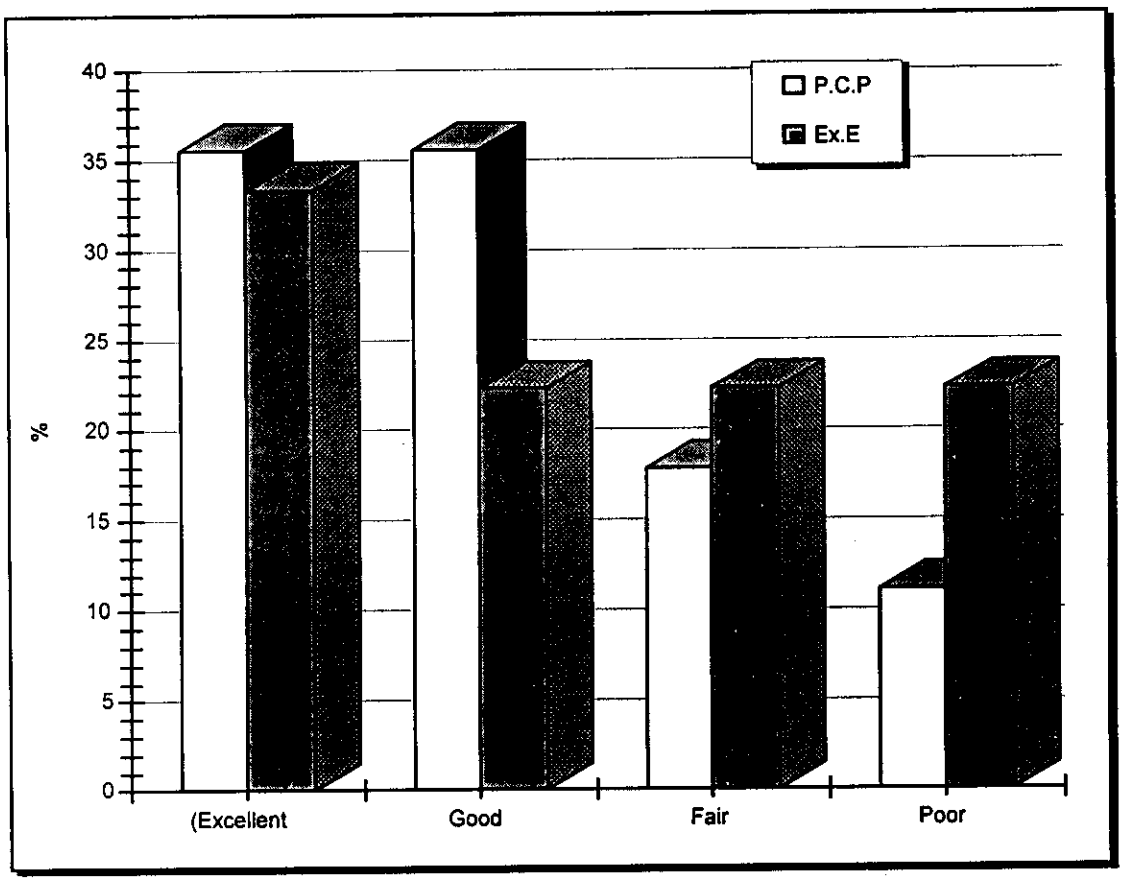


Fig. (74): Diagram of final end results of treatment by different techniques.

So, a final end result as excellent or good of 71.12% was obtained with PCP, as compaired to 55.56% obtained with external fixation.

Recorded complications (Table 66):

1- Peripheral circulation:

None of the patients showed any sign of impaired finger's perfusion or compartmental compression during the post-operative course.

2- Neurologic affection:

- Symptoms of irritation of the superficial sensory branch of the radial nerve were present post-operatively in 3 (4.76%) cases. All of them were managed by PCP. These symptoms subsided completely 2 weaks post-operatively in 2 cases and 5 weaks later in the remaining one case.
- Hyposthesia at the area of distribution of the median or median and ulnar nerves (present pre-operatively in 9 cases) was completely recovered in the first few weaks post-operatively.

3- Tendon injury:

In addition to the patient presented with ruptured extensor pollicis longus tendon at the time of initial assessment, another case (1.59%) was discovered at 7 weaks postoperatively to have a late tendon rupture. Both patients refused doing a tendon repair. However, both of them had a final good score.

4- Post-operative swelling:

Out of the 30 patients presented pre-operatively with mild limb swelling, 5 patients developed moderate swelling post-operatively. Another 2 patients out of those presented with moderate limb swelling (24 patients); developed severe post-operative swelling.

At the 7^{th} day post-operatively, only 2 cases of the whole series were found to have mild finger and wrist swelling which subsided completely after further 3 days.

5- Fingers and thumb movements:

By the end of the 3rd post-operative weak, 26 (41.27%) patients have near full range of finger and thumb movements. Three months post-operatively, they became 47 (74.60%) patients. At the time of final assessment only 2 patients (3.17%) who had mild finger movements limitations; these were treated by combined open reduction and external fixation.

6- Loss of reduction:

- Only one fracture which was severely comminuted and displaced (and was managed by OR and Ex. F.) showed complete loss of position of bony fragments following faulty support by the patient on the affected limb (the patient had accompanied bilateral supracondylar fracture femur and fractured shaft femur). This occurred 3 weaks post-operatively and the patient's general condition did not allow another setting of general anaesthesia and remanipulation. The final total score of this limb was "poor".
- Another 3 cases (managed by PCP) showed mild radial or dorsal shift during the follow-up period. This was 1-2 mm displacement and had a very limited influence on patient's final score.

7- Pin tract infection:

- Superficial pin tract infection occurred in 4 cases managed by PCP around the 3rd weak post-operatively and were managed by daily washing with saline and alcohol and application of local bacitracin powder. This was subsided completely after K-wires removal.
- 2 cases of superficial infection around the pins of the external fixator were recorded at the 5th weak post-operatively. They were managed and subsided in the same way mentioned above.

8- Pin loosening:

- With the use of external fixators no pins were found to be loose at time of pin removal except in one case in which pins were found to be removed with ease (but can not be withdrawn without rotation in the ante-clock wise direction). This case was an old, mildly osteoporotic female.
- With K-wires; 5 cases were found to have the pins extracted without any remarkable bony resistance. All were above the age of 60 years.

9- Pin breakage:

A broken schanz pin (2.7 mm) was discovered during removal of the pins of an AO small external fixator in a musculine young male, 26 years old, with a Frykman's type VII DRF. His final score was excellent.

10- Reflex sympathetic dystrophy:

Only one case with Frykman's type VIII DRF who was a 49 years old female and managed by CREF; developed the classic signs of this disease. Inspite of early intensive physiotherapy and proper treatment course and early active mobilization, this patient had residual moderate finger and wrist motion limitation at the final assessment 24 months post-operative. Her final score was poor inspite of a fair radiologic score obtained.

11- Persistant wrist pain:

8 cases of persistant wrist pain were recorded at the time of final assessment. All were of the moderate severity which occurs on exertion and relieved by rest and simple analgesics. 5 cases (7.94%) described diffuse dorsal wrist joint pain. The remaining 3 cases (4.76%) described only ulnar wrist pain. Local tenderness was elecited over the IRUJ in all the 8 cases. The IRUJ was found to be sublaxed in all of the 8 cases.

12- Non-union of the fractured ulnar styloid:

Out of the 44 fractures presented with an associated ulnar styloid fracture, only 5 fractures (11.36% out of 44) showed healing of the fractured ulnar styloid. These 5 fractures were ulnar styloid basal fractures with no or minimal initial displacement, Table (66).

Table (66): Early and late post-operative complications.

Complication*	Early 3 m, postoperative		At final assessment	
	No.	%	No.	%
1- Ulnar styloid non-union	39	88.64	39	88.64
2- Persistant wrist pain.	17	26.88	8	12.98
3- Finger stiffness (mild)	16	25.40	2	3.17
4- Pin loosening	6	9.52	-	-
5- Pin tract infection (superficial)	4	6.35	-	-
6- Loss of reduction: Partial:	3	4.67	3	4.76
Complete:	1	1.59	1	1.59
7- Injury to superf. Rad. N.	3	4.76	0	-
8- Pin breakage	1	1.59	1	1.59
9- Reflex sympth. Dystrophy	1	1.59	1	1.59

* A total complication rate of 36% was reported in the present series.

DISCUSSION

Distal radius fractures continue to be one of the most common skeletal injuries treated by the orthopaedic or trauma surgeon. Because of this frequency and the impact of the old teaching of Colles and others, this fracture is usually managed by inexperienced junior staff-in many centres; and this accounts for the high percentage of complications associated with such policy of simple conservative management of most of DRFs. As DRFs display infinite variety and behave individually, some authors concluded that no two DRFs are alike; and the management should be individualized to the specific personality of each fracture.

This led to a lot of controversy about the management of DRFs specially unstable fractures. This is because that although these fractures may be easily reduced by traction and manipulation, but it is sometimes extremely difficult to maintain this position and prevent secondary displacement.

Another part of the problem is that inspite of the strong correlation between restoration of the anatomy and the functional outcome, "a poor anatomic results does not preclude satisfactory function, while a good anatomic restoration does not assure a good functional results" ***Jupiter and Masem (1988).*** This is because of the associated (and usually unrecognized) soft tissue injuries.

- **The incidence:** It was found that DRFs account for about 15% of all fractures in adults received in the trauma department during the period of this study.

It forms about 20% of all upper limb fractures received during the same period.

The surgically treated 63 fractures formed 27% of all treated DRF. During the period of this study.

- **The age** of the studied patients ranged from 18 to 80 years old, the mean was 46.89 years.

24.19% of patients were between the age of 40 and 49 year old.

This group formed the commonest age incidence group.

Table (67) and Fig. (75) show a comparison between the age of the patients in different studies series, indicating comparable data.

Table (67): Comparison of age in different series.

Series	No. of patients	Age "years"	
		Range	Mean
Clancy, 1984	30	18-89	75
Clyburn, 1987	31	18-64	40
Jakim et al., 1991	132	18-62	35
Raskin & Melone, 1993	60	18-73	55
Suso et al., 1993	30	18-75	41
Britchett, 1995	100	34-83	65
Ludvigsen et al., 1997	60	31-89	60
Oskam et al., 1997	21	25-78	57
Present series	62	18-80	47

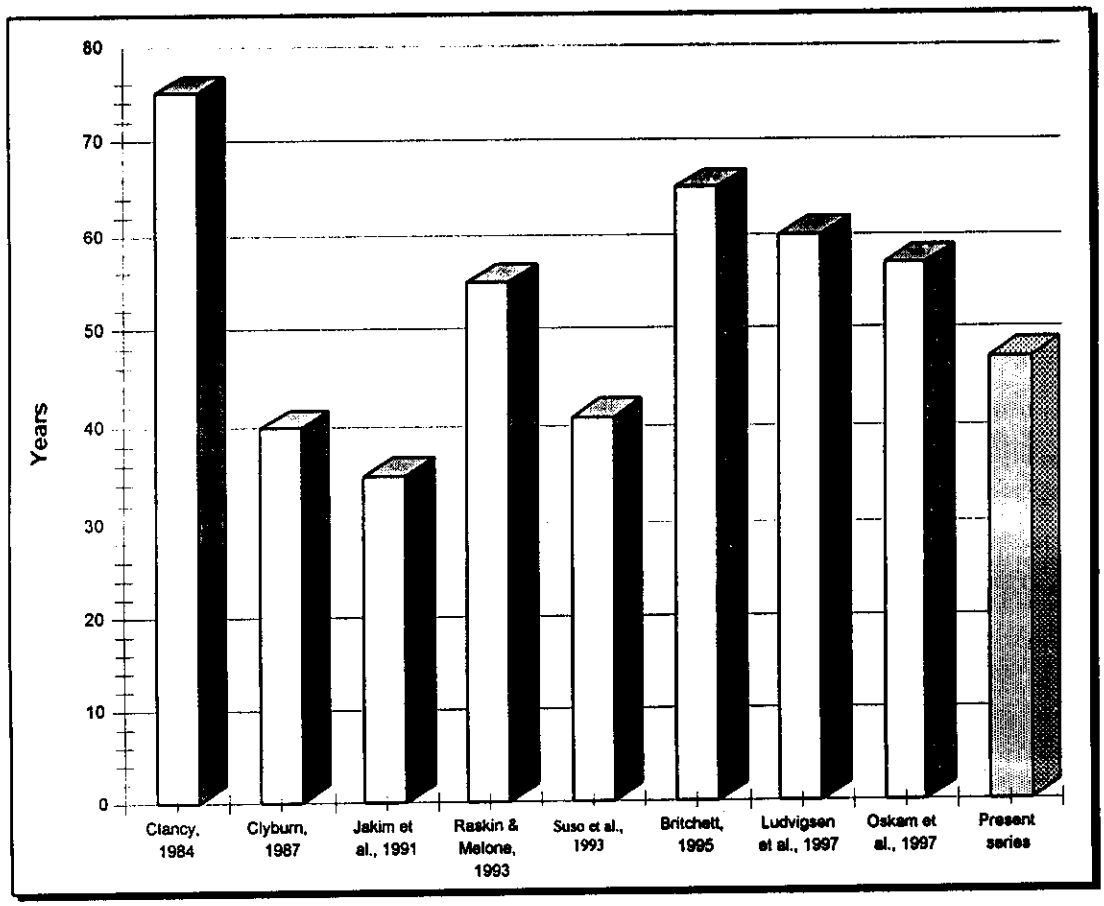


Fig. (75): Comparison of age in different series.

Clyburn (1987), discouraged the use of external fixation in patients over 65 years old. ***Jenkins et al. (1987) and Howard et al. (1989)*** suggested age limits of 70 and 75 years respectively. In this series, age was not a factor in the choice of treatment. Bone quality and patient's activity and demands were of more interrest. This opinion was shared by ***Pritchett (1995).*** So, the oldest case managed by an external fixator in this series was a 75 years old female, and by PCP a male and a female each of 60 years old.

A final end results as excellent or good scoring was obtained in a percentage of 91.6%, 90%, 87.5% and 53.3% in age groups: 30-39, 18-29, 50-59 and 40-49 respectively as compared to a percentage of 50% and 16.7% in older age groups of 60-69 and 70-80 years respectively. So,

as a result of the present study it was found that the younger the patients age, the better the final end results. This may be attributed to better tolerability of injury, better bone quality, better articular surface condition, higher healing power and better cooperation with the physiotherapy programm in the younger age groups.

- **Sex:** Females' incidence was slightly higher than that of males included in the study. This slightly higher females' incidence may be attributed to hormonal factors leading to osteoporosis and general factors such as activity and occupation (most of the patients were female house keepers, farmers or office helpers). ***Oskam et al. (1997)*** reported an incidence of 71.4% of female affection with DRF in his series.

- **Occupation:** The highest incidence was among female house keepers (18 cases = 29.03%) next comes male and female farmers (12 cases = 19.35%), then office helpers (8 cases = 12.90%). This may be attributed to more activity and subsequently liability to injury is increased.

- **Side affected and hand dominance:** The left side was injured more, (34 patients = 54.84%), next comes the right side (27 patients = 43.55%) and lastly comes bilateral injury in one case (1.61%).

An excellent or good result was achieved in 26 cases (76.47%) out of the 34 cases suffering a fractured non dominant hand, as compaired with 16 (59.26%) of the 27 fractures of the dominant hand. ***Knirk and Jupiter (1986)*** and others gave no correlation between hand dominance and end results.

- **Causative trauma:** Cases suffering from simple falls were of better final prognosis than the two other groups due to lesser forces applied at the time of impact to the boney ends and the soft tissues around the wrist region.

- **Associated injuries:**

*** Associated fracture of the ulnar styloid:**

An incidence of 69.84% was reported, in the present series. Table (68) and Fig. (76) show that the data of the present series are comparable to those of different series.

Table (68): Associated fracture of ulnar styloid in different series.

Series	% of associated fracture of the ulnar styloid
Knirk & Jupiter 1986	84
Villar et al., 1987	51
Leung et al., 1989	58.3
Roumen et al., 1991	69.3
Cannegiter & Juttmann, 1997	65.6
Present series	69.8

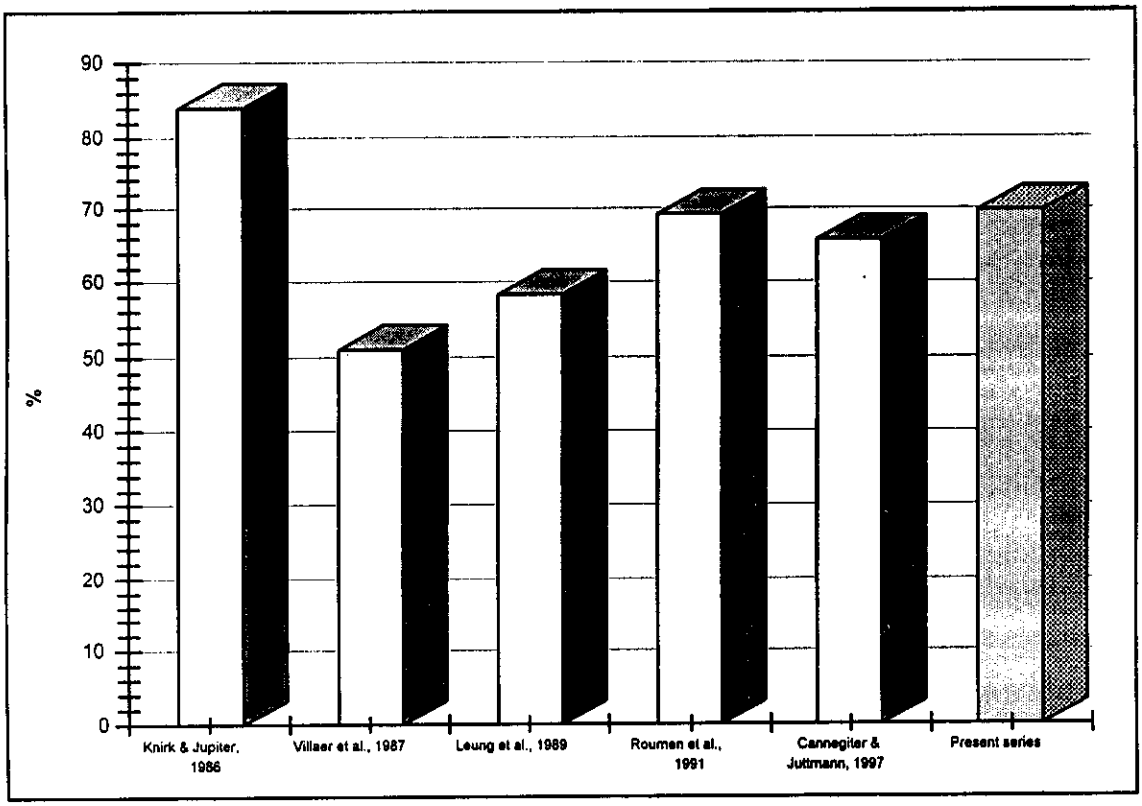


Fig. (76): Associated fracture of the ulnar styloid in different series.

*** Open fractures:**

It was reported by most authors that it is a rare event to have an open DRF., except in high velocity injuries. However, 4 cases (6.45%) were found to have a grade I open DRF.

*** Neurologic affection:**

It was reported by different authors that neurologic irritation or compression symptoms ranges from 6.63% up to 86.65% according to the type and severity of causative trauma. Simple falls accounts for lower incidence while road traffic accidents have the highest incidence ***(Melone, 1986 and Rikli & Regazzoni, 1996).***

In the present series, no cases of acute carpal or ulnar tunnel syndrome were detected pre or post-operatively. Only symptoms of local irritation of median and ulnar nerves were found in 9 cases (14.52%) pre-operatively, and it was subsided completely during the early few weaks post-operatively.

*** Associated injuries:**

Associated injuries in the same limb or other parts of the body were reported to range between 9% and 33% according to different authors.

In this series, an incidence of total injuries of 35.48% was recorded. This may be explained by a total incidence of falling from a height and RTA of 41.94%.

- **Pre-operative radiological evaluation:** Inspite of neglecting the extent and the direction of the initial displacement and the extent of the involvement of the articular surface, Frykman's classification is still the most popular and the most accepted by many authors. It is easy to recall and all DRFs could be classified according to this system.

Melone's classification of intrarticular DRFs is a good descriptive one, but is not applicable to all DRFs.

So, in the present series, these two systems were used together as a guide to the proper management. However, each fracture was assissed individually and managed on the lights of its own presonality.

A comparison of the grading of the studied fractures according to the above mentioned systems with other fractures in different series is shown in tables (69 & 70) and figures (77 & 78), showing a comparable data; between fractures included in the present series and those of other investigators.

Table (69): Fractures' grading according to Frykman's classification in different series.

Series	No. of Fracture	% of different grades							
		I	II	III	IV	V	VI	VII	VIII
Vaughan et al., 1985	52	-	-	-	←	20	→	40	40
Knirk & Jupiter, 1986	43	-	-	7	12	-	-	9	72
Leung et al., 1989	72	1.4	4.2	8.3	18	11.1	9.7	20.8	26.4
Roumen et al., 1991	101	-	2	-	-	21.8	35.6	8.9	31.7
Britchet, 1995	50	-	-	-	-	-	-	-	100
Lenoble et al., 1995	96	31.2 →		44.8 →		12.5 →		11.5 →	
McBirnie et al., 1995	83	10 →		5 →		20 →		65 →	
Cannegieter & Juttmann, 1997	32	-	-	-	-	12.5	28.1	21.9	37.5
Present series	63	1.6	1.6	3.2	3.2	-	12.7	25.4	52.3

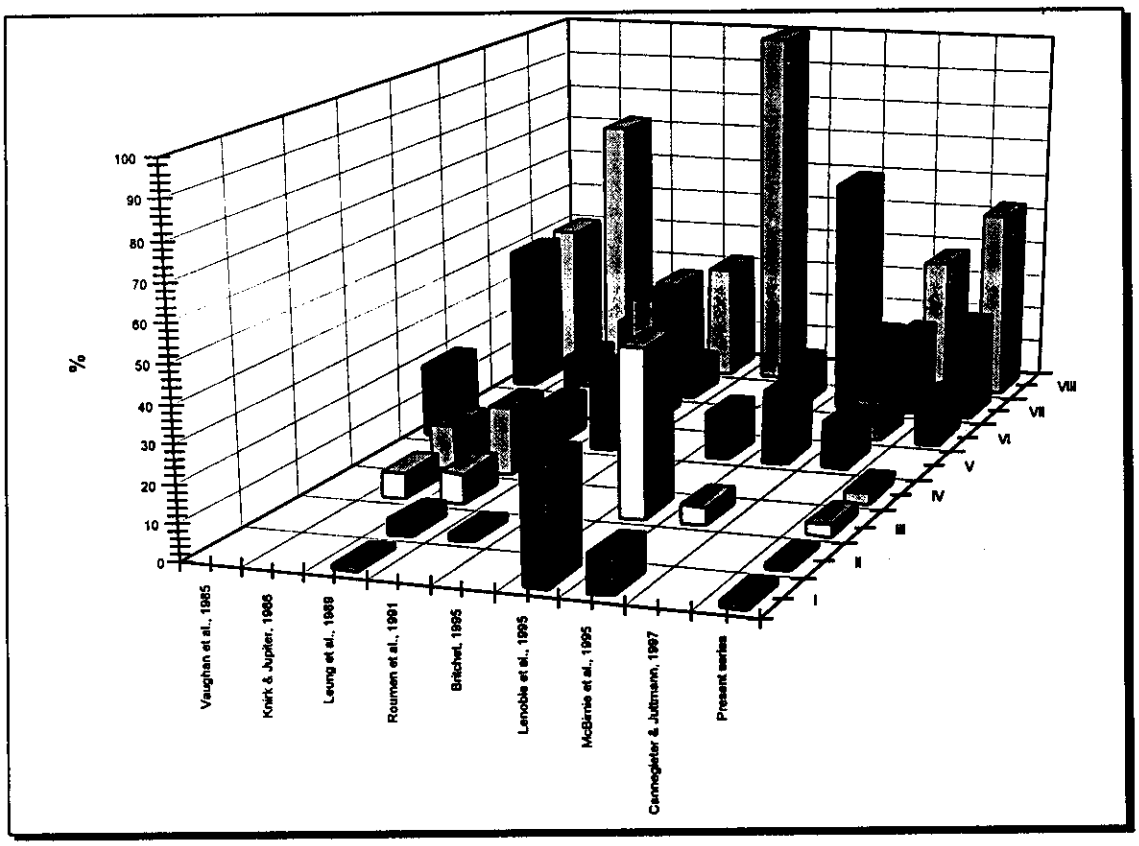


Fig. (77): Frykman's grading of DRFs in different series.

Table (70): Fractures' grading according to Melone's classification in different series.

Series	No. of fractures	% of different grades					
		I	II	III	IV	V	Unclassified
Melone, 1986	15	-	-	-	100	-	-
Axelrod & McMurty, 1990	21	4.8	47.6	25.8	23.8	-	-
Yen et al., 1991	90	23	61	16	-	-	-
Raskin & Melone, 1993	30	-	100	-	-	-	-
Present series	63	3.17	47.61	15.88	7.94	9.52	15.88

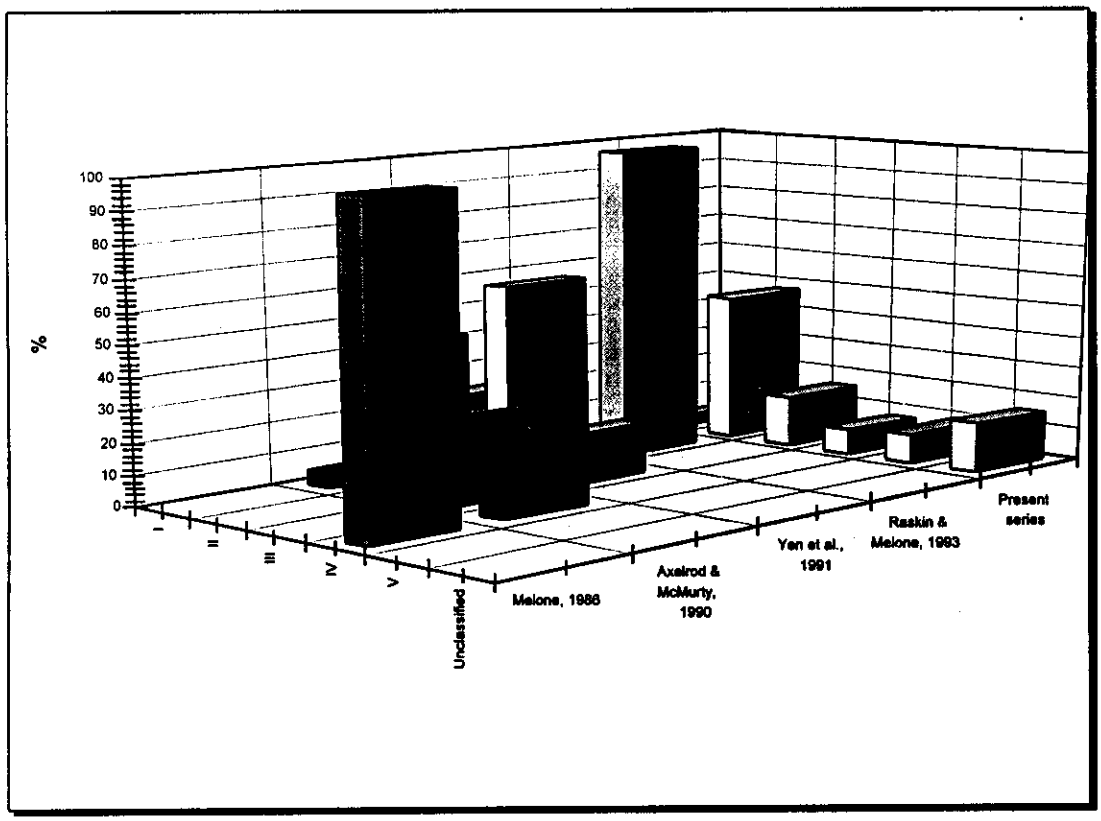


Fig. (78): Melone's grading of DRFs in different series.

Inspite of compairing the grading of fractures of the present series with those of different series using the same morphologic fracture classification, it is considered to be an inaccurate comparison. This is because fractures of the same grade in the same classification may differ markedly in the degree of comminution, displacement, angulation of major fragments, extent of metaphyseal extension, bone stock and associated soft tissue injury around the fracture site. All these make such comparison lacking accuracy as there is no single classification involve all or even most of these variants.

- It was found that, the initial supporting back slab (till preparing for the definitive treatment), limb elevation and encouraging patients to do active finger exercises were very important items in controlling limb swelling.
- The post-operative course and the final end results did not show any significant difference between cases managed immediately post-trauma and those delayed up to 11 days.
- The criteria of instability of DRFs mentioned before and the management algorithm plans suggested by many authors made the decision for which type of surgery more or less easy in most cases. This was true except in few cases presented with marked comminution, shortening and combined volar and dorsal displacement with –usually-an accompained severe limb swelling. For such patients, some controversy was present.
- General anaesthesia (or proper local I.V. anaesthesia) was a must to achieve good muscle relaxation and subsequently good reduction.
- Bi-manual closed reduction was easily done in most cases and acceptable position of the boney fragment was usually obtaind from the first manipulation except in 7 fractures (11.11%) which showed unaccepted reduction and required remanipulation.
- Nine fractures (14.29%) showed irreducibility because of marked comminution and severe impaction and they required open reduction to reduce a severely displaced or rotated fragment or to elevate a depressed impacted articular fragment. It was noted that a depressed central articular fragments of distal radial articular surface, did not show reduction-usually on traction. It usually needed an open reduction, elevation and insertion of a bone graft. This was attributed to its devoidence from ligamentous attachments as compaired to lateral and medial articular ends.

Special problems were faced during closed reduction. The first was restoration of the volar tilt is some cases. This was the most common problem met with in most cases presented with severe dorsal angulation and intra-articular comminution. Remanipulation and insertion of dorsal K. wires as described in Kapandji technique to elevate the distal fragment and rotate it to a more acceptable volar position were not always successful. When ligamentotaxis is restorted to, applying traction across the wrist, the volar ligaments, which are short and tough, tighten first thus preventing the distal radius from inclining in a volar direction. Even with open reduction, severely comminuted fractures showed marked reduction of volar tilt (as compared to non-affected side), even volar tilt was still reversed as a final end result in two (3.17%) cases, and at neutral position (zero degree) in 6 (9.52%) cases.

The second problem was the restoration of radial height. This was perfectly achieved (shortening = 0-2 mm) in 35 (55.55%) fractures. Good controlled traction and proper pin placement are important factors in achieving good radial height.

Ulnar tilt was excellently obtained in 48 fractures (76.19%). This was achieved easily secondary to good restoration of radial height and volar tilt.

External fixation:

- It was found that it is an important step to perform a closed manipulative **reduction** before application of the external fixation device. It is not easy to manipulate in the presence of an external fixator, and pre-application manipulation ensures parallel placement of the four pins in the same plane and prevents unnecessary torsional or angular stresses that could be applied to the pins and the forearm if the pins are not aligned in the same plane, leading-also-to possible fracture displacement.
- The open **pin placement** technique as advised by most authors was used. This prevents injury of cutaneous branches of the radial nerve, tendon injury or interosseous muscle injury and fibrosis, permitting early good functional recovery of the hand and fingers, also, central pin placement is ensured.
- The self tapping Schanz **pins used** were of 3 different diameters (2.7 mm, 3.5 mm and 4.0 mm). Only one case of pin breakage (1.59%) which was of 2.7 mm diameter was recorded in a 26 years old musculine solider who was actively using his hands during the period of external fixation.
- The 4.0 mm diameter pins are realy big to be inserted in the shaft of a metacarpal especially in females and old age. However, no case with a fractured metacarpal was recorded.
- The 3.5 mm diameter pins are recommended to be of choice with external fixation of DRFs because of their tolerability by the metacarpals, resistance to forces applied during ligamentotaxis and lesser incidence of pin-related complications.
- **Wrist position adjustment** during the period of distraction is of extreme importance. Wrist extension relatively relaxes tension on the finger extensor tendons, thereby preventing contractures of the

metacaprophalangeal joint extension. Wrist flexion creates the opposite effect, resulting in metacarpophalangeal joints that can stiffen in extension. So, all cases managed by external fixation were fixed in the position of mild wrist extension, leading to the final result of mild finger movements limitation in only 2 (3.17%) patients managed by combined O.R. and Ext. Fix. at the time of final assessment.

- To help avoid finger stiffness, the least **distraction force** necessary to maintain reduction and radial height was used in synergy with wrist extension to relax the finger extensor tendons.
- **Types** of external fixators used: review of literature shows clearly that the Hoffmann-C series are the most popularly used. Next comes, the small AO modalities. Dynamic external fixators are the least presented in the literature with little clinical data about the additional complex biomechanical considerations, about the effects of wrist motion during fracture healing.

However, it was found as a result of this study that there was no significant difference between the final end results of cases managed by different types of external fixators used (small A.O, Tubular A.O. and Hoffmann's medium-sized fixators). But it is an important point to say that the small A.O type is much lighter in weight, easier in application and allows better visualization of the distal end of the radius in the lateral radiographs. Three fractures were managed by dynamic external fixators; but they were not included in this series because their follow-up period was less than 6 months. Two of them are presented for illustration (Fig. 79 & 80).

a:

b:

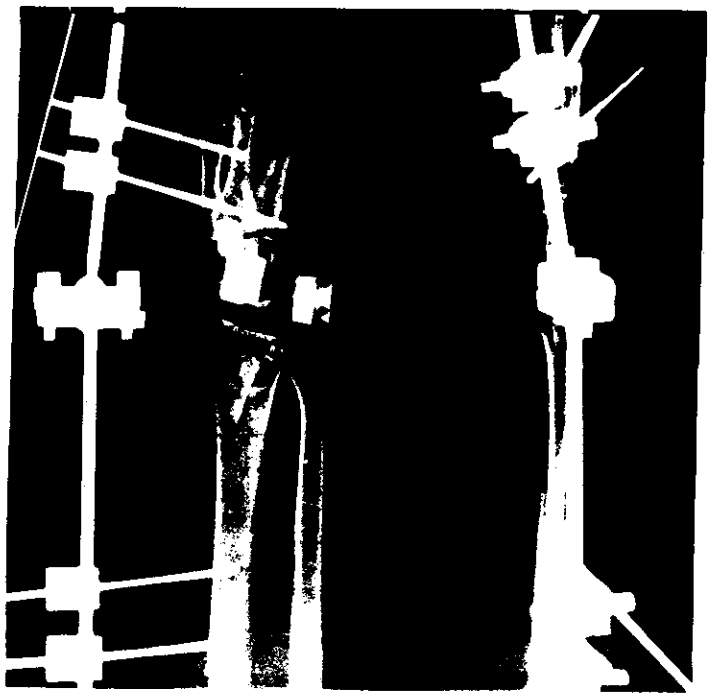


Fig. (79): Radiological results of a case managed by dynamic external fixator.
a: Pre-operative b- Post-operative.

a:

b:

Fig. (80): Radiological results of a case managed by dynamic external fixator.
a: Pre-operative b- Post-operative.

- **Combined** external and internal fixation was a must in 3 cases (16.68%) in which closed manipulative reduction and ligamentotaxis via an external fixator gave an unsatisfactory result due to severe comminution with rotation or unaccepted displacement of a sizable main fragment(s) or due to persistent marked loss of radial height, which could not be delt with via percutaneous insertion of additional K-wires.
- The **approach** used for open reduction was simply choosen according to the position of displaced fragments:
- Impacted dorso-medial fragment (Die Punch Fracture) was disimpacted by a limited dorsal approach (6 patients = 33.32%).
- Radial styloid fractures or fractures with markedly depressed radial scaphoid fossa were reached by the dorso-radial approach (one patient = 5.56%).
- Markedly dorsally displaced fractures were reduced via the long mid dorsal approach (one patient = 5.56%).
- Volarly displaced unstable fractures were reached via the volar approach (one patient = 5.56%).
- A combination of volar and dorsal approaches may be resorted to in explosion fractures. However, this was not needed in this series.
- The application of the external fixation device prior to open reduction was very helpful. It facilitates reduction of the boney fragments markedly and helps elevations of articular pieces.
- The use of additional **lengthening device** gave an excellent view of the articular surface intra-operatively, and helped adjustment of radial height post-operatively and prevented late fracture collapse with simple distraction application without addition of any discomfort to the patient.

- **Bone grafting** was found to be an important tool for filling anatomical defects resulting from crushed metaphyseal bone that are evident following length restoration. This prevents fracture collapse, improves healing and shortens the period of external fixation leading to early functional recovery.

All the 9 cases having their fractures grafted showed early sign of radiologic healing at 3-4 weeks post-operatively and showed no fracture collapse on late follow-up. All the 9 cases had the external fixator removed at 6 weeks post-operatively without any complications regarding fracture position or healing.

A substantial volume of corticocancellous bone graft was always needed and it was always more than expected from the plain radiographs. Bone grafting was advocated by most authors to combine external fixation of DRFs. ***Rayhack (1993)*** insisted on grafting of DRFs managed by percutaneous pinning via small dorsal direct incision if dorsal comminution is evident and bone stock is lacking.

- **The immobilization period,** in conservative treatment, the recommended immobilization time is relatively short usually four to five weeks. ***Wahlstrom (1982)*** demonstrated by bone scanning that unstable fractures of the distal radius are healed and stable after twenty-eight days and do not need longer immobilization. This short time of immobilization in the conservative management is due to the fact that the fracture is allowed to collapse and the surface contact is maximum.

On the other hand skeletal fixation requires a longer immobilization period. This is because these fractures are fractures of cancellous bone and at four to six weeks union will only be present at the points where cancellous bone fragments are in direct contract. If the radius is pulled out to its full length a cavity will be made inside the fracture which will not fill with new bone until many weeks have elapsed. It will fill only by the slow spread of osteogenesis from the points of initial contact. If the apparatus maintaining the length is removed early there will be a tendency to collapse immediately or later in rehabilitation ***(Charnely, 1972).***

So, the recommended immobilization period in such cases ranges from six to eight weeks, according to the degree of comminution and rate of healing. This openion was shared by ***Muller et al. (1991); Suso et al. (1993); Ludvigsen et al. (1997) and Trumble et al. (1998)***

- The radiological (anatomical) scoring system of ***Sarmiento and Latta, (1981)*** and most other scoring systems gave concern to the three main radiologic parameters of the distal radius (radial angle, volar angle and radial length).

Few authors depend on one item ***(Pool, 1973*** measured dorsal angulation only), others depend on two items only ***(Lidstram, 1959:*** measured radial shortening and dorsal angulation while ***Sheck, 1962*** measured dorsal and radial angulation).

No system in the presented literature gave any importance to radial shift or dorsal shift in evaluation of the anatomic outcome. It was left to be evaluated as a visual (clinical) deformity in some scoring systems.

- The final scoring system of ***Jakim et al. (1991)*** used the same three radiologic parameters as positive findings in addition to another two negative findings: radio-carpal and radio-ulnar joints incongraity. This made the radiologic evaluation more accurate and informative.

However, the analysis of IRUJ incongruity is difficult and liable to a lot of falicies. Normally, on the P-A radiograph, the distal radio-ulnar joint measures approximately 2 mm. Incongruity of this joint space may cause **diastasis** or **narrowing** of this joint, but if it does not, subluxation or dislocation of the IRUJ may be over-loocked. In the true lateral radiograph, normal congruence of the IRUJ is shown by nearly complete overlap of the ulnar head and the distal radius, and dorsal or ventral dislocation causes loss of this radial and ulnar superimposition. However,

slight supination or pronation of the forearm from neutral position and slight variation of normal; render an analysis for IRUJ incongruity inaccurate. Thus advanced imaging techniques such C.T. and MRI are to be considered when there is question of the IRUJ subluxation.

The clinical objective findings of ***Jakim et al. (1991)*** system included the clinical deformity, grip strength and wrist and forearm mobility.

As regarding the final forearm and wrist motion regaind, table (71) and Fig. (81) show that the percentage of the finally regained movements were all comparable to that presented in different series. Wrist extension was slightly higher than it in different series. This may be due to the slight dorsiflexion wrist position used in immobilization and the intensive physiotherapy program used with most patients.

Table (71): The final regained wrist and forearm movement in different series, estimated as the mean percentage in relation to sound side.

Series	No. of fractures	Mean of regained movements in percentage					
		Flex.	Ext.	Rad. D.	UL. D.	Pro.	Sup.
Nakata et al., 1985	22	77	77	73	82	84	78
Vaughan et al., 1985	52	86	84	86	80	94	79
Sanders et al., 1991	35	80	79	81	83	99	87
Lenoble et al., 1995	42	59	58	60	61	80	76
Present series	63	84	93	77	75	92	88

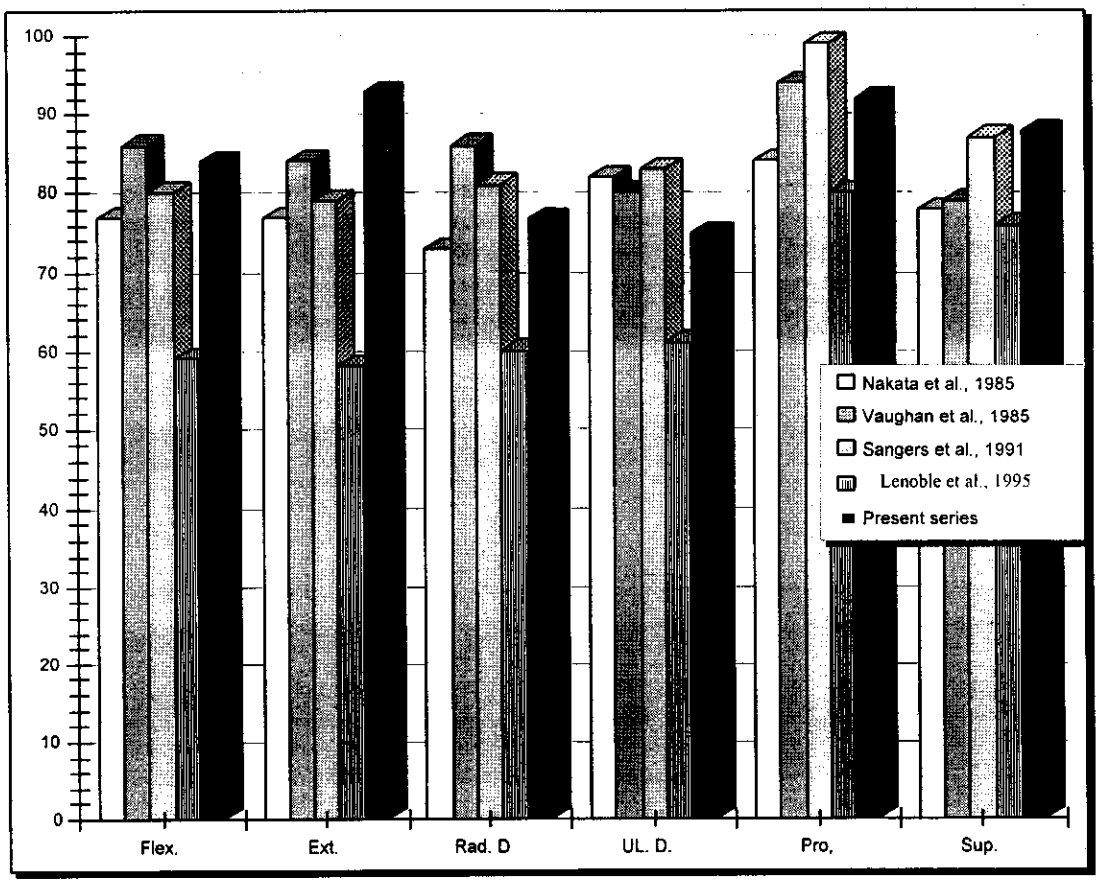


Fig. (81): Diagram of final wrist and forearm movements regained in different series.

No system in the presented literature has considered thumb mobility in its evaluation. This makes the evaluation systems lacking. So, thumb movements were measured in the present series and movement lag was considered as mild, moderate or severe as percentage from total movement on sound side, and was regarded as negative objective clinical findings of –3, -6 or –9 points respectively.

However, in this studied series, at the time of final assessment only the two cases with ruptured extensor pollicis longus tendon showed mild (-3 points) total thumb movement lag, which showed no influence on the final total score of the patients.

* The final regained grip strength in the present series was found to be as high as 88% mean value as compaired to the healthy side. It is higher than it in the other different series (except the last one) presented in table (72) and Fig. (82). This is explained by the longer follow-up period of the present study when compaired with that of other series in table (72).

Table (72): The final regained grip strength in different series.

Series	Mean follow up "m"	No. of fractures	% of regained grip strength
Knirk & Jupiter, 1986	7	75	60
Leung et al., 1989	6	72	70
Yen et al., 1991	6	100	52
Lenoble et al., 1995	12	42	83
Cannegieter & Juttmann, 1997	36	32	95
Present series	16.5	63	88

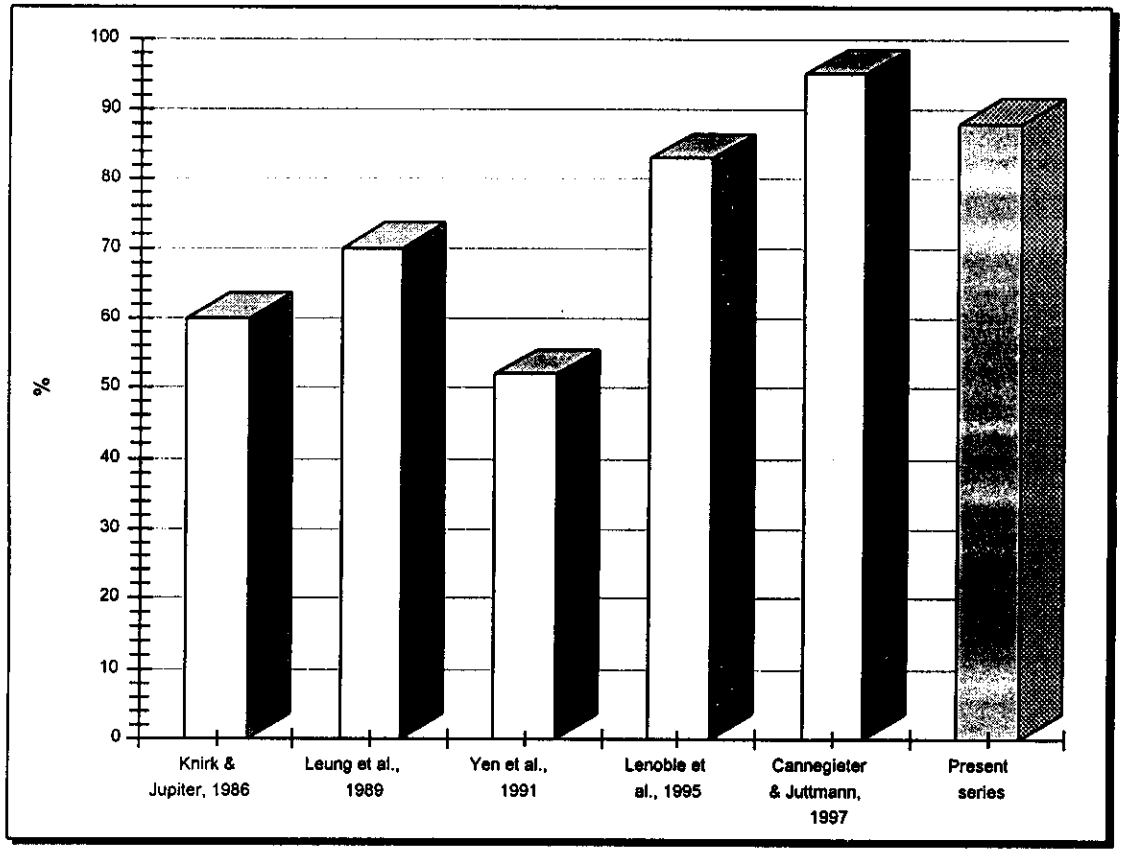


Fig. (82): The final grip strength regain in different series.

* The subjective clinical evaluation is liable to much falacies due to variations of age, activity, occupation, pain threshold, and so on. However, this item can not be neglected, as patient's satisfaction with the method of treatment and its outcome is so important.

In this series 44% of patients were found to have mild to moderate wrist pain at the time of final assessment. ***Roumen et al., (1991)*** reported an incidence of 43% while ***Sanders et al. (1991)*** reported an incidence of 42% of their cases suffering from mild to moderate wrist pain at a mean follow-up period of 29 and 31 months respectively. In the present series, the mean follow-up was 16.5 months and so, it is expected for this 44% pain incidence to be decreased by time.

Final residual deformity present at time of final assessment was found in 6 (7.94%) cases only, and it was graded as mild and it was mainly due to IRUJ subluxation.

Part of the problem in comparing the clinical outcomes of different types of treatment of fractures of the distal aspect of the radius results from the use of multiple classification and evaluation systems. Even when investigators have used the same system, it is difficults to determine if fractures with similar degrees of displacement and fragmentation have been included ***(Knirk and Jupiter, 1986; Jupiter, 1991 and Trumble et al., 1998).***

Another part of the problem is comparing the outcome of different types of treatment in patients with different ages, sex, occupation, pain threshold and motivations. The varieties and efficacy of different rehabilitation programms are another factors that could be added to another important item which is the personal variations in surgical skills and available equipements in different centres.

1- Comparison of the final end results of PCP:

Rayhack (1993) stated that: "I have not attempted to compare the results of each percutaneous pinning techniques because no standardized method of reporting such results exist".

This is true; as it is not reasonable to compare the results of a percutaneous pinning technique in a fracture with certain classification versus that of a different classification or grade, or in a 25 years old patient versus 70 years osteoporotic patients, or bone-grafted fractures with those non-grafted.

So, the whole results of percutaneous pinning techniques were compaired with other reported results regardless the method of pinning used.

Results of treatment of unstable DRFs in five series from 1961 to 1997 were compaired with the present series results.

a- ***Dowling and Sawyer, 1961*** reported his results on 51 patients with 84% final end results as excellent and good.

b- ***Clancy (1984)*** reported his results on 30 fractures with a final outcome of 77% excellent and good final end results.

c- ***Birtchett (1995)*** reported 50 fractures with 96% excellent and good end results.

d- ***Ludvigsen, (1997)*** reported 87% excellent and good results out of the 31 fractures he had treated.

e- ***Oskam et al. (1997)*** reported only 38% excellent and good results out of their 21 fractures.

In the present series 72% excellent and good final end results were reported, with the remaining 17% fair and 11% poor results of the treatment of 45 fractures (Table 73 and Fig. 83).

Table (73): Comparison of results of P.C.P. in different series.

Series	No. of fractures	% excellent	Good	Fair	Poor
Dowling & Sawyer, 1961	51	47	37	16	0
Clancy, 1984	30	60	17	20	3
Britchett, 1995	50	52	44	2	2
Ludvigsen, 1997	31	45	42	10	3
Oskam et al., 1997	21	19	19	52	10
Present series	45	36	36	17	11

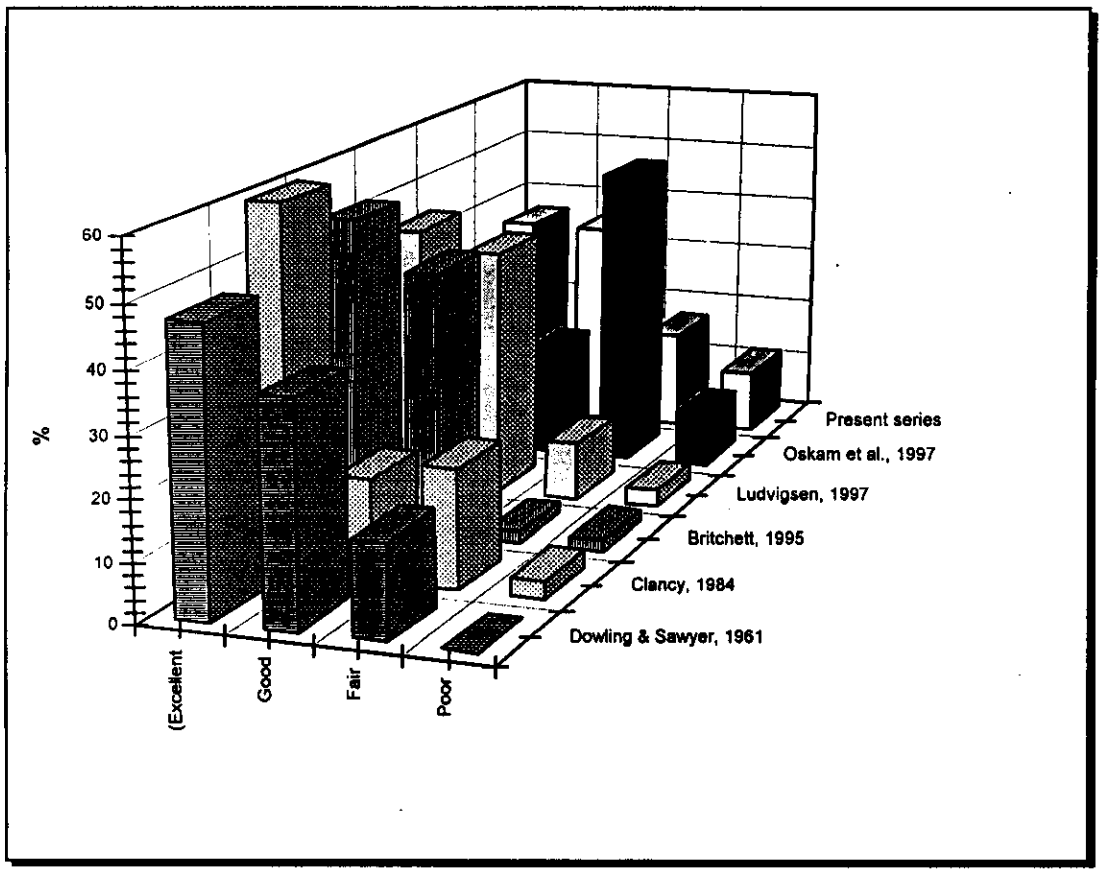


Fig. (83): Results of PCP in different series.

The slightly higher incidence of poor end results in the present series is attributed to diminished forearm movements in most of these 11% patients who were mostly over the age of 70 years. Fair end results were mainly due to diminished grip strength and mild wrist extension lag. Both were mainly due to weak participation in the physiotherapy programme.

2- Comparison of the final end results of external fixation:

Results of the present series were compared with that of 8 different series from 1986 till 1997 (Table 74) and Fig. (84).

Table (74): Comparison of the results of external fixation in different series.

Series	No. of fractures	% excellent	Good	Fair	Poor
Knirk & Jupiter, 1986	43	26	35	33	6
Clyburn, 1987	31	30	64	3	3
Jenkins et al., 1987	32	41	53	3	3
Howard et al., 1989	50	12	44	20	24
Jakim et al., 1991	132	60	23	12	5
Suso et al., 1993	28	47	35	11	7
Britchett, 1995	50	50	34	10	6
Ludvigsen et al., 1997	29	41	41	15	3
Present series	18	34	22	22	22

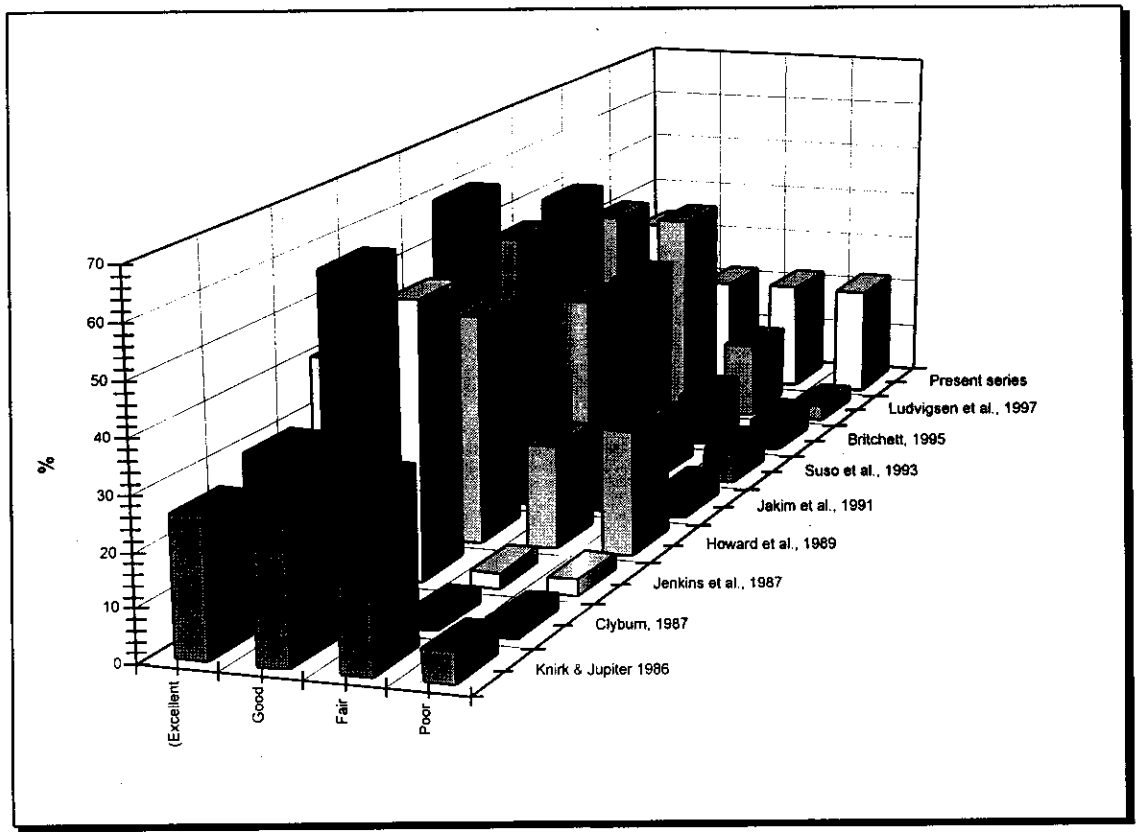


Fig. (84): Diagram of results of external fixation in different series.

The slightly higher incidence of fair and poor end results in the present series is attributed to the highly comminuted, high momentum injury fractures managed in this series; as 77.78% of these fractures were Frykman's type VII or VIII.

It is to be noted also that different types of external fixators were used in the above mentioned studies. Each author has used a different evaluation system such as Gartland and Werley system, its modifications, Marsh and Teal (1972) system, Jakim et al. (1991) used their own system and so on.

3- Comparison between the Anatomical and final end results of the present series:

a- Cases treated by PCP (table 75) and Fig. (85):

Table (75): Anatomical and final end results of PCP.

Results	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
Anatomical	22	48.89	15	33.33	4	8.89	4	8.89
Final	16	35.56	16	35.56	8	17.78	5	11.10

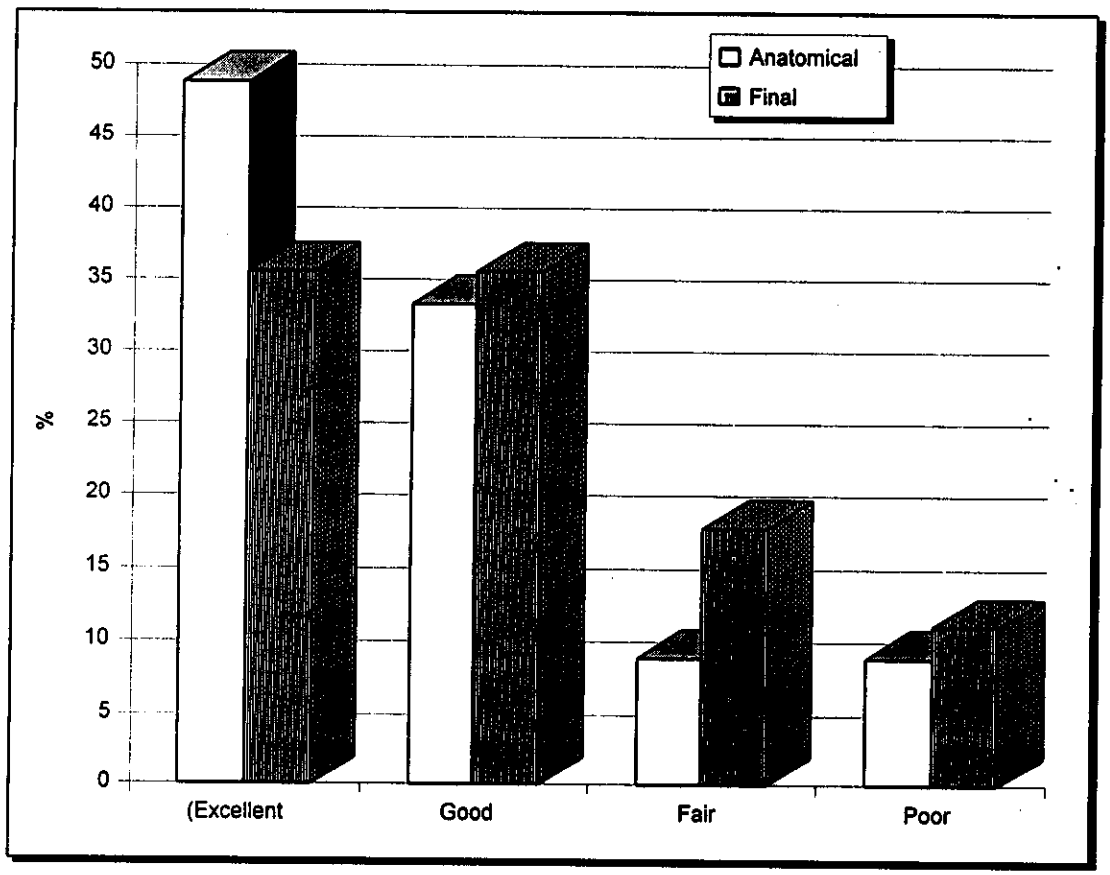


Fig. (85): Diagram for comparison between the anatomical and final end results of PCP.

b- Cases treated by Ext.Fix., Table (76) and Fig. (86).

Table (76): Anatomical and final end results of ext. Fix.

Results	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
Anatomical	8	44.44	4	22.22	5	27.78	1	5.56
Final	6	33.34	4	22.22	4	22.22	4	22.22

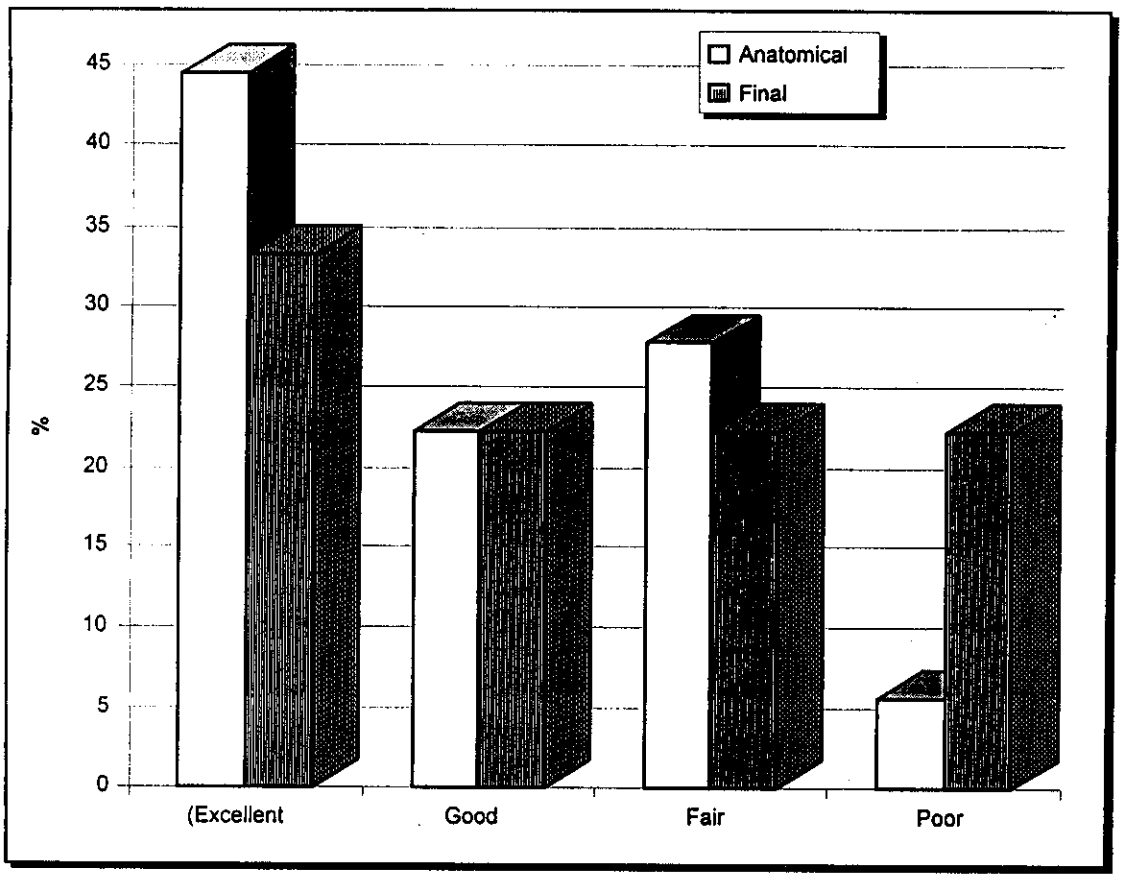


Fig. (86): Diagram for comparison between the anatomical and final end results of external fixation techniques used.

c- All cases managed in the present series, Table (77).

Table (77): anatomical and final end results of all cases.

Results	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
Anatomical	30	47.62	19	30.16	9	14.28	5	7.94
Final	22	34.92	20	31.75	12	19.05	9	14.28

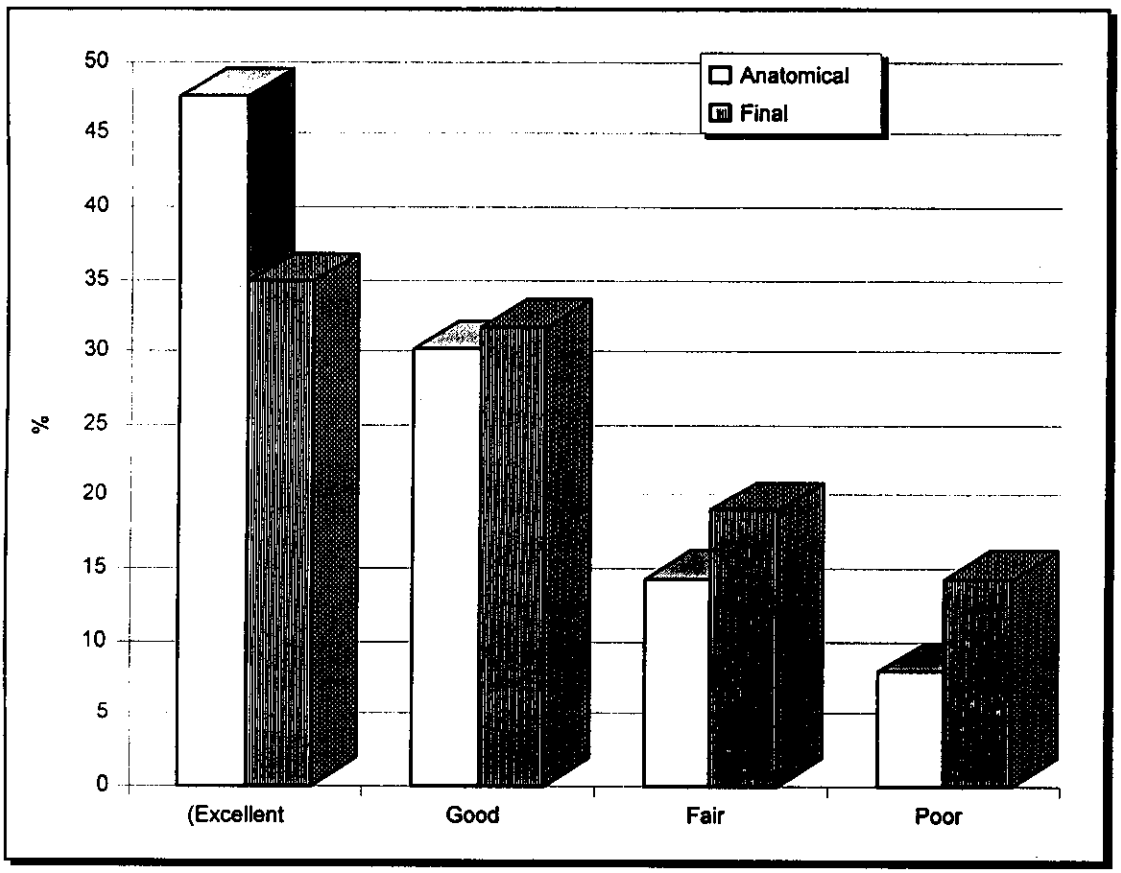


Fig. (87): Diagram for comparison between the anatomical and final end results of all used techniques.

Little data were presented in the literature about the anatomical results. Nearly there are no reported comparable anatomical results only. Comparison between the anatomical and functional final end results of this series revealed strong correlation between them, but as ***Jupiter and Masem (1988)*** stated; "a poor anatomic results does not preclude satisfactory function, while a good anatomic restoration does not assure a good functional results". This is attributed to the associated (and may be unrecognized) soft tissue injuries, associated injuries in the same limb, patients factors such as age, occupation motivations and participation in the physiotherapy programm and the complications either of the fracture it self or due to the chosen line of management.

It is of importance to remember here that 14 DRFs (22.58%) included in the present series were associated with supracondylar humeral fractures, segmental fractures of radius and ulna or fractures of the head of the radius with an association of soft tissue injury of the same limb, with subsequent limitations of forearm and wrist movements; influencing the functional and subsequently the final total score.

However, the results of this study is still comparable to that of different studies weather the results of percutaneous pinning or external fixation techniques. It also supports the premise that an unstable DRF must be managed properly without any hesitation in taking a decision of either a per-cutaneous pinning or an external fixation technique.

Some believe that distal radius fractures have a good outcome regardless of the treatment ***(Benjamin, 1982 and Peltier, 1984),*** but in common with most others, the outcome varies with the type of fracture and the treatment ***(Green, 1975; Fisk, 1980 and Blair, 1997).*** Most surgeon believe that these fractures are complex injuries and are associated with considerable morbidity, ***(Frykman, 1967; Saito & Shibata, 1983; Melone, 1986; Fernandez & Flury, 1994 and Trumble et al., 1998).***

A complication rate of 14 - 62% was reported by different surgeons. Table (78) shows some of the encountered total complication rates in different series and in the present series which was a 36% total complication rate.

Table (78): Complication rate in different series.

Series	Compliation rate %
Cooney et al., 1979	27
Cooney, Dobyns and Linscheid, 1980	31
Weber and Szabo, 1986	62
McQueen et al., 1992	47
Szabo, 1992	50
Raskin & Melone, 1993	20
McBirnie et al., 1995	47
Vaughan et al., 1995	14
Present series	36

Table (79): Differential complication rates in different series on final assessment.

Complication	Series	%
Persistant wrist pain	Cooney et al., 1980	10
	Villar et al., 1987	29
	McQueen & Caspers 1988	30
	Roumen et al., 1991	36
	Tsukazaki & Iwasaki, 1993	37
	Present series	12.98
Pin tract infection	DePalma, 1981	7.1
	Vaughan et al., 1985	1.9
	Weber & Szabo, 1986	23
	Leung et al., 1989	0.0
	Sanders et al., 1991	17
	Raskin & Melone, 1993	6.6
	McBirne et al., 1995	3.6
	Present series	6.35
Loss of reduction	Dowling & Sawyer, 1961	13.7
	Cooney et al., 1979	5
	Mortier et al., 1988	4.7
	Sanders et al., 1991	38
	Mah & Atkinson, 1992	18.75
	Raskin & Melone, 1993	3.3
	Present series	6.35
Superficial R.N. injury	Vaughan et al., 1985	3.8
	Jenkins et al., 1987	9
	Solgaard, 1989	25
	Raskin & Melone, 1993	0.00
	McBirne et al., 1995	2.4
	Present series	4.76
Reflex symp. Dystrophy	Dowling & Sawyer, 1961	1.9
	Stein & Katz, 1975	2.7
	Mortier et al., 1988	7.1
	Howard et al., 1989	0.00
	Kwasny et al., 1990	2.1
	Roumen et al., 1991	13
	McBirne et al., 1995	1.2
	Present series	1.59
Pin loosening	Vaughan et al., 1985	1.9
	Weber & Szabo, 1986	15
	Horesh et al., 1991	0.0
	Raskin & Melone, 1993	0.0
	Present series	0.0
Pin Breakage	Dowling & Sawyer, 1961	3.9
	Vaughan et al., 1985	0.0
	Raskin & Melone, 1993	0.0
	Present series	3.8
Finger stiffness	Raskin & Melone, 1993	0.0
	Present series	3.17
Ulnar styloid non-union	?	?
	Present series	88.64

Table (79) shows that the results of this study has a complication rate which is well comparable to those of different series presented in the literature, few points are to be discussed here:

- The low incidence of persistant wrist pain could be attributed to careful attention to meticulous details of techniques used, early mobilization and early active assisted physiotherapy.
- The low incidence of pin tract infection may be attributed to the continuous sterile closed dressing applied to pins or external fixator contact sites, which was removed and changed only on routine visits.
- Union of the fractured ulnar styloid: very little data were presented in the reviewed literature about the exact incidence of non-union of the fractured unlar styloid. However, it was reported by many authors to be high.

It has been suggested that this injury may predict a poor outcome because of loss of integrity of the radio-ulnar joint ***(Taylor and Parsons, 1938)*** and impaired function of the articular disc. The results of this series does not support such a hypothesis. This opinion was shared also by ***Villar et al. (1987).***

In the present study, forty-four wrists (69.8%) had a concomitant fracture of the ulnar sytloid process. Five only (11.36%) of the fractured ulnar styloids showed union. Out of these 5 fractures 4 (80%) were in wrists with a final excellent or good end results, as compared with the 53% good or excellent results of the 39 fractures in which the ulnar styloid was not united. From this, it looks that non-union of the ulnar styloid is associated with a less favorable final outcome.

CASE PRESENTATION

Case No. (1):

Male patient, 38 years old who suffered a road-traffic accident which resulted in a DRF in addition to an ipsilateral compound comminuted supracondylar intercondylar fracture humerus.

- The DRF was at the left dominant hand.
- It was Frykman's type VIII, Melone's type IIB.
- It was managed 4 hours post-injury by 3 per-cutaneous 1.5 mm parallel K-wires trans-styloid.
- K-wires were removed 6 weeks postoperatively.
- His follow-up period was 24 month duration.
- The fractured ulnar styloid did not unite till the final assessment.
- His radiological score was excellent while his final score was good, due to mild residual forearm motion limitations.
- Radiological results are shown in table (80) and figure (88).

Table (80): Radiological results of case No. (1).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
R	17			20			12		
(L)	-30	18	15	10	23	20	5	12	10

a:

b:

c:

Fig. (88): Radiological results of case No. (1).
a: Pre-operative b- Post-operative c- 6 month post-operative

Case No. (2):

- Female patient, 50 years old who fell on her left non-dominant out-stretched hand; resulting in a DRF of Frykman's type VIII, Melone's type IIB.
- She was managed 24 hours post-injury by one trans-styloid and two dorso-medial K-wires in addition to a 4th K-wire for the fractured neck ulna.
- K-wires were removed 6 weeks postoperatively, her follow up was 8 month duration, by this time the fracture ulnar styloid showed healing.
- Her radiological score was excellent as well as the total final score.
- Radiological results are shown in table (81) and figure (89).

Table (81): Radiological results of case No. (2).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	**Post**	**Final**	**Pre**	**Post**	**Final**	**Pre**	**Post**	**Final**
(R)	11			28			16		
L	-40	10	10	22	26	25	11	16	16

Fig. (89): Radiological results of case No. (2).
a: Pre-operative b- Post-operative c- 7 month post-operative

Case No. (3):

- Male patient, 37 years old, who suffered an industrial accident which resulted in a DRF, amputation of the medial 2 fingers at the level of the heads of their metacarpals and fracture neck radius (in place) of the same limb.
- The DRF was affecting the right dominant hand, it was Frykman's type VIII, Melone's IIB, with an accompanying dorso-medial corner fracture.
- It was managed 3 hours post-injury by one radial styloid, one dorso-medial and one radio-ulnar K-wire via the IRUJ.
- K-wires were removed 6 weeks post-operatively. The follow-up period was 14 month duration.
- The fractured ulnar styloid was united radiologically.
- Both the radiologic and final scores were excellent.
- Radiological results are show in table (82) and figure (90).

Table (82): Radiological results of case No. (3).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
(R)	-8	12	10	17	20	20	7	10	10
L	10			22			11		

a:

b:

c:

Fig. (90): Radiological results of case No. (3).
a: Pre-operative b- Post-operative c- 11 month post-operative

Case No. (4):

- Male patient, 60 years old who fell down on his outstretched left non dominant hand resulting in a DRF which was Frykman's type VII, Melone's type IIB.
- Rayhack per-cutaneous pinning technique was done using 4 K-wires of 1.2 mm diameter one day post trauma.
- K-wires were removed 6 weeks post-operatively and the patient was followed up for 21 month.
- The radiological score was excellent while the final total score was good due to mild residual limitation of forearm rotation and mild persistant wrist pain.
- Radiological results are shown in table (83) and figure (91).

Table (83): Radiological results of case No. (4).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
(R)	15			26			18		
L	-25	13	13	12	26	25	4	17	16

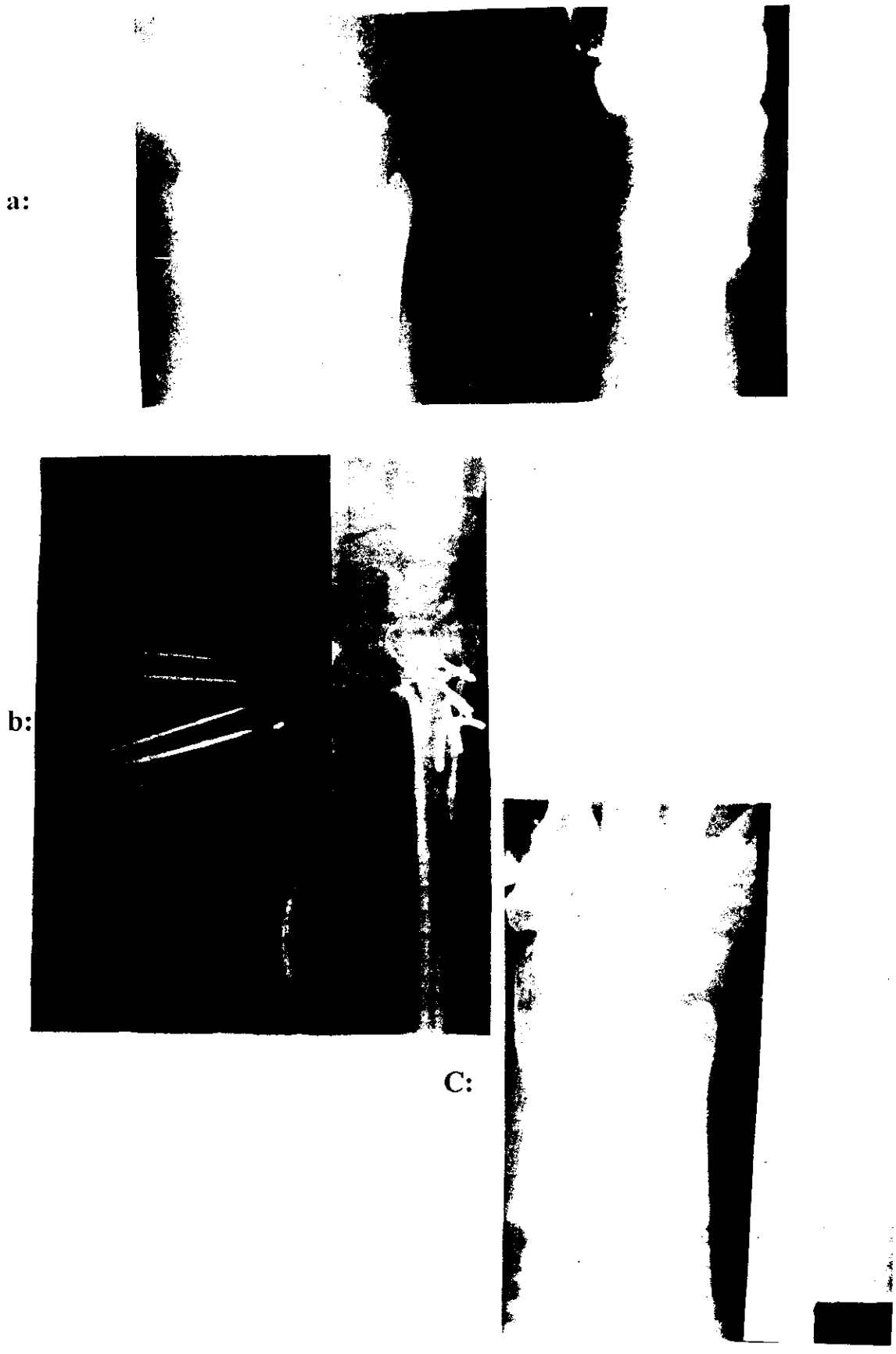


Fig. (91): Radiological results of case No. (4).
a: Pre-operative b- Post-operative c- 21 month post-operative

Case No. (5):

- Male patient, 47 years old who fell-down over his left non-dominant hand resulting in a Frykman type VII, Melone type IIB DRF.
- Manipulation and per-cutaneous fixation by 3 K-wires of 2 mm diameter was done using the principle of Kapandji intrafocal pinning.
- The wires were removed 6 weeks later and the patient was followed-up for 15 month.
- Both the radiological and final total scores were excellent.
- **N.B.:** This patient has in the same limb an old mal-united fracture of both bones at the mid third of the forearm.
- Table (84) and Fig. (92) show the radiological results of this patient.

Table (84): Radiological results of case No. (5).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
(R)	20			17			11		
L	-20	18	18	9	16	15	15	11	10

a:

b:

c:

Fig. (92): Radiological results of case No. (5).
a: Pre-operative b- Post-operative c- 6 month post-operative

Case No. (6):

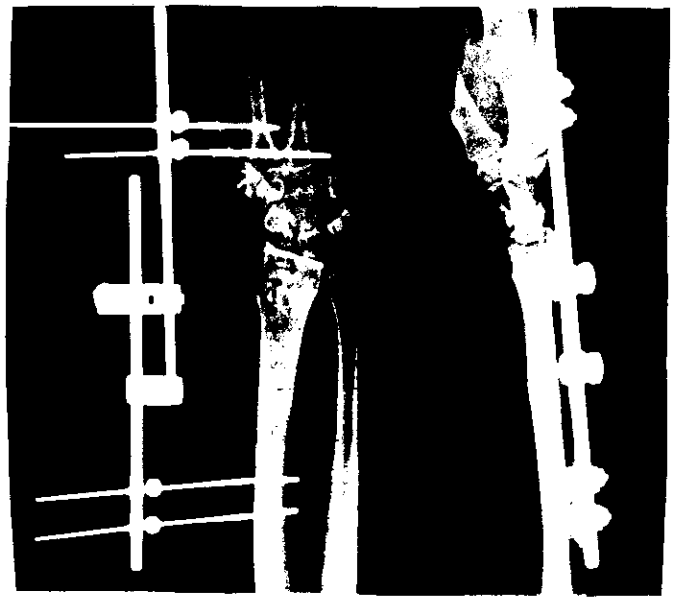
- Female patient, aged 36 years old who fell from a height on her left non dominant outstretched hand resulting in a severely comminuted and impacted DRF which was Frykman's type VII and Melone's type V.
- Closed manipulative reduction was done and an external fixator of the small A.O. type was applied and X-ray shows good reduction. Bone grafting via direct dorsal limited incision was done to fill the resultant defect from distraction and to augment healing.
- External fixator was removed 6 weeks postoperatively, and the patient was followed up for 23 month.
- Both the radiological and final score were excellent.
- Table (85) and Fig. (93) show her radiological results.

Table (85): Radiological results of case No. (6).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
(R)	14			24			15		
L	-20	12	11	16	23	22	2	15	13

a:

b:



c:

Fig. (93): Radiological results of case No. (6).
a: Pre-operative b- Post-operative c- 14 month post-operative

Case No. (7):

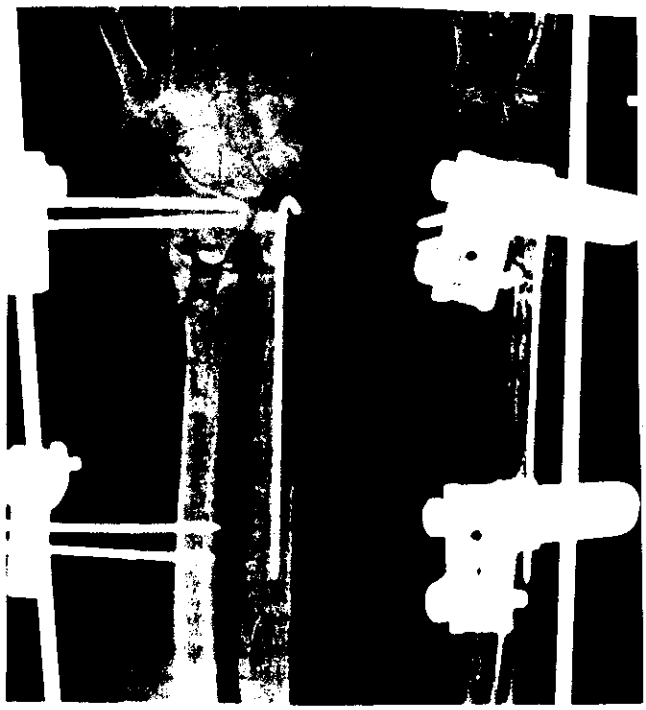
- Female patient, aged 66 years old who fell from a height over her left non dominant outstretched hand. She had an open comminuted metaphyseal fracture of distal ends of radius and ulna. It was graded as Frykman's type II fracture.
- Closed manipulative reduction and a medium sized-Hoffman external fixator was applied using the technique of osteotaxis. An additional intramedullary K-wire was added to fix the fractured distal ulna.
- The external fixator was removed 8 weeks postoperatively. The follow-up period was 20 months.
- The radiological score was excellent, but the final total score was good due to mild grip weakness and mild persistent wrist pain.
- Table (86) and Fig. (94) show the radiological results of this patient.

Table (86): Radiological results of case No. (7).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
(R)	12			30			13		
L	-15	10	10	12	32	28	5	13	13

a:

b:



c:

Fig. (94): Radiological results of case No. (7).
a: Pre-operative b- Post-operative c- 6 month post-operative

Case No. (8):

- Female patient, 18 years old, who fell from a height on her left non-dominant outstretched hand; to have an impacted comminuted intra-articular DRF; of Frykman's type VII and Melone's type IIB.
- Closed manipulative reduction showed successful reduction which was maintained via the principle of ligamentotaxis using a small A.O. external fixator with converging pins technique, the device was supplemented by a small lengthening device of the Hoffmann's variety. No bone grafting was done.
- The patient had an accompanied fracture at the middle of the ulna of the same limb (fracture in-place) which was managed by an additional above elbow back slab which was removed with the external fixator 6 weeks post-operatively when X-rays showed radiologic healing of both fracture sites.
- Follow-up for 9 months proved excellent radiological and final outcome.
- Table (87) and Fig. (95) show the radiologic results of this patient.

Table (87): Radiological measurements of case No. (8).

Side - (dominant)	Volar tilt 0			Ulnar tilt 0			Rad. Height mm		
	Pre	Post	Final	Pre	Post	Final	Pre	Post	Final
(R)	10			28			12		
L	-30	10	10	15	28	26	6	12	11

a:

b:

c:

Fig. (95): Radiological results of case No. (8).
a: Pre-operative b- Post-operative c- 6 month post-operative