SYSTEMATIC REVIEW

Clinical, Functional, and Radiological Outcomes of Core Decompression in Kienböck's Disease: A Comprehensive Narrative Review

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Abstract

Objectives: Kienböck's disease (KD) is a progressive, typically unilateral condition primarily affecting young male manual laborers, causing pain and impaired wrist function. This comprehensive narrative review synthesizes the existing literature to assess clinical, functional, and radiological outcomes of Metaphyseal core decompression (MCD) in KD patients.

Methods: A comprehensive narrative review of the literature was conducted in November 2024 using PubMed, Cochrane Library, Google Scholar (top 20 result pages), and Web of Science to identify studies on core decompression for Kienböck's disease. Eligible articles were qualitatively synthesized with respect to clinical, functional, and radiological outcomes.

Results: Eighteen studies comprising 382 patients (mean age 34.5 years) across Lichtman stages I–IIIb were reviewed. MCD techniques were associated with improvements in clinical and functional outcomes, including VAS, DASH, MWS, and PRWE scores. Radiological findings showed variable progression that did not consistently correlate with clinical deterioration. Capitate Forage Procedure (CFP), though limited in data, seems to offer promising early-term results. Major complications were infrequently reported, and a high proportion of patients (91–100%) returned to work. No procedure-related complications were reported in the reviewed studies, and the reoperation rate associated with MCD was relatively low, ranging from 4.2% to 8.3%. MCD may be beneficial for both young and elderly patients, including those with stage IIIb disease, and could offer socioeconomic advantages due to its minimally invasive nature and lack of implant use. MRI-detected vascular changes may suggest long-term benefits, with Schmitt's method recommended for imaging evaluation."

Conclusion: MCD improves pain relief, range of motion, and grip strength in both early and advanced stages. Pain relief is often observed early, contributing to patient satisfaction, and its efficacy may extend to advanced stage IIIb cases, enabling most patients to return to work. MRI assessments suggest possible long-term vascular benefits. MCD is considered less invasive than RSO, with potential benefits that may justify further cadaveric studies to refine arthroscopic techniques.

Level of evidence: IV

Keywords: Kienböck disease, Lunate bone, Surgical decompression

Introduction

Kienböck's disease (KD), first described by Robert Kienböck in 1910 as lunatomalacia or osteonecrosis of the lunate, is a slowly progressive, typically unilateral disease, with bilateral cases reported in only 4% of cases.[1,2] KD predominantly affects young male manual laborers aged 20-40 years, often resulting in pain, swelling, and compromised wrist and hand function.[3,4] Young male manual laborers represent over 90% of KD cases in some

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studies.[5,6] It has also been observed that carpal tunnel syndrome is 3–4% more prevalent among patients with KD compared to the general population.[7] The prevalence of asymptomatic KD varies widely, being reported at 0.0066% to 1.9% in different populations.[8-11]

Negative ulnar variance, which contributes to uneven load distribution on the lunate, plays a significant role in disease pathogenesis and justifies procedures such as radial shortening osteotomy.[12,13] Repeated loading may lead to stress microfracture on the radial side of the lunate, which can extend toward the ulnar side. This microfracture can heal if loading stops. In contrast, isolated traumatic events—such as a translunate fracture—rarely result in avascular necrosis (AVN).[14,15] AVN is typically attributed to intraosseous compartment syndrome, triggered by elevated intraosseous pressure during wrist extension.[16,17] In KD, arterial inflow, venous outflow, and intraosseous marrow composition influence compartmental bone pressure. Venous outflow obstruction can lead to fat cell edema, resulting in localized or generalized intraosseous hypertension following stress fractures, thereby contributing to AVN. Factors influencing AVN may include age, sex, race, comorbidities, and anatomical variations.[16-18]

Several classification systems aid in staging KD and tailoring treatment strategies. Introduced in 1977, the Lichtman classification is a radio clinical staging system refined from Stahl's earlier model. [19,20] Stage I involves mild pain during wrist extension without radiographic changes. Stage II is characterized by persistent pain and increased lunate density. Stage III involves lunate collapse, later divided into IIIA and IIIB. Stage IV is marked by pancarpal arthritis. In 2010, Lichtman introduced Stage 0 to identify early ischemia detectable only via MRI.[19,21,22] Complementing Lichtman's framework, Bain and Schmitt proposed additional classification systems. Bain's arthroscopic grading system categorizes KD based on nonfunctional articular surfaces, aiding surgical decisions. Schmitt's vascular classification uses gadolinium-enhanced MRI to delineate necrotic regions within the lunate, providing prognostic value.[23-26]

Metaphyseal core decompression (MCD is increasingly recognized as a promising treatment option for early and intermediate KD (Stages I to IIIA). Illarramendi *et al.* (2001) and subsequent studies have highlighted the efficacy of MCD in reducing intraosseous pressure and enhancing vascularity through cytokine-mediated regional vascular changes.[27,28] MCD alleviates distal radius stiffness and radial wrist load, thereby supporting lunate integrity by reducing stress across the radiolunate joint. Clinical benefits are attributed to improved vascularity in the lunate region, primarily due to enhanced regional vascularity, as suggested by Illarramendi, rather than mechanical offloading.[27,29]

Given the heterogeneity in the presentation and progression of Kienböck disease, understanding the functional and radiological outcomes of MCD is crucial. This narrative review critically synthesizes current evidence regarding MCD in KD. By evaluating key patient-centered outcomes, this article offers a qualitative summary and interpretive analysis to inform clinical decision-making and identify areas for future research. It is important to note that, as a narrative review, this article provides a broad synthesis and expert interpretation of available evidence, rather than a systematic quantitative analysis.

Materials and Methods

This narrative review aimed to provide a synthesis of the existing literature on the clinical, functional, and radiological outcomes of core decompression in Kienböck's disease. The search included PubMed, Cochrane Library, Google Scholar (top 20 results), and Web of Science, using the keywords "ulna," "radius," "lunate," "capitate," and "core decompression," limited to articles published by November 20, 2024. Inclusion criteria were studies that involved patients diagnosed with Kienböck's disease, evaluated core decompression outcomes, were published in peer-reviewed journals, reported clinical, functional, and/or radiological outcomes, were available in English, and had a minimum sample size of three patients. Exclusion criteria were studies involving other treatments, case reports, reviews, meta-analyses, articles without full-text access, and publications in languages other than English. Given the limited number of eligible studies, small sample sizes, and methodological heterogeneity, a systematic review with meta-analysis was not feasible. Consequently, a narrative synthesis approach was adopted. These limitations justified the use of a narrative approach to provide a structured yet flexible synthesis of the available evidence. The search strategy and article selection process are detailed through a flowchart presented [Figure 1]. Data extracted from each study included: design, sample size, patient demographics, follow-up duration, and outcome measures. Findings were synthesized qualitatively to highlight patterns, variations, and gaps in the literature. As a narrative synthesis, the findings and conclusions were interpreted descriptively, taking into account the methodological limitations of the included studies.

Results

Eighteen studies employing various MCD methods were included in this review. A total of 382 patients with a mean age of 34.5 years, consisting of 222 men and 146 women, were studied. The patients were distributed across stages: 40 in stage I, 138 in stage II, 153 in stage IIIa, and 25 in stage IIIb. Details of each study are provided in [Table 1]. We reviewed the results from the articles in two sections: Clinical and Functional Outcomes and Radiological Outcomes. Each section provides details on the following types of surgery: MCD of the distal radius (11 studies), MCD of the lunate (5 studies), and the Capitate Forage Procedure (CFP; 2 studies).

Clinical and Functional Outcomes

•MCD of distal Radius:

Illarramendi et al. (2001) performed Radial and Ulnar MCD on 22 patients (stage I-IIIa, mean age = 36 y, minimum follow-up = 6 y). Sixteen patients were pain-free, 4 had mild pain, one had moderate pain, and one developed scapholunate dissociation with intercarpal arthritis at 8-year follow-up. Average wrist Extension/flexion was 59°/57°, with grip strength at 32kg, equating to 77% and 75% of the contralateral side, respectively ($p < .0001$).[27] In a 2003 study, Illarramendi et al. treated 48 patients (stage 0-IIIa, mean age

= 39 y, follow-up = 9 y). Initially, all had pain and reduced wrist motion, but at final follow-up, 34 were pain-free, and 9 had mild pain. Flexion-Extension range was 56°/60° with grip strength at 75% of the contralateral side.[30]

Schulz et al. (2016) observed in their study of 14 patients (stage I-IIIb, follow-up = 35m). At the final follow-up, 11 patients were pain-free, and three experienced pain only after heavy wrist hyperextension. Normal mobility was observed in 13 patients, and grip strength was normal in 11 patients with no functional impairment. According to the MWS, 13 patients rated their outcomes as excellent, and one as good.[31]

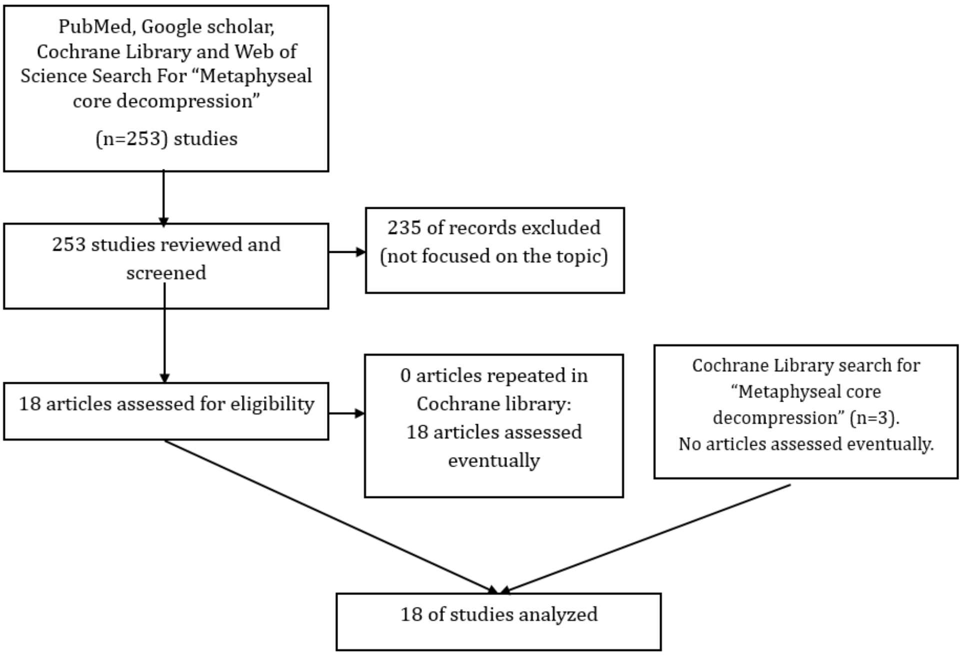

Figure 1. Flow chart of our search strategy regarding the role of Metaphyseal core decompression (MCD) in Kienböck's disease

Table 1. Main characteristics of studies.

First Author/ Year	Country	Study period	Study type	Sample size		Mean age ± SD (range)	Follow-up: mean period ± SD (range)	Stage at diagnosis	
MCD of the distal radius									
Illarramendi[27] 2001	Argentina	1976-1988	Retrospective cohort	male	16	36(18-64)	At least 6 years	I	2
				female	6			II	8
				total	22			IIIa	12
Illarramendi[30] 2003	Argentina	1976-2000	Retrospective cohort	male	35	39(18-64)	9(1-20) years	I	4
				female	13			II	17
				total	48			IIIa	25
								0*	2
Schulz[31] 2016	Germany	NR**	Retrospective cohort	male	NR	NR	35(8-76) months	I	5
				female	NR			II	6
				total	14			IIIa	3

Table 1. Continued

Shah[32] 2016	Pakistan	2014-2016	Retrospective cohort	male	9	31.2(24-42)	12 months	I	2
				female	2			II	6
				total	11			IIIa	3
Sevimli[33] 2017	Turkey	2006-2014	Retrospective cohort	male	7	35.71(18-54)	27.58(6-60) months	I	5
				female	5	38.8(21-66)		II	7
				total	12	37(18-66)			
De Carli[34] 2017	Argentina	1998-2005	Retrospective cohort	male	10	42(28-64)	13(10-18) years	IIIa	15
				female	5				
				total	15				
De Carli[35] 2017	Argentina	1998-2005	Retrospective cohort	male	14	42(28-64)	14(10-19) years	II	8
				female	9			IIIa	15
				total	23				
Schulz[36] 2019	Germany	2008-2016	Retrospective cohort	male	3	35(19-57)	37(12-70) months	I	1
				female	10			II	12
				total	13				
Ari[37] 2022	Turkey	NR	Retrospective cohort	male	11	35.54(19-53)	46.75(26-80) months	II	23
				female	13			IIIa	1
				total	24				
Maniglio[38] 2022	Argentina	1994-2004	Retrospective cohort	*Younger group* Male 14 Female 8 Total 22		28(15-39)	7.6 years	I	5
								II	3
								IIIa	13
								IIIb	1
				Older group Male 6 Female 8 Total 14		52(45-61)	8.2 years	I	3
								II	2
								IIIa	9
								IIIb	0
Maniglio[39] 2024	Argentina	1994-2020	Retrospective cohort	male	14	38(15-58)	10(3-18) years	I to IIIb	24
				female	10				
				total	24				
MCD of the lunate									
Mehrpour[28] 2011	Iran	2004-2010	Retrospective cohort	male	16	29(21-42)	5 years	I	10
				female	4			II	6
								IIIa	3
				total	20			IIIb	1
Kamrani[40] 2022*	Iran	2013-2018	Prospective cohort	male	23	33±11	44±20 months	II	10
				female	21			IIIa	18
				total	44			IIIb	16
Saremi[41] 2024*	Iran	2015-2018	Prospective cohort	male	19	38.8±10.8	39.2±16.7 months	II	17
				female	21			IIIa	17
				total	40			IIIb	6
Mazhar[42] 2022	Iran	NR	Clinical trial	male	4	33.6±12.9	12 months	I	3
				female	4			II	3
				total	8			IIIa	2

Table 1. Continued

Sadri[43] 2024	Iran	2019-2022	Clinical trial	male	2	38(24-59)	6 months	II	3
				female	1				
				total	3				
CFP									
Bekler[44] 2013	Turkey	NR	Prospective cohort	male	6	30(20-40)	6 months	II	7
				female	3			IIIa	1
				total	9			IIIb	1
Sarı[45] 2022	Turkey	2014-2018	Prospective cohort	male	13	21.9±2.9	22.5±5.9 months	IIIa	16
				female	3				
				total	16				

*Two patients with normal radiographs but positive MRI findings for Kienböck disease were classified as stage 0. **Not reported.

Shah et al. (2016) studied 11 patients (stage I-IIIa, average age = 31.2 y, follow-up = 12m). Pain relief was the earliest outcome, with VAS improving from 5 to 2 by the 4th week. Functional improvements were noted with 15 degrees of improvement in flexion and Extension for stage I, and 10 and 13 degrees in flexion and Extension for stage II, respectively.[32]

Sevimli et al. (2017) studied 12 patients (stages I and II, mean age = 37y, follow-up = 27.6m). The median QuickDASH, MWS, and VAS scores were 24.65, 68.75, and 3.41, respectively. Median grip strength and wrist ROM were significantly reduced on the operated side compared to the non-operated side.[33]

De Carli et al. (2017) conducted a study of 15 patients (stage IIIA, mean age of 42 y, follow-up of 13 y). Poor wrist function improved to excellent in 6 patients, to good in 8, and remained poor in 1; all but one patient returned to their original job. The average VAS was seven and decreased to 1.2 ($P < .05$). The flexion/Extension arc and grip strength were 77% and 80% of the opposite side, respectively.[34] In another study by De Carli et al., 23 patients (stages II and IIIa, mean age of 42 years, follow-up of 14 years) were examined. Clinical outcomes were excellent in 9 patients, good in 13, and poor in 1, who required revision surgery. The VAS improved from 7 to 1.1 at the final follow-up ($P > 0.05$). The flexion/Extension arc was 78% of the opposite wrist, and grip strength was 81%.[35]

Schulz et al.'s study (2019) included 13 patients (stage I and II, mean age of 35 years, follow-up of 37 months). Ten patients were pain-free at the final follow-up, while three reported occasional pain during heavy wrist hyperextension. Mobility was normal in all patients, and grip strength was normal in eight patients. The MWS was rated excellent in twelve patients and good in one.[36]

Ari et al.'s 2022 study involved 24 patients (stage II and IIIa, mean age of 35.5 years, follow-up of 46.8 months). Preoperative scores of VAS, DASH, Flexion-Extension, Ulnar-Radial Deviation, and Grip Strength were 7.08, 89.37, 95.08, 40.75, and 7.33, and improved to 2.66, 49.04, 123.95, 50.08, and 25.66, respectively.[37]

Maniglio et al.'s 2022 study included 22 younger patients (mean age of 28) and 14 older patients (mean age of 52). In the younger group, preoperative mean VAS, wrist motion, and grip strength were 6.8±1.4, 75%±15%, and 71%±16%, improving to 1.7±2.3, 80%±13%, and 77%±13% postoperatively. In the older group, preoperative scores were 5.6±2.2, 78%±13%, and 72%±16%, improving to 1.2±1.7, 87%±14%, and 80%±18% postoperatively. Significant reductions in VAS scores were observed in both age groups, but no significant improvement in arc of motion was observed. Grip strength significantly improved in the younger group but not in the older group. There were no significant differences in MWS between the two groups ($p = 0.97$).[38] Maniglio et al.'s 2024 study of 24 patients (mean age 38 years, follow-up 10 years) showed significant pain reduction ($p < 0.001$), but no significant improvement in range of motion or grip strength [Table 2].[39]

•MCD of Lunate:

Mehrpour et al. (2011) evaluated 20 patients (stages I-IIIb, mean age of 29 years, with a 5-year follow-up). Lunate tenderness decreased significantly from 18 preoperatively to 3 postoperatively ($P < 0.001$). The mean VAS decreased from 87.5 to 13.5, while the DASH improved from 84 to 14 ($P < 0.001$). Patients reported significant functional recovery, especially in activities like opening jars and using screwdrivers. Preoperative flexion, extension, radial deviation, and ulnar deviation improved from 30±4, 18±2, 8±1.5, and 14±2 to 45±4, 72±3.5, 18±2, and 30±1, respectively.[28]

Kamrani et al. (2022) compared Arthroscopic Lunate MCD and Radial Osteotomy outcomes in 44 patients (stage II to IIIb, mean age of 33±11y, 44±20m follow-up). VAS improved significantly from 6.6±2.3 to 2±1.9, QuickDASH from 58±22 to 17±15, passive wrist ROM (flexion and extension), and grip strength improved from 15±10 kg to 21±11 kg ($P < .05$). No significant functional outcomes differences in postoperative results were observed between early stages (II, IIIa) and advanced stage (IIIb).[40]

In a 2024 prospective cohort study, Saremi et al. evaluated Arthroscopic Lunate MCD in 40 patients (stage II to IIIb, mean age of 38.8±10.8y, follow-up of 39.2±16.7m). The proportion of patients with severe wrist tenderness decreased from 75% to 5%. Significant improvements were observed in VAS (7.6±1.8 to 2.7±1.9), DASH scores (52.5±13 to 29.2±16.3), and grip strength (6.6±2.7 kg to 12.3±3.1 kg) (P < 0.05). Comparisons of VAS and DASH scores across stages showed no significant differences in postoperative outcomes. Although stage II showed greater numerical improvements, these differences were not statistically significant (P = 0.477). Additionally, significant improvements were found in flexion, Extension, radial deviation, and ulnar deviation (P < 0.05).[41]

Mazhar et al. (2022) evaluated eight patients (stage I to IIIA) treated with Lunate MCD and local deferoxamine (average age of 33.6±12.9 y, 12m follow-up). Deferoxamine promoted bone revascularization. Preoperative scores were VAS 6.5±1.4, Quick-DASH 48.8±22.7, and PRWE 63.4±19.2. Postoperative improvements were significant: VAS 1.9±1, Quick-DASH 22.5±15.6, PRWE 29.3±21.2, radial deviation 16.9°, ulnar deviation 19.4°, wrist extension 63.8°, wrist flexion 62.1°, pinch strength 19.9 lbs, and grip strength 61.9 lbs (P < 0.001).[42]

In Sadri's 2024 phase I open-label clinical trial, three patients (stage II) received autologous bone marrow-derived mesenchymal stem cell (BM-MSC) transplantation following lunate MCD. Preoperative scores were VAS 7, DASH 52.2, wrist Extension 46.6°, and wrist flexion 36.6°. At six months follow-up, scores improved to VAS 2, DASH 17.5, wrist Extension 86.6°, and wrist flexion 80° [Table 2].[43]

•*Capitate Forage Procedure (CFP):*

Bekler et al. (2013) reported excellent to good six-month outcomes with CFP in nine patients (stage II to IIIb, mean age 30 y), with moderate overall satisfaction and some experiencing pain during forceful movements.[44] Sarı et al. (2022) evaluated CFP and RSO in 16 patients (stage IIIa, mean age 21.9y, follow-up 22.5 months), observing significant improvements in modified MWS, increasing from 42.8±6.6 to 76.3±19.9 postoperatively [Table 2].[45]

Table 2. Clinical and functional outcomes.

First Author/ Year		VAS	DASH	MWS	PRWE	Grip	ROM
MCD of the distal radius							
Illarramendi[27] 2001	*pre-op*	NR*	NR	NR	NR	NR	NR
	post-op	NR	NR	NR	NR	32(8-59) kg, 75% (37112%)	Flx**: 57° (30-80), Ext¶: 59° (32-80), Flx/Ext arc: 77%
Illarramendi[30] 2003	*pre-op*	NR	NR	NR	NR	NR	NR
	post-op	NR	NR	NR	NR	0.75	Affected side Flx/Ext: 56°/60°, Non affected side: 77°/78°
Schulz[31] 2016	*pre-op*	NR	NR	NR	NR	NR	NR
	post-op	NR	NR	NR	NR	NR	NR
Shah[32] 2016	*pre-op*	7.1	NR	NR	NR	NR	Flx: 57°, Ext: 52°
	post-op	0.3	NR	NR	NR	NR	Flx: 67.4°, Ext: 64.5°
Sevimli[33] 2017	*pre-op*	NR	NR	NR	NR	NR	NR
	post-op	3.41(0-6)	24.65(2.3-68.2)	68.75(35-95)	NR	26.24±6.99	Flx: 59.75°±8.62, Ext: 63.16°±6.89 Udev‡: 27.83°±5.87, Rdev‡‡: 19.58°±4.85
De Carli[34] 2017	*pre-op*	7(6-10)	NR	Poor in all patients	NR	NR	NR
	post-op	1.2(0-6)	NR	Excellent in 6, good in 8, and poor in one patient	NR	0.8	Flx/Ext arc: 77%
De Carli[35] 2017	*pre-op*	7(6-10)	NR	NR	NR	NR	NR
	post-op	1.1(0-6)	NR	Excellent in 9, good in 13, and poor in one patient	NR	0.81	0.78

Table 2. Continued

Schulz[36] 2019		*pre-op*	NR	NR	NR	NR	NR	NR
		post-op	NR	NR	Excellent in 12 and good in 1 patients	NR	NR	NR
Ari[37] 2022		*pre-op*	7.08	89.37	NR	NR	NR	NR
		post-op	2.66	49.04	NR	NR	NR	Flx/Ext arc: 123.95°, Ulnar/Radial deviation arc: 50.08°
Maniglio[38] 2022	***Younger group***	*pre-op*	6.8±1.4	NR	NR	NR	71% (16)	75% (15)
		post-op	1.7±2.3	NR	NR	NR	77% (13)	80% (13)
	Older group	*pre-op*	5.6±2.2	NR	NR	NR	72% (16)	78% (13)
		post-op	1.2±1.7	NR	NR	NR	80% (18)	87% (14)
MCD of the lunate								
Mehrpour[28] 2011		*pre-op*	88	84	NR	NR	NR	Flx: 30±4, Ext: 18±2, Udev: 14±2, Rdev: 8±1.5
		post-op	14	14	NR	NR	NR	Flx: 45±4, Ext: 72±3.5, Udev: 30±1, Rdev: 18±2
Kamrani[40] 2022		*pre-op*	6.6±2.3	58±22	NR	NR	15±10 kg	Flx: 44±17, Ext: 48±15
		post-op	2±1.9	17±15	NR	NR	21±11 kg	Flx:61±14, Ext: 65±10
Saremi[41] 2024		*pre-op*	7.6±1.8	52.5±13	NR	NR	6.6±2.7	Flx: 17.5±6.4, Ext: 17.5±5, Udev: 8.7±4.7, Rdev: 7.5±2.8
		post-op	2.7±1.9 mean reduction for stage II: 5.2±1.3, IIIa: 4.7±1.7 IIIb: 3.9±1.2	29.2±16.3 mean reduction for stage II: 25.5±13.8, IIIa: 21.8±14, IIIb: 19.1±12.4	NR	NR	12.3±3.1 kg	Flx: 48.5±10.3, Ext: 49.5±8, Udev: 22.4±9.5, Rdev: 13.4±4.8
Mazhar[42] 2022		*pre-op*	6.5±1.4	48.8±22.7	NR	63.4±19.2	45.6±27.7lbs	Flx: 29.4°±27.4°, Ext: 30.0°±17.3°, Udev: 11.3°±9.9°, Rdev: 6.9°±5.9°
		12m post-op	1.9±1	22.5±15.6	NR	29.3±21.2	61.9±32.8lbs	Flx: 62.1°±20.0°, Ext: 63.8°±10.6°, Udev: 19.4°±6.8°, Rdev: 16.9°±5.3°
Sadri[43] 2024		*pre-op*	7	52.2	NR	NR	NR	Flx: 36.3, Ext: 46.6
		post-op	2	17.5	NR	NR	NR	Flx: 80, Ext: 86.6
CFP								
Bekler[44] 2013		*pre-op*	NR	NR	NR	NR	NR	Pronation: 60.78, Supination: 63.67, Flx: 46.22, Ext: 34.56, Udev: 26.56, Rdev: 17.33
		post-op	NR	NR	81.11±8.43	NR	27.2kg, 60.4%	Pronation: 67.00, Supination: 70.11, Flx: 51.67, Ext: 39.67, Udev: 32.00, Rdev: 21.56
Sari[45] 2022		*pre-op*	NR	NR	42.8±6.6	NR	NR	Flx: 46.22±11.68, Ext: 34.56±8.31, Udev: 26.56±6.06, Rdev: 17.33±4.11
		post-op	NR	NR	76.3±19.9	NR	60.44±7.46%	Flx: 51.67±12.69, Ext: 39.67±8.81, Udev: 32±6.45, Rdev: 21.56±4.72

*NR: Not reported, **Flx: Flexion, ¶Ext: Extension, ǂUdev: Ulnar deviation, ǂǂRdev: Radial deviation

Radiological Outcomes

•MCD of the distal radius:

In Illarramendi et al.'s 2001 study, two patients improved from stage III to stage II, two progressed from stage II to stage III, and one advanced from stage III to stage IV. 77% of patients maintained the same Lichtman stage. The average lunate-capitate ratio indicated no significant radiographic progression of lunate collapse (p = 0.981), suggesting stability in the lunate's radiographic appearance. Of five patients with both preoperative and postoperative MRIs, four showed improvement on both T1- and T2-weighted images. One patient with a preoperative stage I MRI showed a normal MRI after three years. Postoperative MRIs in two patients revealed stage II on T1-weighted images, with one also showing stage II and the other showing stage III on T2-weighted images.[27] In Schulz et al.'s 2016 study, MRIs taken 3 to 8 months postoperatively in 13 patients showed reduced lunate bone marrow edema in all but one case, with five patients showing expected results.[31] In Schulz et al.'s 2019 study, MRIs at an average of 21 weeks post-surgery confirmed a reduction in bone marrow edema and fat necrosis in all patients, with six showing normal results in both imaging sequences. These findings suggest significant improvement in lunate radiographic appearance following core decompression.[36]

Shah's 2016 study found that stage IIIA patients had the lowest Stahl index, with one patient progressing to IIIb. De Carli et al.'s 2017 study reported that 83% of patients maintained their preoperative stage, with changes in CHR indicating no significant decrease in lunate height. A 13-year follow-up showed stability in modified CHR for most patients, but some progression to more advanced stages. Ari's 2022 study included five patients who progressed to stage IIIA and 1 to IIIB. Sevimli's 2017 study reported that progression from stage II to stage IV in one patient and from stage II to IIIA in another.

Shah et al. (2016) reported that stage IIIA patients had the lowest Stahl index, with one patient progressing to IIIb.[32] In De Carli et al.'s 2017 study, two patients progressed from II to IIIA, and two patients from IIIA to IIIB. 83% of patients maintained their preoperative stage. CHR values for stage II and IIIA were 1.52 and 1.38, respectively, decreasing slightly to 1.50 and 1.34 at follow-up, indicating no significant decrease in lunate height ($P < 0.05$).[35] In a subsequent 13-year follow-up study, the modified CHR was 1.38 and changed to 1.34. At the final follow-up, three patients had a decreased modified CHR, while 80% remained unchanged. Radiologically, one patient progressed from stage IIIA to IIIB, and another advanced to stage IV.[34] In Ari's 2022 study, five patients in stage II progressed to stage IIIA, and one patient in stage IIIA advanced to stage IIIB. In Sevimli's 2017 study, one patient progressed from stage II to stage IV, and one patient from stage II to stage IIIA.[33,37]

Maniglio et al. (2022) reported that radiographic progression was observed in 7 cases (32%) of the younger group and 3 cases (23%) of the older group, with no significant difference between the two ($P = 0.063$). The modified CHR was 1.39 in the younger group and 1.42 in the older group, and was subsequently decreased to 1.37 and 1.40, respectively.[38] In a subsequent study, modified CHR was 1.39 and decreased to 1.36. Spearman's correlation coefficients showed no significant correlation between the Mayo and Lichtman classifications (−0.06) or between VAS and Lichtman classifications (0.16). Additionally, no correlation was found between radiological progression in the Lichtman classification and follow-up duration (−0.11) [Table 3].[39]

Table 3. Radiological outcomes.

First Author/ Year	Stage			Radioscaphoid angel		Carpal height ratio	
		pre-op	*post-op*	*pre-op*	*post-op*	*pre-op*	*post-op*
MCD of the distal radius							
Illarramendi[27] 2001	I	2	2	NR*	NR	NR	NR
	II	8	8				
	IIIa	12	11				
	IIIb	0	0				
	IV	0	1				
Sevimli[33] 2017	I	5	5	NR	NR	NR	NR
	II	7	5				
	IIIa	0	1				
	IIIb	0	0				
	IV	0	1				
De Carli[34] 2017	IIIa	15	13	NR	NR	1.38 (range, 1.5-1.28)	1.34 (range, 1.42-1.25)
	IIIb	0	1				
	IV	0	1				

Table 3. Continued

De Carli[35] 2017		I	0	0	NR	NR	***Patients at stage II:***	
		II	8	6			1.52 (range, 1.48-1.58)	1.50 (range, 1.40-1.58)
		IIIa	15	15			***Patients at stage IIIa:***	
		IIIb	0	2			1.38 (range, 1.5-1.28)	1.34 (range, 1.42-1.25)
Ari[37] 2022		I	0	0	NR	NR	NR	NR
		II	23	18				
		IIIa	1	5				
		IIIb	0	1				
Maniglio[38] 2022	***Younger group***	I	5	NR	NR	NR	1.39 (range, 1.27-1.78)	1.37 (range, 1.23-1.77)
		II	3	NR				
		IIIa	13	NR				
		IIIb	1	NR				
	Older group	I	3	NR	NR	NR	1.42 (range, 1.3-1.5)	1.40 (range, 1.30-1.50)
		II	2	NR				
		IIIa	9	NR				
		IIIb	0	NR				
Maniglio[39] 2024			I to IIIB	I to IV	NR	NR	1.39 (range, 1.28-1.52)	1.36 (range, 1.23-1.52)
MCD of the lunate								
Mehrpour[28] 2011		I	10	NR	NR	NR	0.56±0.1	0.55±0.09
		II	6	NR				
		IIIa	3	NR				
		IIIb	1	NR				
Kamrani[40] 2022		II	10	8	59°±8°	62°±9°	1.41±0.09	1.38±0.09
		IIIa	18	12				
		IIIb	16	24				
Saremi[41] 2024		II	17	16	56.8°±11°	59.5°±11.8°	0.53±0.05	0.51±0.02
		IIIa	17	15				
		IIIb	6	9				
CFP								
Sarı[45] 2022		IIIa	16	13	NR	NR	NR	NR
		IIIb	0	2				
		IV	0	1				

*NR: Not reported.

•MCD of Lunate:

Mehrpour et al. (2011) reported that the majority of patients showed no radiographic progression according to Lichtman staging. The CHR decreased from 0.56 ± 0.10 to 0.55 ± 0.09, indicating no clinically significant carpal collapse over 5 years.[28]

In Kamrani et al.'s (2022) study, the Lichtman stage remained unchanged in 35 patients (80%) of the MCD group. The Lichtman stage increased in 9 patients: 1 from stage II to IIIa, one from stage II to IIIb, and seven from stage IIIa to IIIb. The CHR changed from 1.41 ± 0.09 to 1.38 ± 0.09, a change that was not clinically significant. However, the RS angle increased significantly from 59 ± 8 to 62 ± 9 ($P < 0.05$).[40]

In Saremi et al.'s (2024) study, the Lichtman stage increased in only 4 (10%) patients: 1 from stage II to IIIa and three from stage IIIa to IIIb. A significant increase in the RS angle was observed, from 56.8 ± 11 to 59.5 ± 11.8 ($P < 0.05$), and the CHR changed from 0.53 ± 0.05 to 0.51 ± 0.02($P = 0.131$).[41]

In Mazhar et al.'s (2022) study, lunate vascularization improved in 6 of 8 patients (75%), while in one patient, MRI showed lunate vascularization that appeared almost normal.[42] Finally, in Sadri et al.'s (2024) study, radiological findings demonstrated that BM-MSC transplantation following MCD resulted in decreased lunate sclerosis [Table 3].[43]

•Capitate Forage Procedure (CFP):

Sarı (2022) did not utilize MRI. Still, direct radiological imaging of two patients with poor clinical outcomes in the

CFP group revealed carpal bone collapse. It was classified as Lichtman Stage IIIB, and one patient progressed to Stage IV. While no significant radiological changes were observed in the other CFP patients, their clinical symptoms improved regardless of the radiological findings [Table 3].[45]

Discussion

In this narrative review, we synthesized all available studies that used the MCD method on the lunate, capitate, radius, and ulna and reported their results collectively. According to the results of all studies, the clinical and functional outcomes of patients, including VAS, DASH, and PRWE, tended to decrease. At the same time, MWS appeared to increase compared with pre-intervention levels, suggesting an improvement in patients' clinical status after the intervention.[28,32,34,35,37,38,40-43,45] Clinical comparison results between the arthroscopic lunate MCD and radial osteotomy groups showed that, despite the higher postoperative mean DASH and VAS scores in the radial osteotomy group compared to MCD, the difference was not statistically significant (VAS p=0.181, DASH p=0.712). Compared with the radial osteotomy group, there were no significant differences except for wrist extension, which was better in the MCD group (P = 0.032). This result appears to align with a systematic review that noted 83% of patients reported improvements in pain after MCD and 90% after osteotomy was performed in the early stages.[40, 46] Analysis of MCD results between the early stage (II and IIIa) and the Advanced stage (IIIb) showed that, despite higher preoperative and postoperative VAS and DASH scores in the advanced group, the difference was not significant, suggesting the potential efficacy of MCD in both early and advanced groups.[40] Analysis of Changes in VAS and DASH scores before and after surgery, separately for each stage, found that, with increasing disease stage, the changes before and after surgery decreased but were not statistically significant (p=0.477). Additionally, minor differences in arthroscopic technique can affect outcomes. Specifically, the absence of a 20° rotational angle of the bur during the core decompression procedure may offer an advantage.[41] Therefore, improving the arthroscopic technique might lead to even better results. The open lunate MCD outcomes, including VAS and DASH scores, appeared to be as favorable as those with the arthroscopic technique.[28] Another advantage of Lunate MCD is its compatibility with intraosseous injections. Results following BM-MSC infusion and deferoxamine suggest improved outcomes and patient satisfaction during follow-up evaluations.[42,43] In a similar study about femur head necrosis, it was concluded that the use of core decompression combined with BM-MCS in the form of concentrated bone marrow, as minimally invasive regenerative hip preservation therapy, can provide significant pain relief, improvement in function, and ultimately halt the progression of AVN of the femoral head.[47] In the Radius MCD approach, the results, including VAS and DASH score, appear to be aligned to Lunate MCD.[32,34,35,37,38] The results were also examined at different ages, and VAS scores before and after surgery were higher in the younger group (Age<45) than in the older group. However, this difference was not statistically significant. Patients were clinically satisfied with the surgery.[38] This may suggest that MCD could be suitable for both old and young patients. Early-term Clinical outcomes of CFP, as a new method, showed significant improvements in a study of relatively young patients. This improvement was compared with RSO, and RSO showed better results.[45] It seems that MCD cannot solely account for all improvements. A study on stage II and IIIa patients receiving conservative treatment reported significant clinical improvements, despite a reduction in grip strength.[48] Another study found no significant difference in clinical outcomes between conservatively and surgically treated groups.[49]

Patient ROM and grip results were also included in this study. It is reported that grip and ROM increase in both young and old patients, with only grip changes in the younger group being statistically significant.[38] This improvement was statistically significant.[27] In two lunate arthroscopic studies, flexion and extension performance significantly improved, although little differences in results between the two studies could be due to technique differences. They both used the trans-4 portal Arthroscopic lunate MCD technique, as fully described in a cadaveric study. Still, Saremi avoided a 20-degree burr during the procedure due to the risk of lunate bone fragmentation.[40,41,50] Similar results were reported in a study with two patients, indicating the suitability of lunate MCD surgery using the Arthroscopic method.[51] It could be suggested that arthroscopic classification and an articular-based approach to KD may provide a high probability of good long-term pain relief and a minimal chance of requiring a salvage procedure.[52] The results are sensitive to small details in the arthroscopic approach, and the technique needs improvement.

In examining radiological results, we collected data on disease progression based on Lichtman classification, CHR, and RS angle. In studies, CHR and RS angles were measured using the Nattrass method.[53] RS angle was reported to show a statistically significant increase.[40,41] Additionally, the post-surgery RS angle was compared with the radial osteotomy group. Although the mean RS angle was higher in the radial osteotomy group, the difference was not statistically significant. In contrast, a study of patients with stage IIIa who underwent RSO showed increases in both RS angle and CHR, with only the RS angle changes being statistically significant.[40,54] CHR decreased across all studies, attaining statistical but not clinical significance in Kamrani's study, whereas no statistical significance was observed in Saremi's study.[40,41] These changes in radiological indices suggested minimal lunate collapse, and the patients were satisfied with the outcomes. In comparing pre- and post-surgery Lichtman classification, Illarramendi's 2001 study showed two patients changing from stage 2 to 3 and two from stage 3 to 2, but in most studies, patients either did not change stages or a limited number of patients increased in stage; this progression varied from 10% to approximately 30%.[27,33-35,37,38,40,41] The Spearman correlation coefficient did not indicate a significant correlation, with values of −0.06 for Mayo and Lichtman classification and 0.16 for VAS and

Lichtman classification. No correlation between the radiological progression in the Lichtman classification and the duration of follow-up was found (−0.11).[39] MRI evaluations have been less frequently studied, but available results suggest notable findings. MRI scans performed an average of 21 weeks post-surgery showed a substantial decrease in bone marrow edema and fat necrosis. Follow-up periods extending beyond 10 years showed near-normal T1 or T2 signal intensities.[27] These results suggest that revascularization is a long-lasting process.[27,36] Such MRI improvements were not observed in patients managed conservatively.[55] It can be inferred that MCD may contribute to enhanced vascularity and a reduction in bone fat necrosis.

For Radial MCD, recommended postoperative care includes immobilization with a cast or splint for 2 to 3 weeks, followed by physical therapy and avoidance of heavy manual tasks for 3 months.[27,30, 32-35,37-39] However, some studies suggest 4 weeks of casting followed by 12 weeks of splinting for daily activities.[31,36] For lunate MCD, a casting or splinting of 6 weeks is advised.[28,40] In the case of CFP, both 4 weeks of casting and the option to forge casting have been reported.[44,45] No complications related to radial MCD were reported, and 91-100% of patients returned to their occupations.[27,30-39] Additionally, the rate of patients requiring subsequent surgery, including proximal row carpectomy (PRC) or extensor carpi radialis longus tendon ball arthroplasty, ranged from 4.2% to 8.3%. In comparison, the rates of unplanned reoperations and PRC were 33% and 13%, respectively, in RSO patients.[33-35,37,38,56] In both lunate MCD and CFP, no procedure-related complications were observed during the planned follow-up period.[28, 40, 41, 45.] There were no complications in studies that combined lunate MCD and injection.[42,43] MCD appears to be a cost-effective, low-risk option that avoids complications associated with joint-leveling procedures, such as nonunion and ulnocarpal impingement. It offers significant socioeconomic benefits, especially amid rising healthcare costs, by avoiding the need for implants and minimizing surgical risks.[27,36]

The results of this study suggest that the MCD method is primarily chosen for patients in early stages, although it may also be used in advanced stage IIIb. Regardless of the bone selected for surgery, MCD appears to be associated with improvements in clinical outcomes, including pain relief, range of motion, and grip strength, in both the short- and long-term, for both young and elderly patients. Pain relief is often the earliest outcome reported, usually leading to patient satisfaction. Although radiological progression was observed in some patients, this progression did not appear to correlate with clinical outcomes. MCD seemed to offer acceptable outcomes, with no reported complications, and most patients returned to their primary occupations.[27,30-39] MRI assessments suggest that changes in vascularity may have long-term effects, and it is recommended to use Schmitt's method for MRI evaluations.[23] MCD is considered less invasive than RSO and can be performed using either open or arthroscopic techniques, thereby avoiding the need for forearm implants that can cause discomfort.[54] However, it seems that improving arthroscopic outcomes requires further Cadaveric studies to optimize current techniques. Limited data is available on the CFP technique, but according to Sarı's study, the absence of a need for splints or casts can be considered an advantage for patients.

Study Limitations

This narrative review has several limitations worth noting. The most significant decision is to use a narrative synthesis rather than a quantitative meta-analysis. This decision was based on the essential differences observed across the studies we included. Specifically, there was significant variation in study design, patient populations, surgical techniques, reporting outcome measures, and follow-up durations. Other limitations include reliance on studies with relatively small sample sizes and inclusion of only English-language publications. Despite these limitations, this narrative review has achieved its goal of providing a broad overview and critical evaluation of the current evidence on MCD for Kienböck's disease, helping to outline the field and highlight key areas for future, more standardized research.

Conclusion

The MCD method is primarily applied in early-stage patients but may also offer benefits in advanced stage IIIb. Evidence suggests that MCD improves clinical outcomes, such as pain relief, range of motion, and grip strength, in both the short- and long-term, and in both young and elderly patients. Pain relief is frequently reported as the earliest observable outcome and may contribute to patient satisfaction. Although radiological progression has been reported in some cases, it does not consistently correlate with clinical deterioration. MCD is generally considered less invasive than RSO, can be performed using open or arthroscopic techniques, and typically avoids the need for forearm implants. Further cadaveric studies could help optimize arthroscopic approaches. Additionally, the CFP technique may benefit selected patients by eliminating the need for splints or casts. Overall, this narrative review indicates that MCD is a promising treatment option. However, these conclusions should be interpreted with caution. As a qualitative synthesis, this review is based on studies that vary widely. More rigorous comparative studies are needed to confirm and expand upon these findings.

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