

The outcome of treatment of Kienbock's disease stage III by excisional arthroplasty and palmaris longus spacer

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Abstract

Purpose: To present the outcomes of treatment of Kienbock's Disease (KD) stage III, by excisional arthroplasty of lunate with Palmaris Longus (PL) tendon as a spacer.

Methods: Twenty-one patients were diagnosed with KD stage III, 14 females, and 7 males. They were treated by excision of the lunate plus PL tendon ball as a spacer. Mean follow up period was 38 months (24-60). Pre- and post-operative treatment assessment were by recording the clinical examination data, the investigation by radiological imaging (plain and CT scan), MRI, and scoring of Disabilities of Arm, Shoulder and Hand (DASH) system.

Results: Nineteen patients improved clinically to a great extent, by relieving symptoms, a better range of movement, functional satisfaction and no conspicuous Carpal Height Ratio (CHR) change. Mean DASH score improved from 38.5 to 6.8. Two patients had less favorable clinical outcome, yet, they were not interested to have further operations.

Conclusions: Treatment of KD stage III by excisional arthroplasty plus palmaris longus tendon spacer is a low demand operation, which can be performed in a moderate hospital environment, and can accomplish good satisfactory results comparable to other more sophisticated, costly procedures. Type of study/Level of evidence: Prospective case series, level IV.

Keywords: Excisional arthroplasty; Kienbock's disease; Lunate collapse; Palmaris longus

1. Introduction

Kienbock's disease (KD) is defined by avascular necrosis of lunate with a predictable pattern of lunate collapse, carpal change, and degeneration, resulting from an apparent combination of vascular, anatomic and traumatic insults.

(KD) was first described in 1983 by Peste through his cadaveric work and observations of lunate collapse [1].

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Robert Kienbock, an Austrian Radiologist, after a review of his own 16 and another 20 patients, coined the term of lunatomalacia to describe softening of the bone in the acute process. He concluded that it was due to traumatic causes. His concept was not widely accepted, because ligament tears not found, and dislocation of the lunate never followed by lunatomalacia [2], other causes were hypothesized; anatomical, vascular, and mechanical. The negative ulnar variance was blamed by Walter Muller in 1920 but never confirmed and still controversial [2, 3]. Genetic factors were noticed by observations in the first kin and familial clusters [4].

Gerwin in 1993 was first surgeon to use the term Kienbock's disease [5]. KD is considered a rare disease with a prevalence of less than 5 in 10000 people. More common in heavy labor men, however, in this study it was more common in housewives.

Currently, no evidence exists demonstrating a treatment that can lead to disease regression or even halt disease progression. The uncertain aetiology goes along with ambiguous diagnostic criteria which in turn account for the uncertain incidence and prevalence.

Diagnosis and treatment based on classification into four stages, by plain radiograph, and CT scan to visualize the condition of the lunate (Lichtman), MRI classification according to the viability of the bone (Schmitt) [6, 7, 8]. Bain/Begg added arthroscopic classification into six stages [9]. Accordingly, algorithms were designed to guide treatment protocols [10].

Treatment protocols designed to relieve symptoms and stop the progression of the disease in the early stages I and II, in later stages III and IV where gross damage to bone occurred, treatments are directed to symptoms and to save the rest of the wrist. Several protocols of treatment are practiced, it depends on the clinical condition, function expectations of the patient and facilities available to the surgeon.

The objective of this study is to present the results of treatment of KD III by excisional arthroplasty of lunate and PL spacer, as a low demand operation, suitable to the moderate community, with comparable good results.

2. Patients and Methods

This is a prospective, case series study, of twenty-one patients diagnosed with (KD) Stage III, and treated, from September 2011 to October 2018. The follow-up period ranged from 24 to 60 months (mean 38 months). Twenty-one patients were admitted, their ages ranged between 17 to 36 years (mean age 26.5Y), there were 14 females and 7 males. 18 right hands, 3 left hands, all affected hands were dominant.

The inclusion criteria were, affection with (KD) stage III, diagnosed by the clinical condition of chronic wrist pain, moderate swelling with tenderness over the dorsal mid wrist, and painful limitation of Range of Movements (ROM).

Radiological imaging (Figure 1, Figure 2, Figure 3) and MRI confirmed the diagnosis; plain radiograph showed deformation collapse of the normal shape with fragmentation, MRI showed avascular ischemia of the lunate. (Figure 4) Exclusion criteria were, (KD) stage I, II, IV, previous fractures and/or operations in the wrist area.

One patient showed a 3mm negative ulnar variance (

Figure 2). Preoperative assessment was by clinical examination, recording pain, wrist (ROM), grip power by sphygmomanometer compared to the healthy hand, and disabilities of Arm Shoulder & Hand (DASH) score questionnaire.

Table 1 Patients demographic data

Case No.	Age by years	Date of Surgery	Time until Diagnosis By month	Dominant Hand	Affected hand	Presentation	Gender
1	30	2/09/11	9	Rt.	Rt.	Pain –weakness-DROM	M
2	28	2/10/11	7	Rt.	Rt.	Pain	F
3	26	20/11/11	7	Rt.	Rt.	Pain –weakness-DROM	M
4	36	04/01/12	6	Rt.	Rt.	Pain -DROM	F
5	33	13/02/12	9	Lt.	Lt.	Pain	F
6	26	18/03/12	8	Rt.	Rt.	Pain	M
7	34	20/06/12	12	Rt.	Rt.	Pain- weakness-DROM	F
8	27	10/09/12	13	Lt.	Lt.	Pain-weakness-DROM	M
9	25	05/09/13	11	Rt.	Rt.	Pain-DROM	F
10	23	07/10/13	3	Rt.	Rt.	Pain	F
11	27	09/12/13	4	Rt.	Rt.	Pain-Weakness-DROM	M
12	30	03/04/14	3	Rt.	Rt.	Pain	M
13	22	04/07/14	4	Rt.	Rt.	Pain	F
14	35	04/03/15	20	Lt.	Lt.	Pain – weakness-DROM	F
15	17	17/06/15	12	Rt.	Rt.	Pain –Weakness-DROM	M
16	20	27/07/15	10	Rt.	Rt.	Pain- weakness-DROM	F
17	21	13/07/15	3	Rt.	Rt.	Pain	F
18	24	25/02/16	4	Rt.	Rt.	Pain-Weakness-DROM	F
19	22	29/03/16	13	Rt.	Rt.	Pain- weakness-DROM	F
20	27	27/04/16	21	Rt.	Rt.	Pain-Weak –DROM	F
21	21	12/05/16	2	Rt.	Rt.	Pain	F
Mean	26.38		8.61			Pain 21, weakness 11 DROM 14	F 14/M 7

Decreased range of motion (DROM); Rt.- Right hand and Lt. –Left hand

The 21 patients treated surgically by excision of fragmented lunate and replacement with tendon ball of ipsilateral palmaris longus (PL) or split part of flexor carpi radialis tendon, (one patient). Patient's data are shown in Table 1. General anesthesia was the rule, one patient had axillary brachial plexus block because of smoker's chest. Above elbow, tourniquet applied. The volar approach used, carpal retinaculum released, median nerve and flexor tendons secured, the lunate bone removed completely, usually piecemeal. Gentle traction on the middle finger by the assistant surgeon was helpful to open the joint. The articular cartilage of the lunate fossa and head of the capitate well protected and inspected to confirm no advanced arthritic changes present in the wrist. The tendon of PL retrieved from its muscular attachment, working proximally by two small incisions, keeping its distal attachment, passed dorsal to the median nerve. The tendon rolled on itself to form a ball, pushed to the base of the lunate void and sutured to the dorsal capsule of the wrist. Then closing the volar capsule of wrist joint by 3/0 absorbable suture, skin sutured by 3/0 nylon continuous subcuticular suture over a fine drain for two days.

Short gypsum below elbow splint to the volar crease of the hand-applied for three weeks in mild flexion (5-10 degrees) of the wrist; to allow stable healing of the wrist capsule, early movements of fingers and elbow encouraged. Antibiotics for five days and analgesia as needed. At the end of the third post-operative week, splint, dressing and skin suture removed, free wrist and hand movements allowed.

Plain PA and lateral radiograph done to confirm the total removal of the lunate and the Carpal Height Ratio (CHR).

All operations are done by the same team headed by the first author. Follow up was on monthly basis for the first three months, then every three to six months for at least two years. In follow up visits, pain, ROM, grip power, work performance, and general satisfaction, were assessed. At six months DASH score questionnaires done, repeated after 6 months by interview and/or telephone. Several patients were followed clinically and radiologically for up to 60 months. Carpal height ratio measured.

The protocol of the study was approved by the Committee of Medical Ethics in our hospital, following the Ethical regulations of the Iraqi Ministry of Health. All patients signed their consents to use their data, with privacy preservation.



Figure 1 Radiological imaging K D. A&B CT Scan wrist, fragmentation collapse. C plain radiograph wrists showing abnormal changes of the lunate. No ulnar variance noted in 20 cases.



Figure 2 Case no. 6. Ulnar variance



Figure 3 CT scan KD III



Figure 4 Case no. 11 MRI KDIII

3. Results

Twenty-one patients diagnosed with KD stage III were subject to this study, treated by excision of the lunate bone with replacement by PL spacer.

In Table 2, the post-operative data are shown which indicated the improvement of all patients postoperatively, regarding the pain, ROM (Figure 5, Figure 6), grip power and general satisfaction.



Figure 5 Case no. 5 ROM 30 months follow up.



Figure 6 Case no. 7 ROM 42 months follow up.

Table 2 Patient results data

Case No.	DASH Score before	DASH Score after	Flexion/Extension before	Flexion/Extension after	Power grip in mm Hg of affected/normal hand	Postop. Carpal height ratio
1	40.2	5.1	30/40	45/60	190/210	0.47
2	28.1	0	40/60	50/60	140/140	0.51
3	35.5	3.1	55/40	50/55	190/200	0.43
4	42.3	6.1	35/30	40/50	130/160	0.46
5	27.6	0.9	55/45	50/50	140/140	0.52
6	30.4	3.3	40/40	55/70	170/190	0.50
7	37.5	4.3	35/40	50/65	130/150	0.49
8	45	6.6	25/30	45/60	180/200	0.46
9	36.1	4.0	30/35	45/60	150/160	0.43
10	33	3.5	37/55	55/60	120/140	0.49
11	44.3	6.3	20/50	55/60	180/200	0.47
12	27.6	2.0	55/70	50/70	200/210	0.51
13	30.7	3.0	45/55	45/60	130/130	0.53
14	46.1	30.2	10/25	40/45	110/140	0.41
15	48.2	7.1	25/40	45/60	170/190	0.47
16	55.7	9.5	20/20	45/45	110/150	0.45
17	29.3	0	55/60	50/60	130/130	0.52
18	38	5.1	45/60	40/60	140/160	0.49
19	46	8.5	25/55	40/50	120/150	0.47
20	57	33.5	5/15	40/45	110/150	0.39
21	29.8	1.3	50/40	55/60	140/140	0.50
Mean	38.49	6.34	34.6/41.9	47.2/57.4	146.7/163.8	0.47

Two patients (No. 14, 20) had less favorable results of improvement in form of moderate residual pain. They had a long history before surgery with some arthritic changes started in the wrist, yet they were not interested to have further procedures. Late radiographs did not show the change in CHR (Figure 7, Figure 8) so there was no further carpal mobilization or collapse 40 months after the removal of the pathological lunate bone and soft tissue spacer replacement.

**Figure 7** Case no. 2 40 months follow up. (Maintained carpal ratio)



Figure 8 Case no.9 Carpal bones 30 months follow up (maintained carpal ratio)

Complications

Infection superficial in one patient and temporary Neuropraxia of the median nerve in three patients resolved within two weeks.

4. Discussion

KD is known for more than 100 years. Much information collected as far as the pathology and aetiology trying to tailor the best treatment. Algorithms had been advocated to guide the surgeons to the best procedure for the current stage of the disease [10].

Many procedures are not enhanced by every surgeon; like arthroscopy of the wrist and new implants to fuse carpal bones. The final choice of the appropriate procedure must fit the patients' need and the operative facilities available. Many patients do not feel easy to remove non-affected bones when we offer proximal row carpectomy for example, even more, when they hear that there is no significant outcome in the results of sophisticated operations with costly implants. The operation of shortening and fixation of the radius is widely practiced despite the non-proven factor of ulnar variance in the development of the disease [11, 12], yet, there is little evidence to support any particular form of operative treatment, or to indicate its superiority; the surgical options may even worsen the outcome [13, 14].

It is generally observed in other studies, that the disease is more common in males with an average ratio of 5: 1, in heavy manual workers [15, 16]. In this study, 14 females, 7 males, with a ratio of 2:1. The predominant females are all housewives who serve big families.

Although the operation performed in this study, is time tested, several authors used it with some modifications and got comparable results. Yasuo Ueba used a dorsal approach and added K wire or external fixation distractor to fix the ball in the void of the removed lunate, he had good results [17]. Levent Kucuk used K wires to fix the PL tendon [18]. Iwasaki N. and Yajima H. added to PL spacer limited carpal bones fixation [19, 20]. Kato H. comparing the PL spacer with silicone implant found superior results with the PL group [21].

Dutta A. used the PL tendon with its muscle belly to enlarge the spacer; he had good results with no carpal collapse after 9 months of follow up [22]. Sakai A. added bone Core to PL tendon with slightly better results in short time follow up [23]. The idea behind all these modifications is to prevent carpal mobilization which can lead to collapse and degeneration of the wrist. Looking back on these studies, they conclude satisfactory functional outcomes despite some decrease in the CHR; Carroll concluded after ten years, improved function and no collapse occurred in his cases [24]. We speculate that the main cause of wrist dysfunction is the inflammatory synovitis due to the presence of the fragmented dead bone; the swelling on the dorsum of wrist and the presence of rest pain may indicate that. Removal of the debris of lunate relieved the joint.

In this study, we did not think these added steps necessary, besides, they carry prolonged morbidity, as out of work periods. In this study, the functional outcomes of the wrists improved, and the carpal height maintained near-normal ratio after 40 months of follow up.

5. Conclusion

The operation of excision of the lunate with replacement by PL tendon is suitable to treat KD stage III. It is a low demand procedure, can be performed in a moderate environment and resulted in good outcomes.

Compliance with ethical standards

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Disclosure of conflict of interest

All the authors declare no conflict of any interest related to this work. No fund was received to produce this study.

Statement of informed consent

Informed consent was obtained from all individual participants included in this study.

Ethical Approval:

The methodology and plan of the study was approved by the committee of ethics in Al Wasity hospital and the guidelines of ethics of the ministry of health in Iraq,

References

- [1] D Cross. Kienbock Disease, OrthopClin N Am us. 2014; 141-152.
- [2] C Irisarri. Etiology of Kienbock Disease, The Journal of Hand Surgery. 2004; 3: 279-284.
- [3] WF Van Leeuwen, K Oflazoglu, ME Menendez, D Ring. Negative Ulnar Variance and Kienbock Disease, J Hand Surg Am. 2020; 41(2): 214-218.
- [4] NH Kazmers, Yu Zhe, T Barker, T Abraham, R Romero, MJ Janyne. Evaluation for Kienbock's Disease Familial clustering: A population-based cohort study. J Hand Surg Am. Jan. 2020; 45: 1-8.
- [5] M Gerwin. The history of Kienbock's disease. Hand Clinics. 1993; 9(3): 385-390.
- [6] D Lichtman. Degnan GG. Staging and its use in the determination of treatment modalities for Kienbock's disease, Hand clinics. 1993 Aug; 9(3): 409-16.
- [7] J Saiz, T Piedra, L Cerezal, J Ward, A Thompson, JA Vidal, A Canga. Imaging of Kienbock Disease, American Journal of Radiology. 2014; 203: 131-139.
- [8] R Schmitt, A Hienze, F Fellner, N Obletter, R Struhn, W Bautz. Imaging and staging of avascular osteonecrosis at the wrist and hand, European journal of radiology. 1997; 25(2): 92-103.
- [9] G Bain, M Begg. Arthroscopic assessment and classification of Kienbock's disease, Tech Hand Up Extrem Surg. 2006; 10(1): 8e13.
- [10] DM Lichtman, WF Pientka II, GI Bain. Kienbock Disease: A New Algorithm for the 21st Century, J Wrist Surg. 2017; 2-6.
- [11] WF Van Leeuwen, SJ Janssen, D Ring. Radiographic Progression of Kienbock Disease, in Radial Shortening Versus No Surgery. J Hand Surg Am. 2016; 41(6): 681-688.
- [12] WF Van Leeuwen, K Oflazoglu, M Menendez, D Ring. Negative Ulnar Variance and Kienbock Disease, J Hand Surg Am. 2016; 41(2): 214-218.

- [13] WF Van Leeuwen, MA Tarabochia, AH Schuurman, N Chen, D Ring. Risk Factors of Lunate Collapse on Kienbock Disease, J Hand Surg Am. 2017; 41(11): 883-888.
- [14] D Delaere, M Dury, A Molderez, G Foucher. Conservative versus operative treatment for Kienbock's disease, a retrospective study. J Hand Surg [Br.]. 1998; 23-33-6.
- [15] F Schuind, S Eslami, P Ledoux. Aspects of Current Management Kienbocks's disease, J Bone Joint Surg [Br]. 2008; 90-B, 133-9.
- [16] C Fontaine. Kienbock's disease, Chirurgie de la main. 28 Feb 2015; 34(1): 4-17.
- [17] Y Ueba, K Nosaka, Y Seto, N Ikeda, T. Nakamura. An operative procedure for advanced Kienbock's disease, in Excision of the lunate and subsequent replacement with a tendon ball implant, Journal of orthopaedic science. 1999; 4(3): 207-15.
- [18] L Kucuk, O Ozdemir, E Coskunol, Sugun TS, Ozaksar. The effect of excisional arthroplasty with palmaris longus tendon on carpal height ratio in stage III Kienbock's disease, Acta orthopaedica et traumatologica turcica, Dec 2011; 45(6): 393-8.
- [19] N Iwasaki, E Genda, P Barrance. Biomechanical analysis of limited intercarpal fusion for the treatment of Kienbock's disease, in a three-dimensional theoretical study, J. Orthop. Res. 1998; 16: 256-63.
- [20] H Yajima, Y Kobata, T Yamauchi. Advanced Kienbock's disease treated with implantation of a tendon roll and temporary partial fixation of the wrist," Scand J Plast Reconstr Hand surg. 2004; 38: 340-6.
- [21] H Kato, M Usui, A Minami. Long term results of Kienbock's disease treated by excisional arthroplasty with silicone implant or coiled palmaris longus tendon, J hand Surg Am. 1986; 11: 6450 53.
- [22] A Dutta, A Sipani, V Agarwala, M. Srikanth. Kienbock's Disease treated with Interposition Arthroplasty using Ipsilateral Palmaris Longus Tendon and Muscle belly," Journal of orthopaedic case reports. 2012; 11(1): 11-4.
- [23] A Sakai, N Toba, T Oshige, H Hirasawa, T Nakamura. Kienbock's disease treated by excisional arthroplasty with palmaris longus tendon, comparative study of cases with or without bone core," Hand Surg. Dec 2004; 9(2): 145-9.
- [24] R Carroll. Long term review of fascial replacement after excision of the carpal lunate bone, Clinc. Orthop. Relat. Resch. 1997; 342: 59-63.

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