



ISOLATED CAPITELLAR FRACTURE FIXATION WITH HEADLESS SCREWS IN DIFFERENT CONFIGURATIONS

FIXAÇÃO DE FRATURA ISOLADA DO CAPÍTULO DO ÚMERO COM PARAFUSOS SEM CABEÇA EM DIFERENTES CONFIGURAÇÕES

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ABSTRACT

Introduction: We evaluated the clinical and radiological outcomes of capitellar fractures treated with modified screw insertion (inserting the first fixation screw anteroposteriorly and the second screw posteroanteriorly), a technique that can be applied with a minimally invasive lateral elbow approach. **Materials and Methods:** Twenty-one isolated capitellum fractures that were surgically treated were included in the study. Fixation was achieved with two headless cannulated compression screws placed in anteroposterior and posteroanterior order using the modified lateral elbow approach. The Broberg-Morrey rating system was used to assess the post-operative functional status of the patients. **Results:** According to the Broberg-Morrey criteria, the mean score was 92.7 (77-100) and 13 cases had excellent, 7 had good, and 1 had fair results. None of the patients developed avascular necrosis or heterotopic ossification. According to the Broberg-Morrey arthrosis score, two cases had Grade 1 and one had Grade 2 arthrosis. One patient had a superficial wound site infection that was treated with antibiotics, and in one case a 60° extension loss was observed in the elbow. **Conclusion:** Treatment of isolated capitellar fractures with 2 headless screws placed anteroposteriorly and posteroanteriorly can provide stable fixation and is less traumatic for the elbow joint. **Level of Evidence IV; Therapeutic Studies - Investigating the results of treatment.**

Keywords: Fracture fixation, internal. Humeral fractures. Intra-articular fractures.

RESUMO

Introdução: Avaliamos os resultados clínicos e radiológicos das fraturas do capítulo do úmero tratadas com a técnica de inserção de parafuso modificada (inserção do primeiro parafuso de fixação anteroposterior e do segundo parafuso posteroanterior), que pode ser aplicada com acesso lateral minimamente invasivo do cotovelo. **Material e Método:** Foram incluídas no estudo 21 fraturas isoladas do capítulo que foram tratadas cirurgicamente. A fixação foi obtida com dois parafusos de compressão canulados sem cabeça colocados em ordem anteroposterior e posteroanterior, usando acesso lateral modificado do cotovelo. O sistema de classificação Broberg-Morrey foi usado para avaliar o estado funcional pós-operatório dos pacientes. **Resultados:** De acordo com os critérios de Broberg-Morrey, o escore médio foi de 92,7 (77-100) e 13 casos foram excelentes, 7 bons e 1 regular. Nenhum paciente desenvolveu necrose avascular ou ossificação heterotópica. De acordo com o escore de artrose de Broberg-Morrey, dois casos tinham Grau 1 e um tinha artrose de Grau 2. Um paciente tinha infecção superficial da ferida, que foi tratada com antibióticos, e em um caso observou-se perda de 60° da extensão do cotovelo. **Conclusão:** O tratamento de fraturas isoladas do capítulo do úmero com 2 parafusos sem cabeça colocados anteroposterior e posteroanteriormente pode proporcionar fixação estável e é menos traumático para a articulação do cotovelo. **Nível de evidência IV; Estudos terapêuticos - Investigação dos resultados do tratamento.**

Descritores: Fixação interna de fratura. Fraturas do úmero. Fraturas intraarticulares.

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INTRODUCTION

Fractures of the capitellum comprise 1% of the fractures around the elbow.¹⁻⁶ The mechanism of formation of these fractures is the shearing force exerted by the radial head on the capitellum due to fall while the elbow is in flexion and the hand is stretched.^{1,3,4,5-9}

Due to its intraarticular nature and the tendency of the fractured fragment to form a mechanical block in the elbow by displacing toward the superior, these fractures generally require surgical treatment.^{2,3} For internal fixation of capitellum fractures, lateral or anterolateral exposure to the elbow is preferred.¹⁰ Kirschner wires

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The study was conducted at the University of Health Sciences Turkey, Metin Sabancı Baltalimani Bone Diseases Teaching and Research Hospital.

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(K-wires), partially threaded cannulated screws, headless cannulated compression screws and 3.5 mm lag screws may be used for fixation. The most reported and the most preferred method for fixation of capitellum fractures is fixation with anteroposterior directed or posteroanterior directed headless cannulated screws.^{6,8,9,11,12,13} In addition, a minimally invasive fixation method with cannulated screws under the guidance of elbow arthroscopy has been defined.¹⁴ Excision of the fragment is preferred in small and unfixable osteochondral fractures, while a prosthetic replacement is a less favored method.^{3,5} As the fracture is an intraarticular one, the head of the fixation component should not be left outside and inserted adequately under the articular surface. For this reason, headless cannulated compression screws is a good option, providing the above requirements and an effective compression.^{1,4,8,15}

The treatment of capitellum fractures is made with two screws to resist fracture fragment rotation and shearing forces over the fracture line. However, if the placement direction of these screws is posteroanterior, the screw on the medial side is difficult to insert because there is not enough space, it increases the risk of neurovascular injury and is often not sent perpendicular to the fracture line. When these screws are sent from the posterior to anterior direction, sufficient compression cannot be obtained in the fracture line and the need for soft tissue dissection in the posterior of the lateral epicondyle increases. We placed one screw (first screw) in the anteroposterior direction from the lateral part of the fragment, and one screw (second screw) in the posteroanterior direction from the epicondyle to fix the medial of the fragment. Thus, we avoided the difficulty of inserting the medial screw, the risk of neurovascular injury in the anterior, and the risk of insufficient compression in the fracture line. In our study, we aimed to describe the modified version of the conventional Kocher lateral approach to elbow to fixate capitellar fracture and to give details of the screw placement technique. As a secondary outcome, we evaluated the clinical and radiological outcomes of patients with capitellar fractures treated with describe technique.

MATERIALS AND METHODS

Clinical data of the patients treated for capitellum fracture between January 2012 and December 2015 were retrospectively evaluated after having approval from the Institutional Ethical Committee&Review Board (document number: 2016-44). Informed consent was obtained from all patients, including for the use of clinical data for scientific purposes. We included patients with a minimum follow-up period of 12 months. Those with open fractures or concurrent unilateral fractures were excluded (two cases). The fractures were classified according to the Dubberley classification.¹⁶ Anteroposterior and lateral radiographs were used for diagnosis (Figure 1 A, B). Also, all patients were asked to undergo computed tomography to evaluate the fracture displacement and comminution better, detect any possible trochlear fracture extension or accompanying injuries, and for surgical planning (Figure 1 C, D).

Surgical Technique

Infraclavicular block anaesthesia was administered to all patients. The operation was commenced under tourniquet with the patient in the supine position. Elbow ligament injury and instability were sought and compared to the uninjured side. A shorter incision than the usual extended Kocher lateral approach was performed on the lateral elbow.¹⁷ The incision centering the lateral epicondyle was extended 3 cm to the proximal and 2 cm to the distal. In contrary to the classical approach, the extensor origin muscles were partially elevated (Figure 2A, B). In one case with Type 3A fracture, the incision was extended as in the classical approach, and the extensor origin was elevated as a whole. Proximally, the interval between the



Figure 1. Preoperative AP and Lateral elbow X-ray images of 42-year-old female patient (A-B); Preoperative CT (C-D).

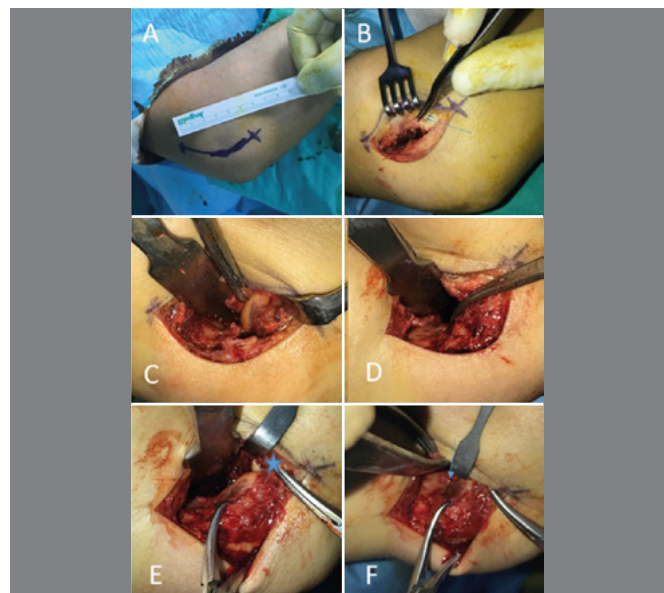


Figure 2. Perioperative pictures showing A: Length of incision, B: Partial elevation of common extensor muscles from lateral epicondyle (shown with blue line) C: Capitellar fracture that displaced anterosuperiorly D: After reduction, E: Intact annular ligament (blue asterisk) F: Capitellum medial is also anatomically reduced (blue arrow head).

triceps and brachioradialis, and between the extensor carpi ulnaris muscle (ECU) and anconeus muscle at the distal was used to reach the lateral epicondyle. The fracture line was reached after the joint capsule was opened. The capsule was opened from the anterior distally without damaging the annular ligament. In all cases, surgical exposure was performed without cutting the annular ligament, and the fracture line could be reached (Figure 2 D). Besides, soft tissues and capsule were not elevated from the posterior surface of the lateral epicondyle to preserve the blood supply of condyle. Hematoma, blood clots, crushed bone and cartilage fragments, and the interposed soft tissue debris on the fracture line were removed. The joint was irrigated and debrided with saline solution. Then, the joint was checked for any accompanying injuries. The fractured fragment had migrated toward the anterosuperior in all cases (Figure 2 C). The anterosuperior displaced capitellum was reduced, and the continuity of the joint surface at the medial and lateral side was checked. Medial joint surface continuity was controlled while

the elbow is flexed and lateral cortex fracture line continuity with the posterior cortex while the elbow is extended (Figure 2 E). When the anatomical reduction was achieved, the reduction was maintained with C-clamps in the anteroposterior direction (Figure 2 D). To efficiently reduce the elbow was relaxed by flexion and pronation maneuverer. Two screws over K-wires were used for fixation of the fracture line (Figure 3 A, B, C, D). The first screw was used laterally from the anterior to the posterior direction to get compression, and the second screw was placed at the medial of the fragment from the posterior to the anterior direction to get rotational control and more stability. The position of the second screw head, which was placed from the posterior to the anterior direction, was made with fluoroscopic control without soft tissue dissection. Both screws were sent vertically to the fracture line. Moreover, during the insertion of the second screw, the neurovascular structures in the anterior were protected by a retractor. The integrity of the reduction and the fracture line was checked under fluoroscopy (Figure 3 B, D). In sequence, a screw, 2 mm shorter than what was measured with the guidewires, was selected. The screws were advanced over the guidewire, and attention was paid to keep the screw tips beneath the joint (Figure 3 E, F). In multi-fragmented fractures and large fractures with medial extension, additional screws can be placed in the anteroposterior or posteroanterior direction, depending on the ease of insertion, in addition to screw 1 and 2. We used Acutrak 2 Mini System screws with 3.5 mm tip and 3.6 mm tail thickness. The C-arm fluoroscope was once more used to check the final reduction and position. Joint stability and arc of motion were assessed. Haemostasis was achieved, and the partially elevated extensor origin was reattached to its original position with transosseous sutures. Hemovac drains were inserted, and the layers were closed in an anatomic manner.

Postoperative Follow-up Protocol

Posterior elbow plaster splint was applied to all patients for post-operative pain and edema control in an elbow position of neutral rotation and 90° flexion in the first week of operation. Drains were withdrawn within two days after surgery. No medical treatment was given for Myositis Ossificans prophylaxis. At the 1st week, passive exercises in the range of 30-130 degrees were given within the varus-valgus stabilised hinged elbow brace. Active motion was permitted after the 6th week of operation. Clinical follow-up of the patients were performed at first, second, sixth week, and third month postoperatively. Then, annual clinical control was performed. In the early post-operative period, local wound problems and any fracture-related complications were noted. The Broberg-Morrey rating system was used to assess the post-operative functional status of patients. We also categorized the patients according to The Broberg-Morrey score. Elbow and forearm range of motion of the injured and uninjured side measured and compared. Additionally, we examined patients for any elbow instability. Anteroposterior (AP) and lateral radiographs of the elbow were evaluated for union, osteonecrosis, heterotopic ossification, and posttraumatic arthrosis at final control (Figure 4 A, B, C, D). Arthrotic findings in the joint were assessed with the Broberg and Morrey arthrosis classification.¹⁸

Statistics

Mean, standard deviation, lowest and highest frequency, and ratio were used to describe the data. The chi-square test was used to evaluate the relationships between categorical variables. For comparison of continuous variables, Mann-Whitney U test was used. A p value <0.05 was considered to indicate a statistically significant result. SPSS IBM Statistics 22 (IBM, Armonk, New York, USA) was used for all statistical analyses.

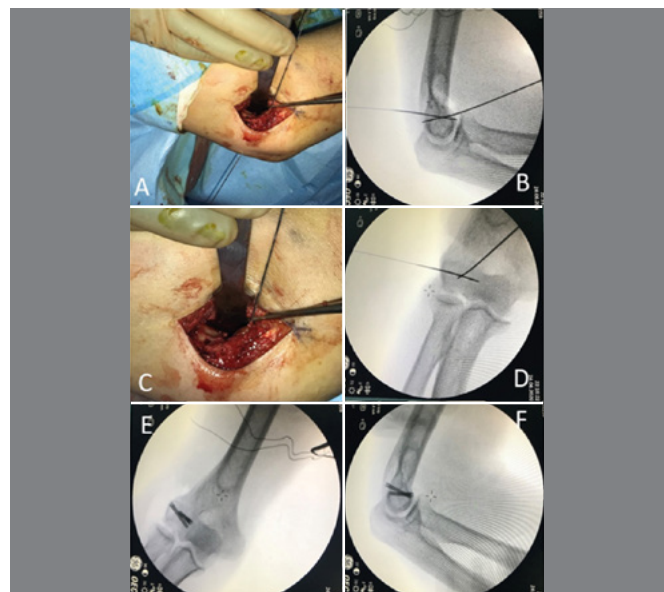


Figure 3. Perioperative pictures and scopy views showing: A-D: K-wire placements, one anteroposterior and one posteroanteriorly E: After placement of headless compression screw AP scopy view F: After placement of headless compression screw lateral scopy view.

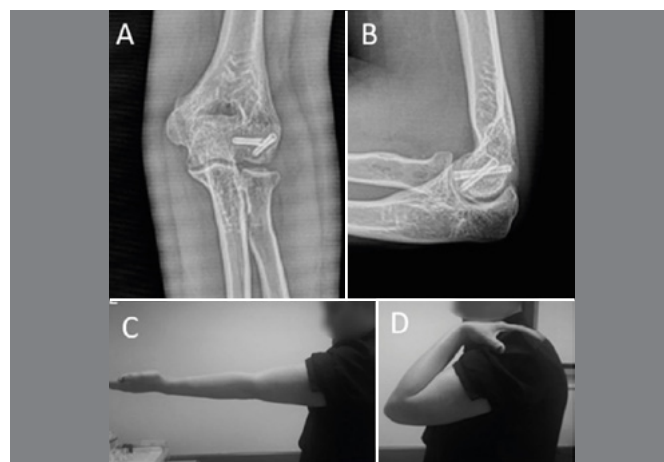


Figure 4. Post-operative AP and lateral radiographs (A-B); and images from final follow-up (twenty-six months) examination demonstrating the ranges of motion of the joint (C-D).

RESULTS

Twenty-one patients (9 males, 12 females) operated in our clinic between 2012 and 2015 due to isolated displaced fractures of the capitellum included in the study. Demographic data of patients were represented in (Table-1). Capitellum fractures occurred after a fall in 14 patients, as a result of a traffic accident in 5 patients, and as a result of sports injuries in 2 patients. Eight of the fractures were on the right side and 13 were on the left side. The mean age of the patients at the time of fracture was 34.8 (16-62) years. The mean follow-up period of our patients was 47.3 (26-63) months. According to Dubberley classification system, 12 cases were classified as 1A, 5 cases as 1B, 3 cases as 2A, and 1 case as 3A. The average time to surgery after trauma was 2.9 (0-7) days. Union in the fracture line was achieved in all patients during our follow-up. The mean time to union was 6 (4-8) weeks. According to the Broberg and Morrey criteria, the mean functional score was 92.7 (77-100). Thirteen cases had excellent, seven had good, and one had fair results. There were

Table 1. Pre-operative demographic data of patients and post-operative functional evaluation.

Patient No	Age	Gender	Fracture Side	Fracture Classification	Time to surgery (D)	Time to Union (W)	Follow-up (M)	Final Ext/Flex Pro/Sup	Final B-M Rating Score
1	50	M	R	1A	1	6	63	130/0 85/90	86
2	32	M	R	1A	7	6	62	130/0 85/80	86
3	32	M	L	2A	4	5	61	125/-10 70/85	77
4	42	F	R	1B	3	5	56	135/0 95/80	95
5	62	F	L	1B	2	8	52	145/0 85/80	100
6	49	M	R	3A	7	7	46	120/-10 85/80	82
7	33	F	L	1A	7	7	55	145/0 90/90	100
8	19	F	L	2A	1	4	38	135/0 85/85	98
9	21	M	L	1A	5	4	37	135/0 90/90	100
10	44	F	L	1A	1	5	26	135/0 90/85	100
11	32	F	L	1A	0	6	32	135/0 85/85	95
12	16	M	L	2A	4	5	30	145/0 85/80	95
13	40	F	L	1A	1	6	29	145/0 85/85	96
14	19	F	R	1A	1	6	26	135/-10 90/90	90
15	36	F	R	1B	0	7	27	145/0 80/80	95
16	40	F	L	1B	2	6	42	135/-10 85/85	90
17	28	F	L	1A	4	5	50	130/0 80/90	90
18	34	M	R	1B	3	6	34	145/0 90/80	96
19	20	M	R	1A	5	5	33	145/0 80/85	95
20	44	F	L	1A	1	6	47	135/-10 85/85	86
21	38	M	L	1A	2	6	46	135/0 85/85	95

R; right, L; Left, D; Day, W; Week, M; Month, Ext; Extension, Fix; Flexion, Pro; Pronation, Sup; Supination, B-M; Broberg-Morrey Rating System

statistically significant differences between the mean elbow range of motions values of the injured side compared to the uninjured side (Table 2). Radiographic findings confirmed that none of the patients developed avascular necrosis. According to the Broberg and Morrey's arthrosis score, two cases had Grade 1, and one had Grade 2 arthrosis. None of our patients developed heterotopic ossification. One patient had a wound site infection which healed with close follow-up and antibiotics treatment. In one case, 60 ° extension loss was observed in the elbow during follow-up. Since the extension loss did not improve despite the rehabilitation, an anterior capsulectomy with lateral exposure was performed in the 7th month after surgery. The total range of motion of 125° was achieved postoperatively.

DISCUSSION

We fixed the capitellar fractures with a less invasive method than the standard approach, using one anteroposterior and one postero-anterior directed headless cannulated screws with the capability of compression and getting a safe room to placing a medial screw. We faced no radiological reduction loss and screw migration. All patients had excellent and good functional results based on the Broberg and Morrey criteria except one. None of our patients developed the usual complications of avascular necrosis or heterotopic ossification. Joint stiffness was observed in only one of our patients. There are several methods of treatment for capitellar fractures. These include closed reduction and cast treatment,¹⁹ fragment excision,^{20,21} arthroscopic guided reduction and internal fixation,^{9,14,22} and the most preferred method today, open reduction and internal fixation.^{1,4,8,11,13,15,19,23,24} Excision of the capitellar fragment might be recommended as an easy procedure, however, as it leads to joint stiffness in the long term, this method should be employed only when the fractured fragment is too small to fix.^{20,21} Although debates continue about optimal surgical exposure and fixation in capitellum fractures, the most important criteria for ideal treatment are stability and anatomical reduction.⁶ Since the blood supply of the capitellum is from the posterolateral capsular attachment, the extensile posterior approach is not preferred and the extensive lateral approach is generally preferred. It is suggested that especially

Table 2. Comparison of range of motions of operated and non-operated elbows.

	Operated	Non-operated	p value
Flexion	114 ± 15	135,9 ± 6	0.000
Extension	6,6 ± 7	0 ± 3	0.007
Pronation	81,6 ± 7	88,8 ± 4	0.002
Supination	78,8 ± 5	85,2 ± 7	0.001

the medial aspect of the trochlea is involved for capitellar coronal fractures, the anterolateral approach should be preferred over the lateral approach.¹⁰ Likewise, discussions continue on the selection of the implant to be used for fixation. An insertion of the screw from anterior can cause injury to the cartilage surface and can lead to collapsing of fragment.^{12,25,26} In the treatment of large capitellar fragments anterior to posterior cannulated headless compression screws may be useful, which have been shown to be biomechanically superior to postero-anterior cannulated lag screws or Herbert screws.^{5,13,27} However, with postero-anterior placement of lag screws or Herbert screws than after anteroposterior placement we can get better motion and functional scores.²⁸ Reasonable outcomes have also been got with use of threaded K-wires cut at the same level with the joint surface.¹⁸ For comminuted fractures at the posterior wall bone grafting with posterolateral column plating may be chosen.²⁹ For severely comminuted fractures hinged external fixation to allow early range of motion seems to be a choice.³⁰ Capitellum fracture fixation under arthroscopic guidance may hold promise. In addition, it may be advantageous to remove small fragments that cannot be fixed by arthroscopy.^{14,22} Although there are very limited publications in the form of case reports in the literature on this subject, the classical advantages of arthroscopy are minimally invasive, low infection rate, and most importantly, avoiding open surgery, especially protecting the ligaments around the elbow and eliminating the need for dissection, which is the cause of bone avascular necrosis.

One of the significant post-operative problems is the limited ROM and stiffness in the elbow after surgical treatment of capitellar fracture. For this reason, extensive dissections should be avoided,

and bleeding control should be performed. Also, since the origin of the main arterial circulation is the perforating arteries in the posterior elbow, the posterior dissection of the capitellum should be avoided. Vaishya et al.¹ used the less preferred anterolateral approach in the treatment of capitellar fractures and reported that the extensor origin was kept intact and the fracture line could be accessed directly. However, the necessity of performing an extensive dissection and preserving the neurovascular structures despite this dissection is the disadvantage of this approach. We employed the classical lateral approach with a smaller incision, partially elevated the extensor origin anterior to the lateral epicondyle and had access to the fracture line. Thus, we were able to keep the extensor origin and lateral ligament complex intact. Only one of our patients had limited ROM, and none of our patients developed heterotopic ossification.

The screws can be inserted in different configurations when fixing the fracture.^{1,8,15,23} Elkowitz et al.¹³ compared the stability of fixations with two cancellous screws, one sent anteroposterior and the other posteroanteriorly, with posteroanteriorly placed two headless cannulated compression screws and found that the headless cannulated compression screw provided the least stable fixation. The authors achieved a more stable fixation with the posteroanteriorly placed screws in both groups fixed with cancellous screws. As placing two posteroanterior screws will not provide a stable fixation in case the subchondral bone is inadequate, Carrol et al. pointed out to

the necessity of anteroposterior fixation in such cases.² Another problem in sending two posteroanterior screws is the technical challenge when a more medial point is intended for screw insertion. We chose to insert an anteroposterior screw from the lateral and a posteroanterior screw from the medial of the fracture site in order to overcome this challenge and obtain a more stable fixation. In this manner, the fixation takes less time to perform and is less traumatic for the soft tissues around the elbow joint. We believe this method can also reduce the duration of surgery significantly, and due to less surgical trauma in the elbow, it avoids complications like joint stiffness.

The limitations of our study are its retrospective design and lack of a comparison or control group. However, we believe that sharing the results of our new modified technique performed on a decent sized patient population with adequate follow-up will be of use for the literature. Further comparative case series studies on capitellar fractures are required to increase the level of evidence.

CONCLUSION

Fixation with headless cannulated compression screws is considered a safe method that provides a stable fixation and allows for early motion. As an alternative to the currently used surgical approaches and fixation methods, we believe performing a small incision and inserting an anteroposterior and a posteroanterior screw is an easily applicable method that provides a stable and safe fixation.

AUTHORS' CONTRIBUTION: MB: contributed to the intellectual concept of the study, wrote and reviewed the article and performed some of the surgeries. SA: analysed the data and wrote the article. MM: performed statistical analysis, participated at the surgeries. MVK: performed statistical analysis and contributed to the intellectual concept of the study. HEA: analysed the figures and tables and reviewed the article, participated at the surgeries. KO: performed surgeries, reviewed the article.

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