Locking Plate alone or in Combination with Cannulated Screws for Hoffa Fractures: A retrospective cohort study

Zhen Li
Guangzhou University of Chinese Medicine
Zhenyue Chen
Guangzhou University of Chinese Medicine
Xiaotan Wang
Shandong University of Traditional Chinese Medicine
Jingyin Li
the First Affiliated Hospital of Shandong University of Traditional Chinese Medicine
Lizhong Jing
the First Affiliated Hospital of Shandong University of Traditional Chinese Medicine
Xuewei Cao (caoxuewei2021@163.com)
Guangdong Provincial Hospital of Chinese Medicine

Research Article

Keywords: Hoffa fractures, locking plate, cannulated screws, early rehabilitation

Posted Date: March 10th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-203399/v2

Version of Record: A version of this preprint was published at Orthopaedic Surgery on January 30th, 2022. See the published version at https://doi.org/10.1111/os.13201.

Abstract

Purpose

Locking plate or screws have been used for Hoffa fractures; however, evidence to support the effectiveness of the procedure remains scarce. The present study aimed to determine the efficacy of distal femur condyle locking plate(DFCLP)alone or in combination with cannulated screws for Hoffa fractures.

Methods

In this cohort study, 13 patients with isolated Hoffa fractures were enrolled during the study period (May 2014 to February 2019) and retrospectively analyzed. Patients underwent open reduction and internal fixation by DFCLP alone or in combination with cannulated screws followed by early active rehabilitation postoperatively. The primary outcome was evaluated with Knee Society Score (KSS), the range of movement (ROM), International Knee Documentation Committee (IKDC) scoring system and the stability of the fixation site of the patients during the 24-month follow-up period.

Results

A total of 13 patients completed the 24-month follow-up assessment and achieve bone re-union at Hoffa fracture sites. The average follow-up period was 24.5months (ranging from 24 to 28 months), and the average time to healing was 3.5 months (ranging from 3 to 4 months). The mean ROM was determined as 119°, the mean KSS was 87.9, and the mean IKDC score was 84.2. It is worth mentioning that 2 patients suffered from knee joint stiffness and osteoarthritis during the 24 months follow-up. Eleven patients (84.6%) achieved satisfactory knee joint function through early postsurgical rehabilitation.

Conclusion

In patients with Hoffa fractures, treatment with DFCLP alone or in combination with cannulated screws followed by early active rehabilitation resulted in great stability and satisfactory functional results after 24 months.

Introduction:

Hoffa fractures, also known as posterior coronal plane shear fractures of the femoral condyle, are rare injuries accounting for only around 8.7%~13% of distal femur fractures [1, 2]. They were originally described by Friedrich Busch and then named in 1904 by Albert Hoffa[1–3].It is an unstable intra-articular fracture that is involved in 17% of supracondylar and intercondylar fractures[3].

Hoffa fractures are most commonly associated with high-energy trauma and typically occur when the knee is in a flexed position with excessive axial forces resulting in shearing of condyles, particularly from motor vehicle accidents and falls from a height[4, 5]. These fractures can often be overlooked in plain radiographs and could be associated with further displacement if not identified soon.Therefore,computed tomography (CT) is the recommended imaging modality for examinations[3]. Non-operative treatments have traditionally yielded poor results[4], whereas open reduction with internal fixation combined with early rehabilitation is the ideal treatment approach for better functional outcomes[5].

Nowadays, various surgical approaches and fixation methods have been established and widely practiced[1–4, 12, 15]. However, no standard treatment method exists for Hoffa fractures. Moreover, there are many problems linked with the internal fixation method, and the unstable nature of Hoffa fractures could result in displacements of fractured fragments and non-union[3–6], increasing the patient's disease and economic burden. In our study, distal femur condyle locking plate (DFCLP) specially designed for Hoffa fractures could achieve enough stability. To date, no literature on this type of fixation method of Hoffa fractures exist.

The purpose of this study is to evaluate the clinical performance of surgical treatments and early rehabilitations on Hoffa fractures in 13 patients fixed by DFCLP alone or in combined with cannulated screws, which provide rigidity and achieve active rehabilitation sooner.

1. Materials And Methods

1.1 Patients

Using the orthopaedic trauma files in our institute, data were gathered for this retrospective study. Initially, data from a total of 657 patients who had suffered from intra-articular distal femur fractures between May 2014 and Feb 2019 were identified through searching from a prospective orthopaedic database, out of which there were 19 cases (2.89%) with Hoffa fractures. Patients who had undergone conservative treatments, open or pathological fractures, any additional supra-condylar or inter-condylar fractures, severe neurovascular injury and any previous surgery of the involved knee were all excluded. In the end, a total of 13 patients who had suffered Hoffa fractures were enrolled in the study. All patients underwent surgery with DFCLP fixation alone or in combination with cannulated screws followed by early active rehabilitation. The DFCLP and cannulated screws were provided by Jiangsu Jinlu Medical Company. Study subjects include 13 patients, the attendance on the follow-up appointments were perfect and no patients dropped out. Our work complies with the STROBE criteria.

Before the surgery, the involved leg was fixed with plaster to avoid further injury. Meanwhile, X-ray, MRI, and CT scanning were performed to determine the fracture types and the conditions of soft tissues. The patient sample comprised of 9 males and 4 females with an average age of 49.9 years (ranging from 26 to 64 years old) at the time of surgeries. The fracture side, mechanisms of injuries, time of operation and follow-up period were all recorded. All fractures were closed and categorised according to the Letenneur

descriptions[7]. The fractures included 10 lateral (77%) cases and 3 medial cases (23%). Misdiagnosis occurred in 1 (7.7%) patient who suffered from continuous pain and limited knee flexion, and 4 weeks elapsed since the initial injury to being diagnosed.

For all patients, DFCLP was favoured over other fixation devices. Screws were placed according to fracture fragment. The general patient demographic data are shown in Table 1.

1.2 Surgical management

The operation was performed by professional orthopaedic surgeons. Open reduction through the modified medial or lateral approach was used to treat all fractures. Patients were placed supine on the operating table with the involved knee bent at 60º and a soft pad inserted under the popliteal fossa. Patients were under general or spinal anaesthesia for the surgery; tourniquets were used during the surgery to limit blood flow.

The medial approach incision was made at the level of the femoral adductor tubercle, which was curved parallel to the tibial margin, and the incision was stopped at the lower margin of the tibial plateau. The sartorius anterior margin was identified first and separated along the space between itself and the vastus medialis. Then, the knee was flexed and pulled back the sartorius to expose the adductor magnus tendon and the adductor tubercle, and the adductor magnus tendon was pulled back last to expose the fracture. The lateral incision approach extends downwards along the lateral femoral axis across the lateral femoral condyle, turns to the tibial tubercle, enters along the anterior or posterior side of the iliotibial tract, cuts fascia in front of the lateral muscle septum, and pulls the lateral femoral muscle upward to expose the fracture and articular surface. The hematoma was cleaned, and the articular surface reduced with forceps. The intact fragment of the Hoffa fracture was reduced and temporarily fixed by Kirschner wires in the anteroposterior or posteroanterior position. The direction of Kirschner wire was as far vertical to the fracture line as possible. Biplanar fluoroscopic imaging was used to confirm the reduction.

Afterward, DFCLP or cannulated screws were used to fix fracture fragments. The ideal screw directions would be perpendicular to the fracture line. There are many sizes of screws that can be used, depending on fracture fragment size, ranging from mini fragment implants (2.0 and 2.4mm) to 3.5mm cortical screws, and 4mm or 6.5mm cannulated screws. Meanwhile, DFCLP was placed on the side of the femoral condyle for preventing the fragment from gliding vertically as well as fixing it with angular stability. However, it should be evaluated accurately how the plate was placed to prevent the screws from interfering with each other. Direct fluoroscopic visualization was then used to confirm the precision of the reduction and implant placement. The stability and motion range of the knee were checked for, followed by the deflation of the tourniquet and closure of the wound over suction drains. No external fixation was used after operation.

During the last follow-up appointment, all patients were assessed using the following methods: PA, physical examination, and lateral radiographs. A goniometer was used to measure the bilateral knee range of motion (ROM) and any restriction was recorded. The Knee Society Score (KSS) and International

Knee Documentation Committee (IKDC) was used to evaluate the functional outcomes. Any stability, type of fixation, bone union time, and complications were noted. The details are presented in Table 2.

1.3 Rehabilitation

In order to restore optimum functions of the injured knee, a comprehensive early active rehabilitation program was adhered to. The functional outcome analyses were conducted according to the KSS,ROM, IKDC and the fixation stability.

One of the most crucial targets during the early stage of the postoperative rehabilitation was to minimize swelling and pain, thus elevation of the affected leg combined with non-steroidal anti-inflammatory drugs were recommended. When the pain and swelling subsided, the continuous passive motion (CPM) system was used for helping the knee joints to do extension and flexion exercises in all patients from day 3 postoperatively [2]. On day 7 post-operatively, the degree of knee flexion increased from 0°to 60°. Starting from the 2^{nd} week, the frequency of the exercise was increased to 2 to 3 times a day, to achieve a 10°to 15°advance in the range of knee flexion every day. By the end of week 3 post-operatively, patients were encouraged to reach a milestone of between 100°to 130°of flexion. In the fourth week, patients were allowed to perform a full range of motion for 30 to 40mins 2 to 3 times a day. During weeks 6 to 8 after surgery, patients began practicing walking without bearing weights using crutches, which is followed by partial weight-bearing walks at around week 10. For patients who had been discharged, the weight born was gradually increased following the guidance of the clinician given through telerahabilitation. Full weight-bearing walks were allowed once signs of bone reunion were detected on radiographs from weeks 14 to 28 postoperatively.

After being discharged, patient follow-up was carried out every month for the first 3 months using X-ray or CT imaging, then every 3 months in the following 9 months, and finally at the 12^{th} and 24^{th} months.

2. Results

Patients who participated in this study were all cooperative and the full clinical data were gathered. The bone reunion was observed in all patients on their Hoffa fractures sites, with the articular surface of femoral condyles reduced anatomically. The average follow-up period was 24.5months (ranging from 24 to 28 months). Six patients were treated by DFCLP in combination with cannulated screws and the remaining 7 patients were treated by DFCLP alone. The mean ROM was 119°(ranging from 100°to 130°). The mean KSS was 87.9 (ranging between 80 and 92 points) with 11 patients evaluated as excellent, 2 as good, and zero bad case. The mean KSS was 87.7 for patients with medial Hoffa fractures and 88.1 for those with lateral Hoffa fractures. The mean IKDC score was 84.2 (ranging from 74.7 to 89.7 points), with 10 evaluated as excellent, 3 as good, and no bad case. The mean IKDC score was 83.3 for patients with medial Hoffa fractures and 84.4 for those with lateral Hoffa fractures. The X-ray image CT scans were used to assess the healing of the fractured site. The results indicated that at month 3, the bone union was evident in 7 patients (54%), at month 4, bone union was seen in 6 patients (46%). In the end, all fractures

had healed, and knee joint stability was achieved in all patients. However, 2 patients suffered from knee joint stiffness and osteoarthritis during the follow-up period. Eleven patients (84.6%) in total regained satisfactory function of their knee joint and ability to walk with decent clinical results obtained through early postoperative rehabilitation. Additionally,non-union, infection, bone resorption, or secondary displacement didn't happen, and patients were all free from pain and able to walk without any aid.

In our research,case 1(a 60 years old female) suffered the left medial Hoffa fracture(Letenneur III)from a High-velocity fall.A DFCLP and four cannulated screws were placed at the medial distal femoral condyle.Twenty-four months after the operation,a range of motion approximately 0□130° was obtained with a good functional recovery(Fig.1).Another case 6(a 52 years old male) suffered the left lateral Hoffa fracture(Letenneur III)from a Motor vehicle accident.A DFCLP alone was placed at the lateral distal femoral condyle.Twenty-four months after the operation,a range of motion approximately 0□120° was obtained with satisfactory functional results(Fig.2).

3. Discussion

In this present study, we have found that DFCLP alone or in combination with cannulated screws followed by early active rehabilitation are efficacious in providing stability and improving function after 24 months in patients with Hoffa fractures. Hoffa fractures are very uncommon and previous studies on the effects of Hoffa fracture had all been case reports and small case series, investigation on a larger scale was indeed lacking [2,5,17]. Most studies recommended open reduction and internal fixation as the ideal treatment modality[2,5,9-12]. Hoffa fractures involving medial condyles were even rarer than the lateral condyle as mentioned in the past literature [2,5,12]. The present study recruited 10 lateral and 3 medial Hoffa fractures, which were throught to be the consequences of the particular injury mechanism involving the genu valgum in the knee joint as explained before by White et al[6]. In the present study, high-energy trauma is the typical injury mechanism mostly seen in the setting of motor vehicle accidents and high-velocity falls. According to White et al. [6], the knee was placed at 90°or more in a flexed position, hence the femoral condyle would be more prone to be subjected to direct anteroposterior force, thereby inducing Hoffa fractures.

One (7.7%) patient in our research was diagnosed 4 weeks after the initial fracture. The patient presented with continuous pain ,swelling and disability. Making accurate diagnoses of this fracture is challenging, and it is often overlooked on plain radiographs – the rate of correctly identifying coronal plane fractures using plain radiographic imaging is only 69%. Nork et al. [3] highly proposed a preoperative CT scanning to detect any related coronal fractures. Onay et al. [5] also suggested the crucial need of CT scans to distinguish coronal fractures more accurately as Hoffa fractures can be easily neglected on plain radiographs. It is believed that CT scan is the best method for diagnosing and improving the diagnostic yield when there is clinical and radiological suspicion of Hoffa fractures.

No consensus has been reached in the most suitable surgical approach so far [10-12], careful selection on a case to case basis in addition to the fracture classification has been recommended[13-14].Nowadays,

locking plate or screws have been recommended for Hoffa fractures[15-18]. There are two directions of screw fixation including anterior-posterior (AP) and posterior-anterior (PA) [8,20-23]. AP screw fixation is suitable for type Letenneur Ⅰ and Ⅱ, which has larger fracture fragments. The screws should be parallel to the oblique plane of the medial and lateral condyle of the femur, 25º to the medial condyle and 10º to the lateral condyle [8,12,14]. It is commonly accepted to have screw heads indented below the articular surface. PA screw fixation is suitable for type II, which has smaller fracture fragment. However, this method has a higher risk of damaging the nerves and vessels. Xu et al. [28] proposed the triangular cross fixation with three screws for Hoffa fractures, which proved to be as effective as the traditional fixation with two screws for parallel compression. The deficiency of screws is that they are insufficient to resist the sheer force of plane as well as varus and valgus stress during flexion and extension of knees, therefore, simple screw fixation has a higher rate of failure [8,16-18]. Due to the different positions, it can be divided into the posterior anti-sliding plate and the lateral buttress plate. The design of the posterior anti-sliding plate is more consistent with the mechanical principle of Hoffa fractures. Gao et al. [2] reported that the use of posterior anti-sliding plate can enhance the fixation stability and allows early rehabilitation. However, the use of this plate may damage blood supply and hamper knee joint flexion. In addition, the latest biomechanical studies have shown that the shear strength of the lateral buttress plate is stronger than that of the posterior anti-sliding plate[24-25]. Li et al. [14] pointed out that the posterior anti-sliding plate could not be placed directly behind the femoral condyle due to the blocking of the attachment point of the gastrocnemius, and the lateral buttress plate could play the same role. Recent reports on Arthroscopy-assisted fixations have also received some attention, which are minimally invasive technology and could accurately pinpoint damages[26-27].

In the present study, we used the lateral buttress plate, DFCLP, or in combination with cannulated screws to treat Hoffa fractures, which could provide sufficient stability and permit early exercise. A systematic early active rehabilitation programme was undertaken to achieve maximum restoration of the injured knee joint. In the end, 11 patients (84.6%) patients regained sufficient knee joint function and ability to walk with decent clinical results through this fixation method and early postsurgical rehabilitation. Moreover, DFCLP has many advantages in terms of design for Hoffa fractures（Fig.3）. First of all, its anatomic design could better fit the surface of medial and lateral condyle of femur. Secondly, 10 fix screw holes are evenly distributed on the condyle, which can better fix the fracture fragments. Eight of them are arranged in arc along the boundary and could fix the joint surface effectively. Thirdly, multiplanar fixation via 3.5 mm screws could improve the stress and stability. In addition, there are six sutural pores in the distal plate, which can reinforce the suture of the joint capsule and small fragments, improving the stability. Finally, the proximal plate presents a slope inserting design, so the proximal screws could be fixed through minimally invasive approaches.

In conclusion, our results show that DFCLP alone or in combination with cannulated screws followed by early active rehabilitation are efficacious in providing stability and improving function after 24 months in patients with Hoffa fracture.

The scope of this retrospective cohort study was restricted largely by s small sample size, and more high-quality random clinical trials with larger sample size are essential to verify the current results. The lack of control groups and the limited patient sample were due to the rarity of Hoffa fractures. Meanwhile, the enrolled patients of the present study do not include Letenneur II type C fracture, which makes the study flawed. Besides, our follow-up time is mean 24.5 months, and we need a study with a longer follow-up time. Our long-term goal is to elucidate the effectiveness of functional outcomes long-term, with high-quality follow-up and large samples.

Declarations

Acknowledgements

We would like to thank our colleague Jingyin Li and Lizhong Jing for providing surgery guidance.

Conflicts of interest

All named authors hereby declare that they have no conflicts of interest to disclose.

Authors Contributions

All authors contributed equally to the manuscript.

Ethical Approval

All procedures followed were in accordance with the ethical standards of responsible committee on human experimentation (institutional and national)and with Helsinki Declaration of 1975,as revised in 2008.Informed consent was obtained from all patients for being included in the study.The study was approved by the ethics committee of Shandong University of Traditional Chinese Medicine Affiliated Hospital(approval no.2019-037-01).

Funding

This research received no specific grant from any funding agency in the public,commercial,or not-for-profit sectors.

Conflicts of interest

All named authors hereby declare that they have no conflicts of interest to disclose.

References

[1] Bartoníček J, Rammelt S. History of femoral head fracture and coronal fracture of the femoral condyles. Int Orthop. 2015 Jun;39(6):1245-50.

[2]Gao M, Tao J, Zhou Z, et al. Surgical treatment and rehabilitation of medial Hoffa fracture fixed by locking plate and additional screws: A retrospective cohort study[J]. International Journal of Surgery, 2015, 19:95-102.

[3]Nork S E,Segina D N , Aflatoon K , et al. The Association Between Supracondylar-Intercondylar Distal Femoral Fractures and Coronal Plane Fractures[J]. JBJS, 2005, 87(3):564-9.

[4]Arastu M H , Kokke M C , Duffy P J , et al. Coronal plane partial articular fractures of the distal femoral condyle: current concepts in management.[J]. Bone Joint J, 2013, 95(9):1165-1171.

[5]Onay T, Gülabi D, Çolak İ, Bulut G, Gümüştaş SA, Çeçen GS. Surgically treated Hoffa Fractures with poor long-term functional results. Injury. 2018 Feb;49(2):398-403.

[6]White E A, Matcuk G R, Schein A, et al. Coronal plane fracture of the femoral condyles: anatomy, injury patterns, and approach to management of the Hoffa fragment[J]. Skeletal Radiology, 2015, 44(1):45-45.

[7]Letenneur J, Labour P E, Rogez J M, et al. [Hoffa's fractures. Report of 20 cases (author's transl)][J]. Annales De Chirurgie, 1978, 32(3-4):213.

[8]Lee SY, Niikura T, Iwakura T, Sakai Y, Kuroda R, Kurosaka M. Bicondylar hoffa fracture successfully treated with headless compression screws. Case Rep Orthop. 2014;2014:139897.

[9]Sahu R L , Gupta P . Operative management of Hoffa fracture of the femoral condyle.[J]. Acta Med Iran, 2014, 52(6):443-447.

[10]Shi J, Tao J, Zhou Z, Gao M. Surgical treatment of lateral Hoffa fracture with a locking plate through the lateral approach. Eur J Orthop Surg Traumatol. 2014 May;24(4):587-92.

[11]Sun H, He Q F, Huang Y G, et al. Plate fixation for Letenneur type I Hoffa fracture: a biomechanical study.[J]. Injury-international Journal of the Care of the Injured, 2017, 48(7).

[12]Trikha V, Das S, Gaba S, Agrawal P. Analysis of functional outcome of Hoffa fractures: A retrospective review of 32 patients. J Orthop Surg (Hong Kong). 2017 May-Aug;25(2):2309499017718928.

[13]Gammon L, Hansen E, Cheatham S. Technique for Reduction and Fixation of a Hoffa Fracture with Ipsilateral Patella Dislocation from Low-Energy Trauma, a Rare Injury: A Case Report. JBJS Case Connect. 2020 Jan-Mar;10(1):e0250.

[14]Dua A , Shamshery P . Bicondylar Hoffa Fracture: Open Reduction Internal Fixation Using the Swashbuckler Approach[J]. J Knee Surg. 2010, 23(1):21.

[15]Singh R, Singh R B, Mahendra M. Functional Outcome of Isolated Hoffa Fractures Treated with Cannulated Cancellous Screw.[J]. Malaysian Orthopaedic Journal, 2017, 11(2):20-24.

[16]Öztürk A, Özkan Y, Özdemir R M. Nonunion of a Hoffa fracture in an adult[J]. Musculoskeletal Surgery, 2009, 93(3):183-185.

[17]Min L, Tu CQ, Wang GL, Fang Y, Duan H, Liu L, Zhang H. Internal fixation with headless compression screws and back buttress plate for treatment of old Hoffa fracture. Chin J Traumatol. 2014 Apr 1;17(2):79-83.

[18]Manfredini M, Gildone A, Ferrante R, et al. Unicondylar femoral fractures: therapeutic strategy and long-term results. A review of 23 patients.[J]. Acta Orthopaedica Belgica, 2001, 67(2):132.

[19]Meyer C, Enns P, Alt V, et al. [Difficulties involved in the Hoffa fractures].[J]. Der Unfallchirurg, 2004, 107(1):15.

[20]Kapoor C, Merh A, Shah M, Golwala P. A Case of Distal Femur Medial Condyle Hoffa Type II(C) Fracture Treated with Headless Screws. Cureus. 2016 Sep 23;8(9):e802.

[21]Lu B, Zhao S, Luo Z, Lin Z, Zhu Y. Compression screws and buttress plate versus compression screws only for Hoffa fracture in Chinese patients: a comparative study. J Int Med Res. 2019 Jan;47(1):142-151.

[22]Westmoreland G L, Mclaurin T M, Hutton W C. Screw pullout strength: a biomechanical comparison of large-fragment and small-fragment fixation in the tibial plateau.[J]. Journal of Orthopaedic Trauma, 2002, 16(3):178.

[23]Jarit G J, Kummer F J, Gibber M J, et al. A mechanical evaluation of two fixation methods using cancellous screws for coronal fractures of the lateral condyle of the distal femur (OTA type 33B)[J]. Journal of Orthopaedic Trauma, 2006, 20(4):273.

[24]Ostermann P A W, Neumann K, Ekkernkamp A, et al. Long term results of unicondylar fractures of the femur.[J]. Journal of Orthopaedic Trauma, 1994, 8(2):142-6.

[25]Shi J, Tao J, Zhou Z, et al. Surgical treatment of lateral Hoffa fracture with a locking plate through the lateral approach[J]. European Journal of Orthopaedic Surgery & Traumatology, 2014, 24(4):587-592.

[26]Atesok K, Doral M N, Whipple T, et al. Arthroscopy-assisted fracture fixation.[J]. Knee Surg Sports Traumatol Arthrosc, 2011, 19(2):320-329.

[27]Ercin E, Baca E, Kural C. Arthroscopic Treatment of Isolated Hoffa Fractures. J Knee Surg. 2017 Oct;30(8):842-848.

[28]Xu Y , Li H , Yang H H , et al. A comparison of the clinical effect of two fixation methods on Hoffa fractures[J]. SpringerPlus, 2016, 5(1):1164.

Tables

Table 1.Demographic data of the patients.

Case	Age/Gender	Injury Mechanism	Fracture subtype	Surgical Approach	Late diagnosis (weeks)	Follow-up (months)
1	60/F	High-velocity fall	/MC	medial	-	24
2	46/M	High-velocity fall	b/LC	lateral	4	24
3	61/M	Motor vehicle accident	/LC	lateral	-	26
4	37/M	Motor vehicle accident	b/MC	medial	-	24
5	51/M	Heavy object smashing	a/LC	lateral	-	24
6	52/M	Motor vehicle accident	/LC	lateral	-	28
7	64/F	High-velocity fall	/LC	lateral	-	24
8	45/M	High-velocity fall	a/LC	lateral	-	24
9	46/M	Motor vehicle accident	/LC	lateral	-	24
10	26/F	Motor vehicle accident	/LC	lateral	-	24
11	63/F	High-velocity fall	/MC	medial	-	24
12	54/M	High-velocity fall	/LC	lateral	-	24
13	44/M	High-velocity fall	/LC	lateral	-	24

M:male F:female MC:medial condyle LC:lateral condyle ACL:anterior cruciate ligament LCL:lateral collateral ligament MCL:medial collateral ligament

Table 2.Functional results and complications of the patients.

Case	Fixation	Knee ROM(degree)	SCORE		Bone union time(months)	Stability	Complications
			KSS	IKDC			
1	Plate and screws	0-130	88	88.5	3	Stable	-
2	Plate	0-120	90	86.2	3	Stable	-
3	Plate	0-125	91	87.4	4	Stable	-
4	Plate	0-110	86	75.9	4	Stable	-
5	Plate	0-115	85	82.8	3	Stable	-
6	Plate	0-120	84	81.6	3	Stable	Stiffness
7	Plate and screws	0-120	91	89.7	4	Stable	-
8	Plate	0-125	90	85.1	3	Stable	-
9	Plate and screws	0-100	80	74.7	4	Stable	Stiffness osteoarthritis
10	Plate	0-120	88	83.9	3	Stable	-
11	Plate and screws	0-120	89	85.6	3	Stable	-
12	Plate and screws	0-125	92	87.4	4	Stable	-
13	Plate and screws	0-120	90	85.2	4	Stable	-

ROM:range of motion

KSS:Knee Society Clinical Score

IKDC:International Knee Documentation Committee

Figures

Figure 1

a-b)3-D CT of left knee showing a distal femoral Letenneur III medial Hoffa fracture. c-d)Anteroposterior and lateral radiographs of left knee showing internal fixation with a DFCLP and four cannulated screws.e-f)A range of motion approximately 0–130° could be obtained after 24 months postoperatively with a good functional recovery.

Figure 2

a-c)Lateral radiograph and 3-D CT of left knee showing a distal femoral Letenneur III lateral Hoffa fracture.d-e)Anteroposterior and lateral radiographs of left knee showing internal fixation with a DFCLP alone.f-g)A range of motion approximately 0□120° could be obtained after 24 months postoperatively with satisfactory functional results.

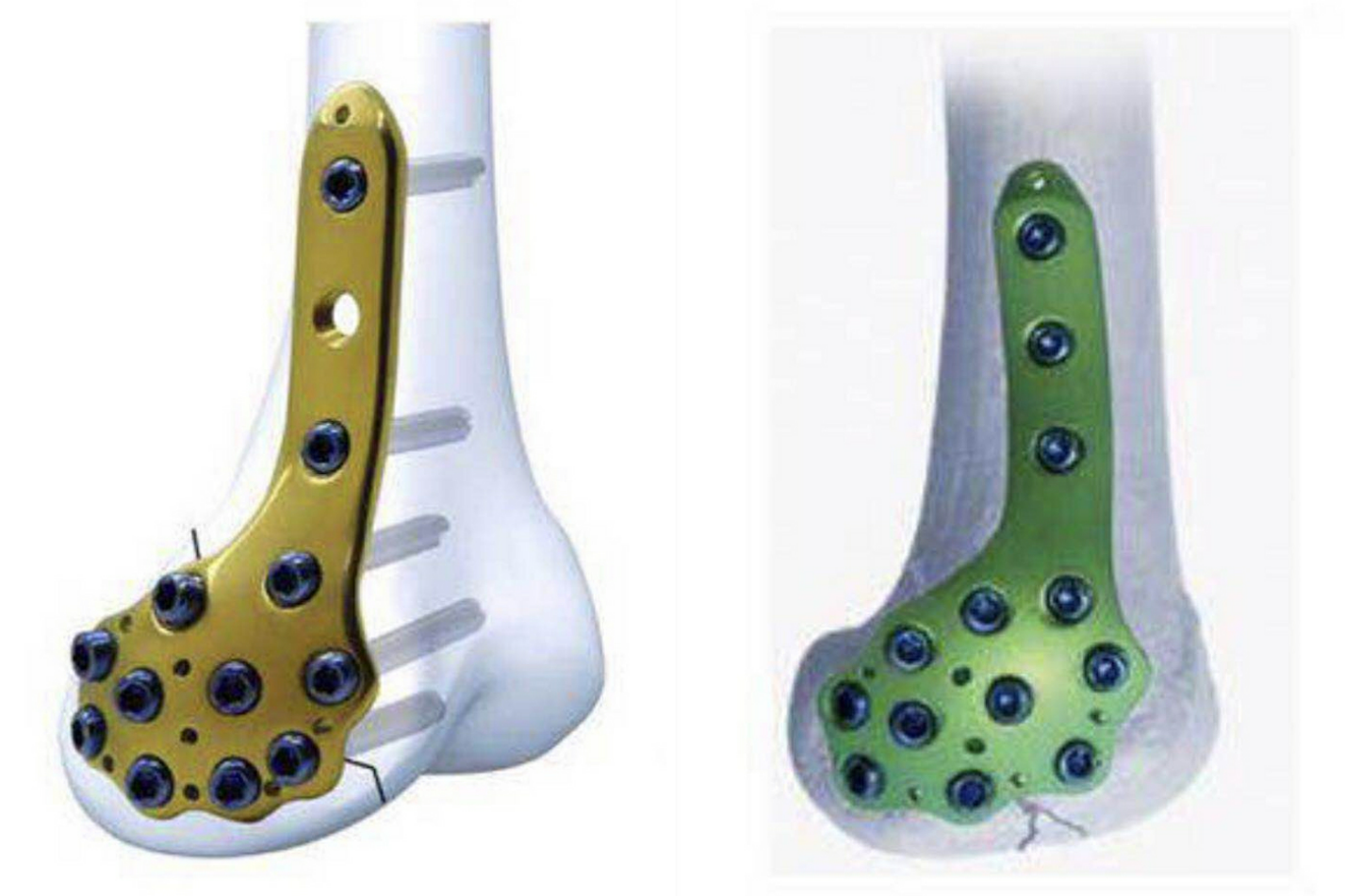

Figure 3

Mode pattern of anatomic locking plate on distal femur lateral condyle and internal condyle.