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Original Article

Effect of unicompartmental knee arthroplasty combined with arthroscopic debridement on knee osteoarthritis and analysis of risk factors of deep venous thrombosis

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Abstract: Objective: To analyze the clinical effect of unicompartmental knee arthroplasty combined with arthroscopic debridement on knee osteoarthritis and the risk factors leading to deep venous thrombosis (DVT). Methods: Data of 110 patients with knee osteoarthritis admitted to The People's Hospital of Wenjiang Chengdu for surgical treatment from February 2019 to June 2021 were retrospectively analyzed. According to the surgical treatment methods, 58 patients treated with unicompartmental knee arthroplasty were included in the control group. The remaining 52 patients with combined treatment of unicompartmental knee arthroplasty and arthroscopic knee debridement were included in the observation group. The therapeutic effect, knee joint function score, Visual Analogue Scale (VAS) score, time required for knee flexion of 90°, length of hospital stay, and incidence of postoperative DVT were compared between the two groups 1 month after the operation. Risk factors leading to the development of DVT were analyzed. Results: One month after the operation, the overall response rate, knee joint function score, and VAS score in the observation group were significantly better than those in the control group. The time required for knee flexion of 90° and length of hospital stay were shorter and the incidence of DVT was lower in the observation group than those in the control group. According to the occurrence of DVT, patients were divided into a DVT group and a non-DVT group. The univariate analysis revealed that age, body mass index, history of diabetes, coagulation parameters, and surgical methods were related to the occurrence of DVT. The logistics regression analysis revealed that age, body mass index, coagulation parameters, and surgical methods were independent risk factors affecting the occurrence of postoperative DVT. Conclusion: The combined treatment of unicompartmental knee arthroplasty and arthroscopic debridement can significantly improve knee joint function and bone metabolism and reduce the incidence of postoperative DVT of patients with knee osteoarthritis, achieving a more satisfactory therapeutic effect.

Keywords: Unicompartmental arthroplasty, unicompartmental knee arthroplasty, knee osteoarthritis, DVT

Introduction

Knee osteoarthritis (KOA) is a chronic disease based on degenerative pathological changes that occur in middle-aged and elderly patients. It is clinically characterized by swelling, pain, clicking, and effusion at the knee joint [1]. The most common causes of KOA are overexertion, knee degenerative diseases, and trauma. Severe KOA can seriously affect patients' quality of life [2]. With the change of living environment and habits, the incidence of a variety of middle-aged and elderly diseases is gradually increasing in China, including KOA. KOA has become a major orthopedic disease affecting elderly patients [3]. Timely diagnosis and active treatment are the key to improve the prognosis of KOA. With the continuous development of medical technology, a variety of clinical treatment options for KOA - drug therapy, physical therapy, and surgical treatment - have been recognized [4, 5]. Surgical treatment includes arthroscopic debridement, osteotomy, and replacement [6]. In recent years, with the popularization of "knee

preservation" and the promotion of arthroplasty, various surgical methods have been investigated and compared worldwide.

Arthroscopic debridement and unicompartmental knee arthroplasty are two commonly used surgical treatments. Unicompartmental knee arthroplasty has the advantages of short operation time, less trauma, short average hospital stay, rapid recovery, and less cost [7]. The surgical indications need to be strictly evaluated. The arthroscopic minimally invasive debridement technique can accurately assess the degree of the entire joint cavity lesions and minimally invasive treatment on the lesions, making up for the lack of unicompartmental knee arthroplasty in clinical practice [8]. There are few comprehensive analyses orientated on the efficacy of the combined treatment of unicompartmental knee arthroplasty and arthroscopic debridement on KOA. Postoperative deep venous thrombosis (DVT) is a common complication for KOA patients. DVT affects patients' postoperative rehabilitation, and causes long-term deep venous insufficiency and pulmonary embolism [9]. It is of great clinical significance to analyze the risk factors of postoperative DVT in KOA patients to improve their prognosis.

In this study, we analyzed the efficacy of unicompartmental knee arthroplasty combined with arthroscopic debridement in the treatment of KOA and the risk factors for the occurrence of postoperative DVT. This provided more insights for the treatment of KOA and the improvement of the prognosis. Previous studies have analyzed the risk factors leading to postoperative DVT in patients with KOA. It is unclear if different surgical methods are independent risk factors leading to postoperative DVT in patients with KOA.

Materials and methods

Clinical data

Data of 110 patients with KOA admitted to The People's Hospital of Wenjiang Chengdu for surgical treatment from February 2019 to June 2021 were retrospectively analyzed. There were 58 patients treated with unicompartmental knee arthroplasty set apart as the control group, and 52 patients treated with unicompartmental knee arthroplasty combined with arthroscopic knee debridement set apart as the observation group.

Inclusion criteria: Patients who were diagnosed with KOA and had surgical indications; Patients who aged between 45 to 65 years old; Patients with complete case data and follow-up data.

Exclusion criteria: Patients with immune system diseases, acute or chronic infections, malignant tumor, or severe dysfunction of vital organs such as heart, liver, brain, and kidney; Patients with surgical contraindications; Patients with mental dysfunction. This experiment was approved by the ethics committee of The People's Hospital of Wenjiang Chengdu and conformed to the Helsinki Declaration.

Treatment methods

The procedures were performed by the same group of physicians using general anesthesia.

Patients in the control group were treated with simple unicompartmental arthroplasty. The medial patella was used as the incision approach. The joint capsule of the patients was incised, and the patella was not dislocated. Horizontal vertical osteotomy was performed on the medial tibia. After removing the medial bone block, the femoral osteotomy guide was inserted into the action site to cut the posterior condyle. The flexion and extension gap were balanced by grinding the femoral condyle. Suitable prosthesis was implanted and fixed with bone cement. After irrigation, a vacuum suction tube was placed for drainage. The incision was closed at 45 degrees of flexion, and the excipients were dressed. Before unicompartmental arthroplasty, patients in the observation group were treated with arthroscopy to trim and clean the degenerated cartilage surface, cartilage fragments, and loose bodies in the joint, trim or partially resect, and shape the lateral meniscus with injury. Minimally invasive unicompartmental arthroplasty was performed.

Tourniquets were standardized during the surgery, and postoperative routine prevention of lower limb thrombosis treatment was performed. Negative pressure drainage was removed 24-48 h after the operation. Active quadriceps contraction was started on the day of the operation. Passive movement of the knee joint was

increased the next day. A continuous passive movement machine was used to extend and flex the knee joint 0°-45°. The passive movement of the knee joint should reach 0°-90° 3-4 d after the operation, and 0°-110° 1 week after the operation. Full weight-bearing walking exercises were allowed 10 days after the surgery. The stitches were removed 2 weeks after the surgery.

Outcome measures

Primary indicators: (1) The therapeutic efficacy of the two groups of patients was evaluated and compared. The efficacy was divided into highly significantly effective (no recurrent symptoms of postoperative diseases, complete recovery of limb function, no limb disorders, and non-contact exercise), effective (no obvious recurrent symptoms of diseases, no pain, mild limitation of limbs, and no obvious disability symptoms), and ineffective (no significant change after surgical treatment, aggravated condition, local necrosis, or amputation). The overall response rate = (highly significantly effective + effective)/total × 100%. (2) The time required for knee flexion of 90° and the length of hospital stay were recorded and compared between the two groups. (3) Knee function was assessed using the Hospital for Special Surgery (HSS) Knee-Rating Scale [10] 1 week before the treatment and 6 months after the surgery in both groups. Scores ranged from 0 to 100 points. Higher scores represented better knee function.

Secondary indicators: (1) The Visual Analogue Scale (VAS) score [11] was used to evaluate the pain of the two groups before and after the treatment. The scores ranged from 0 to 10 points, of which 0 indicated painless and 10 indicated intolerable pain. The lower score represented less pain of the patients. (2) The incidence of adverse reactions during the treatment was compared between the two groups, including joint hematoma, knee joint infection, fever, and DVT. (3) Univariate analysis and multivariate logistic regression were used to analyze the risk factors associated with postoperative DVT in patients. An automatic coagulation tester (Zhongchi XL3600c) was used to test the coagulation function. Coagulation function indicators included thrombin time, prothrombin time, fibrinogen, and activated partial thromboplastin.

Statistical methods

Data were analyzed using SPSS 18.0 (IBM) software, and figures were plotted using GraphPad Prism 8 software. Enumeration data were presented as number of cases and percentage (%), processed by χ^2 test. Measured data were presented as mean ± standard deviation. Inter-group comparison and intra-group comparison before and after the treatment were conducted by independent sample t-test and paired t-test, respectively. Multivariate logistic regression analysis was used to determine the independent risk factors of postoperative DVT in patients. $P < 0.05$ indicated a statistically significant difference.

Results

Clinical information

The two groups of patients had no significant difference in terms of sex, age, and smoking history ($P > 0.05$). The participants were comparable (**Table 1**).

Comparison of treatment efficacy

In the observation group, there were 30 highly significant effective cases, 20 effective cases and 2 ineffective cases. In the control group, there were 20 highly significant effective cases, 26 effective cases, and 12 ineffective cases. The overall response rate of the observation group was significantly higher than that of the control group (96.15% vs. 79.31%, $P < 0.05$, **Table 2**).

Comparison of time required for knee flexion of 90° and length of hospital stay between the two groups

The time required for knee flexion of 90° and the length of hospital stay in the observation group were 6.13±0.37 and 8.06±0.41 respectively. Those in the control group were 10.15±0.44 and 11.14±0.4, respectively. The observation group held significantly shorter time required for knee flexion of 90° and shorter length of hospital stay than the control group ($P < 0.05$). See **Table 3**.

Comparison of knee function and VAS score before and after the treatment between the two groups

There was no significant difference in preoperative knee joint function and VAS score between

Table 1. General information table [n (%)]

Variable	Observation Group n = 52	Control Group n = 58	t/X^2	P
Sex			0.007	0.933
Male	30 (57.69)	33 (56.90)		
Female	22 (42.31)	25 (43.10)		
Age (years)			0.006	0.938
≥ 56	31 (59.62)	35 (60.34)		
< 56	21 (40/38)	23 (39.66)		
BMI (kg/m^2)			0.019	0.889
≥ 23	28 (53.85)	32 (55.17)		
< 23	24 (46.15)	26 (44.83)		
Smoking history			0.006	0.938
Yes	38 (73.08)	42 (72.41)		
No	14 (26.92)	16 (27.59)		
History of Hypertension			0.059	0.807
Yes	32 (61.54)	37 (63.79)		
No	20 (38.46)	21 (36.21)		
History of Diabetes			0.007	0.994
Yes	35 (67.31)	39 (67.24)		
No	17 (32.69)	19 (32.76)		
Alcohol history			0.043	0.836
Yes	34 (64.00)	36 (62.07)		
No	18 (36.00)	22 (37.93)		

BMI: Body Mass Index.

Table 2. Comparison of treatment efficacy [n (%)]

Therapeutic Efficacy	Observation Group n = 52	Control Group n = 58	X^2	P
Highly significantly effective	30 (57.69)	20 (34.48)	-	-
Effective	20 (38.46)	26 (44.83)	-	-
Ineffective	2 (3.85)	12 (20.69)	-	-
Overall response rate	50 (96.15)	46 (79.31)	8.003	0.008

Table 3. Comparison of time required for knee flexion of 90° and hospital stay between the two groups

Variable	Observation Group n = 52	Control Group n = 58	t	P
Time required for knee flexion of 90° (d)	6.13±0.37	10.15±0.44	51.54	< 0.001
Length of hospital stay (d)	8.06±0.41	11.14±0.4	39.85	< 0.001

the two groups (P > 0.05). After the operation, the HSS score increased significantly and the VAS score decreased significantly in the two groups. The changes were more significant in the observation group than in the control group (P < 0.05). See **Figure 1**.

Comparison of adverse reactions

The incidence of adverse reactions was much lower in the observation group than in the control group (P < 0.05, **Table 4**).

Risk factors affecting DVT in patients

Patients were divided into a DVT group (n = 40) and a non-DVT group (n = 70) according to the occurrence of postoperative DVT. The univariate analysis revealed that age, body mass index (BMI), history of diabetes, coagulation parameters, and surgical approach were associated with the occurrence of DVT in patients (**Table 5**, P < 0.05). We assigned values (**Table 6**) and analyzed the above factors by using the logistics regression analysis. We found that age,

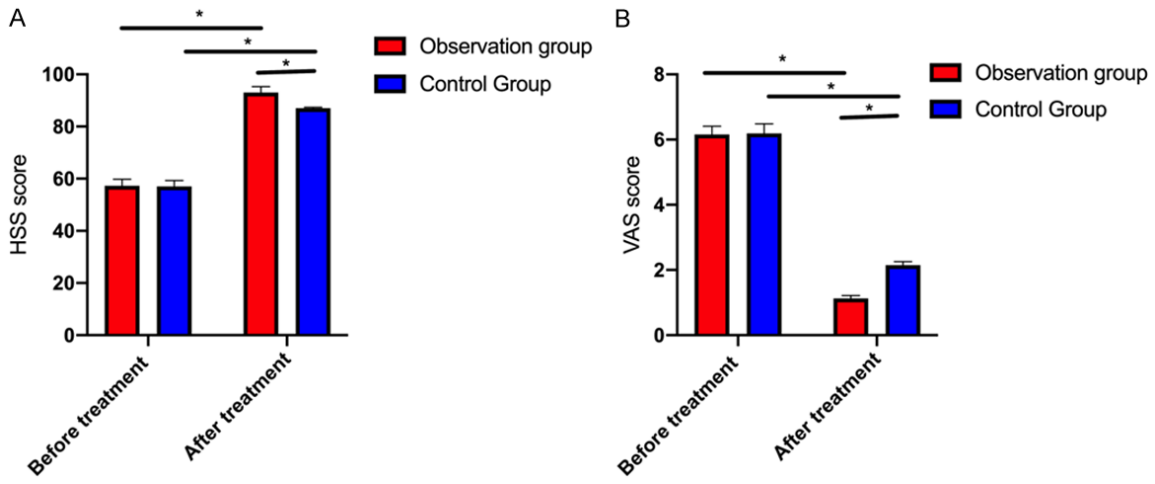

Figure 1. Comparison of knee joint function and VAS score before and after the treatment between the two groups. A: Comparison of HSS scores; B: Comparison of VAS scores. HSS: Hospital for Special Surgery Knee-Rating Scale; VAS: Visual Analogue Scale. * Indicates $P < 0.05$.

Table 4. Adverse effect comparison

Adverse reactions	Observation Group n = 52	Control Group n = 58	X^2	P
Joint hematoma	2 (3.85)	3 (5.17)	-	-
Knee infection	1 (1.92)	2 (3.45)	-	-
Fever	1 (1.92)	1 (1.72)	-	-
DVT	13 (25.00)	27 (46.55)	-	-
Total incidence	17 (32.69)	33 (56.90)	6.479	0.011

DVT: Deep Venous Thrombosis.

BMI, coagulation parameters, and surgical approach were independent risk factors affecting the occurrence of postoperative DVT in patients (**Table 7**, $P < 0.05$).

Discussion

KOA is an articular cartilage damage disease, knee cartilage degeneration, synovial hyperplasia, and chronic inflammation, manifesting as clinical joint pain and dysfunction [12]. Reasonable and effective treatment measures are of great significance to improve the life quality of KOA patients.

Conservative treatment is used in the early stage of the disease, but it cannot prevent disease progression. Its effect is inaccurate. Arthroscopic debridement and joint replacement have been used for end-stage patients in recent years, both of which have achieved good clinical results [13]. Unicompartmental arthroplasty can reduce the resection area by preserving the normal articular surface and cruciate ligament, resulting in less trauma to the patient [14]. It has been shown that, compared with proximal tibial osteotomy, unicompartmental arthroplasty can achieve a higher success rate in the early stage of surgery with less postoperative complications, early ambulation, and rapid postoperative recovery [15]. Compared with total knee arthroplasty, it preserves the anterior and posterior cruciate ligaments, maintains normal dynamics of the knee joint, higher levels of mobility, and proprioception of the knee joint, and restores postoperative knee function better [16]. It was reported [17] that 42 patients who underwent unicompartmental knee arthroplasty had quite a favorable prosthesis survival rate of 86% after 11 years of follow-up. In recent years, with the continuous development of unicompartmental condylar replacement prosthesis in design and mature surgical techniques, the long-term surgical results of unicompartmental condylar replacement surgery are making progress. The limited incision of unicompartmental arthroplasty does

Table 5. Univariate analysis

Variable	DVT group (n = 40)	non-DVT group (n = 70)	X^2 value	*P* value
Sex			0.191	0.662
Male (n = 63)	24 (60.00)	39 (55.71)		
Female (n = 47)	16 (40.00)	31 (44.29)		
Age			16.37	< 0.001
≥ 56 years (n = 66)	34 (85.00)	32 (45.71)		
< 56 years (n = 44)	6 (15.00)	38 (54.29)		
BMI (kg/m^2)			16.43	< 0.001
≥ 23 (n = 60)	32 (80.00)	28 (40.00)		
< 23 (n = 50)	8 (20.00)	42 (60.00)		
History of Diabetes			19.81	< 0.001
Yes (n = 74)	33 (82.50)	27 (38.57)		
No (n = 36)	7 (17.50)	43 (61.43)		
History of Hypertension			0.735	0.391
Yes (n = 69)	23 (57.50)	46 (65.71)		
No (n = 41)	17 (42.50)	24 (34.29)		
Analysis of coagulation function indicators			32.17	< 0.001
Normal (n = 87)	20 (50.00)	67 (95.71)		
Abnormal (n = 23)	20 (50.00)	3 (4.29)		
Surgical method			5.503	0.019
Unicompartmental replacement (58)	27 (67.50)	31 (44.29)		
Unicompartmental ankle replacement combined with arthroscopic debridement (52)	13 (32.50)	39 (55.71)		

DVT: Deep Venous Thrombosis; BMI: Body Mass Index.

Table 6. Value assignment sheet

Factor	Assignment Value
Age	≥ 56 years = 1, < 56 years = 0
BMI	≥ 23 kg/m^2 = 1, < 23 kg/m^2 = 0
Diabetes History	Yes = 1, No = 0
Coagulation function indicators	Abnormal = 1, Normal = 0
Surgical method	Unicompartmental ankle replacement = 1, Unicompartmental ankle replacement combined with arthroscopic debridement = 0

BMI: Body Mass Index.

Table 7. Multivariate analysis

Factor	B	S.E.	Wals	P	Exp (B)	95% CI	
						Lower limit	Upper limit
Age	-3.198	0.815	15.390	0.001	24.493	4.955	121.066
BMI	2.571	0.722	12.688	0.001	13.097	3.178	53.822
Diabetes History	0.724	0.686	1.113	0.291	2.062	0.537	7.912
Coagulation function indicators	1.600	0.671	5.668	0.017	4.955	1.330	18.459
Surgical method	3.332	0.871	14.619	0.001	27.996	5.073	154.491

BMI: Body Mass Index.

not effectively expose the lateral compartment and patellofemoral joint. It does not display the degree of patellar cartilage damage, which limits its extension of indications [18].

Arthroscopic debridement is a minimally invasive procedure, performed by stripping and freeing the diseased tissue through subarticular techniques. It can remove the pathogenic

lesion tissue debris and inflammatory mediators in the joint, repair the uneven articular surface, and break the vicious cycle of osteoarthritis [19]. Arthroscopy can visually examine the entire joint cavity. Minimally invasive treatment with arthroscopy is an effective treatment for patients with patellar cartilage injury, combined lateral meniscus injury, and mild compartment osteoarthritis [20, 21]. It has a poor effect on articular surface adjustment. There have been reports on synovial and cartilage wound oozing at the joint caused by arthroscopic surgery in recent years [22]. These studies have shown that unicompartmental knee arthroplasty or arthroscopic debridement has good efficacy in patients with KOA. There is no evidence demonstrating the efficacy of the combination of these two methods. In this study, we found that the observation group had a significantly higher overall response rate, better knee function, lower VAS score and lower incidence of adverse reactions than the control group. This suggested that the combined treatment of unicompartmental knee arthroplasty and arthroscopic debridement can significantly improve therapeutic efficacy. This is because arthroscopic debridement can accurately evaluate the degree of the whole joint cavity lesions and provide minimally invasive treatment on the corresponding lesions in the joint cavity. This makes up for the lack of unicompartmental knee arthroplasty in clinical practice.

We analyzed the risk factors affecting the occurrence of postoperative DVT in patients. DVT usually refers to the formation of clots in veins where red blood cells, platelets, fibrin, and white blood cells are slow or disturbed. Orthopedic surgery is a high risk factor leading to its formation. This is because bone cement prostheses can destroy monocytes and granulocytes in the blood, release proteolytic enzymes, activate the complement system, and accelerate thrombosis [23]. Age, BMI, coagulation parameters, and surgical procedures were found to be risk factors affecting patient outcomes in our study. Elderly patients are prone to medical diseases such as hyperlipidemia, heart disease, and diabetes because of poor physical fitness. Decreased muscle tone, vascular degeneration, and poor blood status in the elderly are likely to cause DVT after major orthopedic surgery [24]. Metabolic abnormalities are considered to be an important risk factor for the development of lower extremity DVT. High BMI values represent hyperlipidemia content. These patients' blood procoagulant factor levels are generally higher than those with regular BMI. Dyslipidemia and increased blood viscosity can lead to the development of lower extremity DVT [25]. Unicompartmental knee arthroplasty is a risk factor for DVT in patients. Bone cement prostheses can destroy monocytes and granulocytes in the blood, release proteolytic enzymes, and activate the complement system, accelerating thrombosis [26]. Combined arthroscopic debridement can trim and debride the degenerated cartilage surface, cartilage fragments in the joint, and loose bodies, reducing thrombosis.

In this study, we determined that unicompartmental knee arthroplasty combined with arthroscopic debridement can improve the clinical efficacy of patients with KOA and promote the postoperative recovery of patients. There are certain limitations in this study. The long-term efficacy of patients remains unclear because we did not conduct follow-ups. This was a single center study with limited samples. The results of this retrospective study may be biased. We plan to carry out follow-up studies and include more samples to refine our study conclusions.

In summary, the application of unicompartmental knee arthroplasty combined with arthroscopic debridement in the treatment of KOA can significantly improve the therapeutic efficacy, reduce adverse reactions, and benefit knee function.

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Disclosure of conflict of interest

None.

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