Original Article
An implementation study of periarticular knee osteotomy in the treatment of knee osteoarthritis

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Abstract: Objective: To analyze the clinical effects of periarticular knee osteotomy (PKO) in the treatment of knee osteoarthritis (KOA). Methods: A total of 180 patients with KOA admitted to our hospital were selected as the study subjects, and were divided into study group (90 cases) and control group (90 cases) in accordance with different intervention measures. The study group was treated with PKO, while the control group was treated with joint replacement. The perioperative indices, and postoperative pain degrees, knee joint function, quality of life, inflammatory factors and complications were compared between the two groups. Results: The control group was superior to the study group regarding the amount of preoperative bleeding, surgical duration, and incidence rate of complications, while the study group was superior to the control group regarding the long-term (over 2 years) knee joint function and quality of life ($P < 0.05$). There was no marked difference in the postoperative pain degrees and preoperative and postoperative levels of inflammatory factors between the two groups ($P < 0.05$). Conclusion: PKO, exhibiting a high safety profile, can remarkably improve the joint pain symptoms, knee joint function, quality of life and symptoms of KOA in patients with KOA. Therefore, PKO is worthy of clinical promotion and implementation.

Keywords: Periarticular knee osteotomy, knee osteoarthritis, treatment, implementation study

Introduction

Knee osteoarthritis (KOA) is a chronic, progressive and degenerative knee joint disease characterized by degeneration of articular cartilage and synovitis [1]. Most patients with KOA are accompanied by joint pain and dysfunction. In severe cases, the patients have to receive total joint replacement. Clinical findings show that KOA is highly prevalent in older adults. Regarding the people aged over 50 years, KOA is second only to cardiovascular disease among the diseases that lead to long-term disability, seriously affecting the health and quality of life of patients and adding the social and economic burden. The statistics show that KOA may become the fourth leading disease that leads to disability in China by 2020 [2, 3].

To date, there are multiple clinical options for KOA. Oral drugs can relieve patients' symptoms in the short run. However, most clinical drugs for KOA, which are effective in alleviating pain and inflammation symptoms, exhibit no remarkable effect in relieving the degradation of articular cartilage and repairing damaged articular cartilage [4]. Intra-articular injection of hyaluronic acid can relieve pain through lubricating joints and reducing friction. However, there is no strong evidence to prove that it can delay the progression of disease course and promote the regeneration of articular cartilage [5]. Physical interventions (e.g., acupuncture and massage) are effective in improving joint mobility and reducing joint pain degrees, but they are mostly applicable to patients with mild symptoms [6].

Clinical studies suggest that the exact etiology of KOA remains unknown currently. KOA may occur as a result of multiple factors, but the change in the line of gravity of lower extremities may be one of the main causes of KOA, providing a theoretical basis for the surgery [7]. PKO, including high tibial osteotomy (HTO), distal

femoral osteotomy (DFO) and proximal fibular osteotomy (PFO), is commonly implemented to treat KOA. PKO has been proved to be an effective intervention for KOA. A retrospective analysis of 90 patients with KOA shows that DFO can significantly reduce joint pain degrees, improve knee joint activity, and lead to a high overall satisfaction of patients [8]. The objective of this study was to explore the implementation effects of PKO in treating KOA based on perioperative indices, joint pain degrees, joint activity, quality of life and complications, so as to provide clinical references for the improvement of the prognosis of patients with KOA.

Materials and methods

General data

A total of 180 patients with KOA admitted to our hospital from January 2012 to January 2015 were selected as the study subjects, and were divided into study group (90 cases) and control group (90 cases) in accordance with different intervention measures.

Inclusion criteria: (1) compliance with the diagnostic criteria for KOA formulated by American Society of Rheumatology (ACR) [9], and corresponding clinical symptoms; (2) complete medical records; (3) clear consciousness and ability to cooperate with the investigation; (4) investigation submitted to the hospital ethics committee for approval and implementation; (5) voluntary signing of informed consent form; (6) unilateral lesions.

Exclusion criteria: (1) complicated with mental illness; (2) complicated with systemic immune system diseases; (3) complicated with chronic infectious diseases; (4) complicated with severe hepatic and renal dysfunction; (5) pregnancy or lactation; (6) complicated with contraindications of surgery; (7) alcohol or drug addiction.

Rejection criteria: (1) loss to follow up; (2) voluntary withdrawal during the investigation; (3) death cases during the investigation.

Intervention methods

After admission, the two groups received active preoperative preparations, including preoperative fasting and water deprivation and active monitoring of vital signs. The study group underwent PKO. The joint lesions were observed using imaging or arthroscopy before surgery, and HTO, DFO, and PFO were performed based on the actual conditions of patients. Active antibacterial treatment after surgery, early active and passive joint training, off-bed activities 4 weeks after surgery, weight training 6 weeks after surgery, and active cooperation with physiotherapy and CPM that promote the restoration of joint function were performed. The control group underwent arthroscopic surgery, and preoperative arthroscopy was conducted to determine the surgical plan. Postoperative treatment and rehabilitation exercise of joint function were actively carried out.

Primary observational indices

Follow-up comparison of joint pain degrees: The visual analogue scale (VAS) was used to assess the pain degrees in the two groups before and after intervention. The VAS consists of a straight line of 0-10 cm. 0 cm indicates painless and 10 cm indicates severe pain. The patients selected a scale to indicate their own pain degrees based on their conditions. This assessment method is simple and convenient, and can be extensively implemented [10].

Before surgery and 7 d, 30 d, 90 d, 1 year, 2 years, and 3 years after surgery, the assessments on the pain degrees of the patients were performed.

Follow-up assessment on joint function: The knee joint functions in the two groups were assessed using the Hospital for Special Surgery (HSS) scale before and after intervention. HSS scale includes pain, function, range of motion and muscle strength. The total score of the scale is 80 points. A higher score indicated a better knee joint function of the subjects [11]. Before surgery and 7 d, 30 d, 90 d, 1 year, 2 years, and 3 years after surgery, the assessments on the joint function of the patients were performed.

Secondary observational indices

General clinical indices during the perioperative period: The perioperative indices (e.g., amount of intraoperative blood loss, surgical duration, amount of intraoperative drainage) in the two groups of patients were recorded by the

responsible nurse. Each index was continuously tested for 3 times to take the average value as the final result. The differences between the two groups were compared.

Follow-up assessment on quality of life: The activity of daily living (ADL) scale was used to assess the quality of life in the two groups before and after intervention. The ADL scale can assess the necessary activities of individual daily life, including eating, bathing, dressing, walking, going up and down stairs, etc. The total score of the scale is 100 points. > 60 points indicates the basic self-care ability, 40-60 points indicates assistances required from others, 20-39 points indicates basic assistances required from others, and < 20 points indicates full assistances required from others [12]. Before surgery and 90 d, 1 year, 2 years, and 3 years after surgery, the assessments on the quality of life of the patients were performed.

Analysis of changes in inflammatory factors

Before surgery and at 3 d and 5 d after surgery, the fasting venous blood samples in the two groups were collected and placed in a vacuum tube for 30 min. After the blood samples were coagulated, the serum was centrifuged for later use. Then, the levels of inflammatory factors, interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α) in the blood samples were detected by the enzyme-linked immunosorbent assay (ELISA), and the differences between groups and within groups were compared.

Comparison of incidence of complications

The follow-up visits to the two groups of patients were carried out by the responsible nurse, the incidence rates of postoperative complications (e.g., incision infection, deep venous thrombosis (DVT), and joint stiffness) in the two groups were recorded, and the differences between the two groups were compared.

Statistical method

The collected data were input into an EXCEL table, and SPSS 22.0 was adopted for statistical analysis. The collected data were detected using normal distribution. The data conforming to normal distribution were expressed using [n (%)]. The differences between groups were ana-

lyzed using chi-square test. The measurement data were expressed using mean ± standard deviation. The differences between groups were analyzed using t test, and the comparison of differences in continuous variables was detected using t test. The graphs were drawn by GraphPad Prism 8. $P < 0.05$ indicated a statistically significant difference.

Results

Comparison of differences in general data between the two groups

The comparison between groups showed that there was no statistically significant difference in the general clinical data (e.g., gender, mean age, mean course of disease, mean weight, underlying heath conditions, education level and family income) between the two groups ($P > 0.05$), so the data were comparable (**Table 1**).

Follow-up comparison of degrees of joint pain between the two groups

The assessment on the degrees of knee joint pain in the two groups exhibited that before surgery and 7 d, 30 d, 90 d, 1 year, 2 years, and 3 years after surgery, there was no statistically significant difference in VAS scores between the two groups ($P > 0.05$). Generally, the postoperative degree of joint pain in the two groups showed a downward trend, and the VAS scores in the two groups 30 d after surgery were remarkably lower than those before surgery ($P < 0.05$) (**Figure 1**).

Follow-up assessment on joint function in the two groups

The comparison revealed that there was no marked difference in the scores of HSS scale between the two groups before surgery ($P > 0.05$). After intervention, the scores of HSS scale in the two groups declined for a period of time. However, the scores of HSS scale in the two groups increased significantly 30 d after surgery, which were remarkably higher than those before surgery ($P < 0.05$). The comparison between the two groups showed that there was no marked difference in the function, activity and muscle strength in the HSS scale between the study group and the control group from 1 day to 1 year after surgery ($P > 0.05$), but the scores of the function, activity and mus-

Table 1. Comparison of general clinical indices between the two groups ($\bar{x} \pm sd$)/[n (%)]

| General clinical data		Study group (n=90)	Control group (n=90)	t/X^2	P
Gender	M	49	46	0.201	0.654
	F	41	44		
Mean age (years)		51.29±3.11	50.98±2.98	0.683	0.495
Mean weight (kg)		64.33±2.98	64.81±1.88	1.292	0.198
Mean course of disease (years)		1.01±0.11	0.98±0.26	1.008	0.315
Education level	University and above	21	21	0.445	0.561
	High school	50	49		
	Junior high school and below	19	20		
Monthly income	< RMB 1000	30	29	0.981	0.212
	RMB 1000-5000	50	52		
	RMB 5000 and above	10	9		
Hypertension	Yes	10	12	0.207	0.649
	No	80	78		
Diabetes	Yes	9	8	0.065	0.799
	No	81	82		
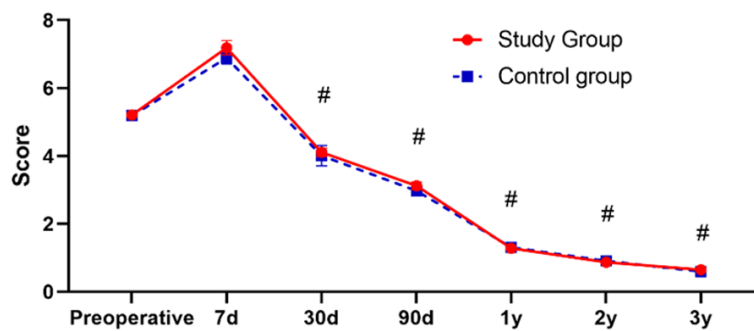
Figure 1. Follow-up comparison of degrees of joint pain between the two groups. The comparison exhibits that before surgery and 7 d, 30 d, 90 d, 1 year, 2 years, and 3 years after surgery, there is no marked difference in the VAS scores between the two groups ($P > 0.05$). However, VAS scores in the two groups 30 d after surgery are significantly lower than those before surgery ($P < 0.05$). # indicates a statistically significant difference between the two groups before and after surgery.

cle strength in the study group were notably higher than those in the control group from 2 years to 3 years after surgery ($P < 0.05$). There was no marked difference in the scores of pain degrees between the two groups before and after surgery ($P > 0.05$) (**Figure 2**).

Comparison of general clinical indices between the two groups during the perioperative period

Compared with the control group, the study group had a longer surgical duration and much more amount of intraoperative bleeding ($P < 0.05$), but there was no statistically significant difference in the amount of postoperative drainage between the two groups ($P > 0.05$) (**Figure 3**).

Follow-up comparison of quality of life between the two groups

The comparison of the scores of quality of life between the two groups demonstrated that there was no significant difference in the scores of ADL scale between the two groups before surgery ($P > 0.05$). The ADL scores in the two groups after surgery were markedly elevated compared with those before surgery ($P < 0.05$). The comparison between the two groups showed that there was no significant difference in ADL scores between the two groups 90 d and 1 year after surgery ($P > 0.05$), but the ADL scores in the study group were higher than those in the control group 2 and 3 years after surgery ($P < 0.05$) (**Figure 4**).

Analysis of changes in inflammatory factors between the two groups before and after surgery

The laboratory test revealed that there was no remarkable difference in the levels of IL-7 and TNF-α between the two groups before surgery
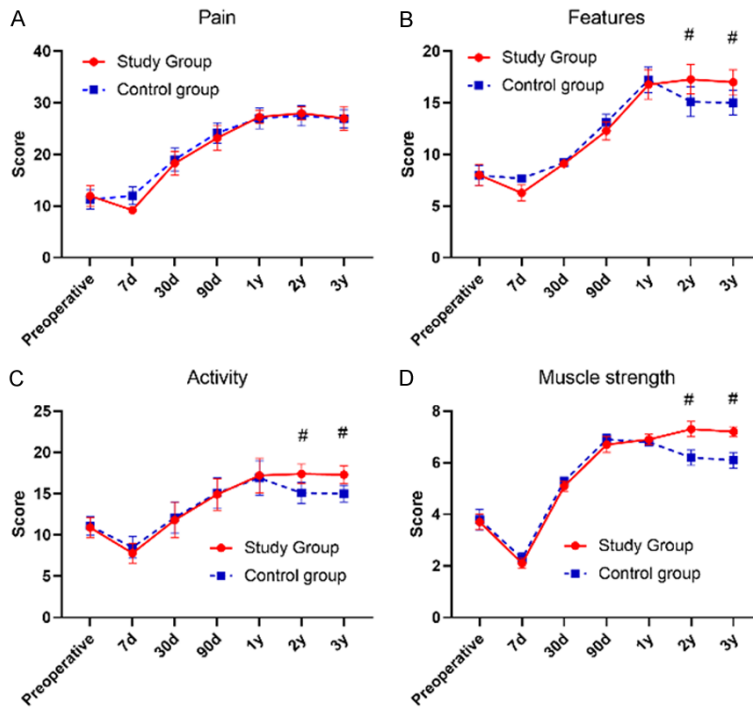
Figure 2. Assessment on joint function in the two groups before and after intervention. The assessment shows that there is no significant difference in HSS scores between the two groups before intervention ($P > 0.05$). After intervention, there is no remarkable difference in the scores of joint function, range of motion and muscle strength between the two groups from 7 days to 1 year after intervention ($P > 0.05$). However, the scores of joint function, range of motion and muscle strength in the study group are higher than those in the control group from 2 years to 3 years after intervention ($P < 0.05$). # indicates a statistically significant difference in the same indices between the two groups before and after surgery.
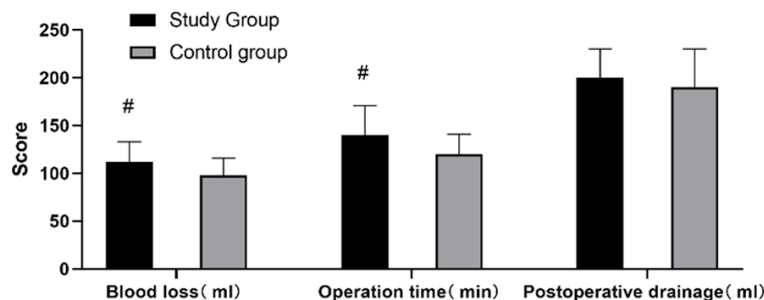

Figure 3. Comparison of general clinical indices between the two groups during the perioperative period. The comparison shows that compared with the control group, the study group has much more amount of intraoperative bleeding and a longer surgical duration ($P < 0.05$). There is no marked difference in the amount of postoperative drainage between the two groups ($P > 0.05$). # indicates a statistically significant difference between the two groups.

and 3 d and 5 d after surgery ($P > 0.05$). However, the overall analysis showed that the levels of serum IL-7 and TNF-α in the two groups 5 d after surgery were significantly lower than those before surgery ($P < 0.05$) (Figure 5).

Comparison of postoperative complications between the two groups

There was 1 case with incision infection and the total incidence rate of complications was 1.11% in the study group, but there were 2 cases with incision infection, 3 cases with joint stiffness and 2 cases with DVT, and the total incidence rate of complications was 7.78% in the control group. There was a statistically significant difference in the incidence rates of complications between the two groups ($P < 0.05$) (Table 2).

Discussion

Epidemiology shows that KOA is the most common type of arthritis with an extremely high incidence rate. KOA is highly prevalent in middle-aged and elderly people. The statistics show that approximately 10% of men and 18% of women suffer from KOA across the globe, and the overall prevalence rate of KOA in China has reached 8.1%. Recently, as the population ages, the incidence rate of KOA has been on the rise [13, 14]. The pathogenesis of KOA remains unclear. Most studies indicate that genetic and environmental factors, age, and obesity contribute significantly to the occurrence and progression of KOA. Currently, there is a lack of specific drugs for the clinical treatment of KOA. The treatment of KOA is performed with a focus on relieving pain and delaying the progression of lesions, but the clinical effects vary greatly [15]. For example, Western medicine advocates non-steroidal anti-inflammatory drugs and glu-
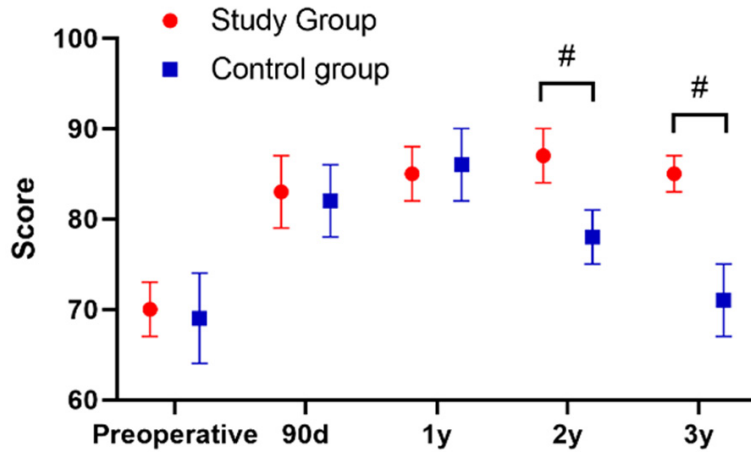
Figure 4. Follow-up comparison of quality of life between the two groups. The comparison reveals that there is no marked difference in ADL scores between the two groups before surgery and 90 d and 1 year after surgery (P > 0.05). However, the ADL scores in the study group are significantly higher than those in the control group 2 years and 3 years after surgery (P < 0.05). # indicates a statistically significant difference in the same indices between the two groups before and after surgery.
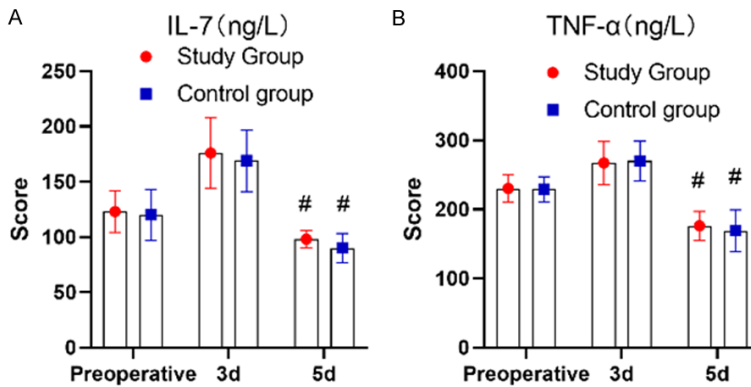

Figure 5. Analysis of changes of inflammatory factors between the two groups before and after surgery. The comparison suggests that there is no significant difference in the levels of IL-7 (A) and TNF-α (B) between the two groups before surgery and 3 d and 5 d after surgery (P > 0.05). However, the comparisons within groups before and after intervention exhibit that the levels of IL-7 and TNF-α in the two groups decrease remarkably 5 d after surgery (P < 0.05). # indicates a statistically significant difference between the two groups before and after surgery.

cosamine hydrochloride capsules. If necessary, hyaluronic acid can be injected into the articular cavity for treatment. For patients with severe KOA, it advocates surgical treatment, such as HTO and intra-articular debridement [16, 17].

There are numerous clinical studies on the advantages and disadvantages of multiple intervention measures. The results of an experiment on rabbits with KOA show that the levels

of nitric oxide (NO) and IL-1β in the articular cavity are obviously reduced through injecting cervus and cucumis polypeptide injection into the articular cavity of rabbit knee, signaling that intra-articular injection treatment can significantly alleviate the inflammatory symptoms in the articular cavity of rabbits with KOA, and exhibit a satisfactory therapeutic effect [18]. Another multi-center retrospective study on patients with KOA shows that fumigation with traditional Chinese medicine (TCM) can remarkably relieve pain symptoms and improve joint mobility. However, the scholar indicates that fumigation with TCM is only applicable to patients with mild KOA, and surgical intervention is recommended for patients with severe KOA [19].

In this study, the two groups were established to analyze the implementation effects of PKO in treating KOA. The results showed that compared with the control group, the study group had much more amount of intraoperative bleeding and a longer surgical duration regarding the general clinical indices during the perioperative period. This may be due to the reason that arthroscopic surgery, which is a minimally invasive surgery, causes less trauma to patients. In this study, the joint pain degrees in two groups were followed up for further assessment. The comparison showed that the postoperative pain degrees in the two groups increased transiently. In the long run, surgeries obviously relieved the joint pain symptoms of patients. A medium-and long-term investigation on patients with KOA has suggested that HTO is effective in treating KOA, with the results of the medium-and long-term follow-up study showing that the pain degrees of

Table 2. Comparison of incidence rates of postoperative complications between the two groups [n (%)]

Group	Number of cases	Incision infection	Ankylosis	DVT	Total incidence rate
Study group	90	1 (1.11)	0 (0.00)	0 (0.00)	1 (1.11)
Control group	90	2 (2.22)	3 (3.33)	2 (2.22)	7 (7.78)
X^2	-	-	-	-	4.709
P	-	-	-	-	0.03

patients improved significantly after intervention, and most patients can conduct weight-bearing exercise 8-10 weeks after surgery. The follow-ups at 6 months, 1 year, 3 years and 5 years after surgery suggest that the knee joint pain and deformity of patients with KOA are basically disappeared, and the joint function and range of motion of the patients are basically recovered, and the findings of the scholars suggest that osteotomy has a good intervention effect on arthritis and is helpful to improve the joint function of patients [20]. The authors of the present study believe that the line of gravity of lower extremities of patients with KOA change obviously as a result of changes in the joint function and deformity. Osteotomy can correct the line of gravity of lower extremities, and shift the axis passing through the medial joint space outward to the lateral normal joint space, so as to relieve the load on the medial compartment, thus alleviating the symptoms of joint space stenosis, delaying the inflammation process in the medial compartment, and relieving pain [21, 22].

The follow-up assessments on joint function in the two groups were carried out. The results showed that there was no marked difference in joint function between the two groups after surgery in the short term. In the long term, osteotomy was more effective in improving the joint function. 2 years after intervention, the study group was superior to the control group regarding the function, mobility and muscle strength in HSS scale. A controlled study conducted on 68 elderly patients with KOA has shown that osteotomy can markedly improve the clinical symptoms of patients with KOA, with the overall response rate (ORR) as high as 94.1%, which is far superior to the control group receiving the conservative treatment; meanwhile, the 6-month follow-up showed that osteotomy can remarkably improve the scores of locking sensation, swelling and stair climbing in the

Lysholm scale, and it is more effective in improving the joint function of patients with KOA [23]. The authors believe that arthroscopic surgery and osteotomy are commonly implemented to treat KOA recently. Although arthroscopic surgery can cause less trauma and shorter time to first off-bed activity after surgery, joint replacement may cause the risk of prosthesis damage in the long run [24, 25]. This primarily contributes to the decline in joint function and quality of life in the control group 2 years after intervention.

Finally, the comparison of changes of inflammatory factors and the incidence of postoperative complications between the two groups show that the pathogenesis of KOA may be closely related to inflammatory responses. After intervention, the levels of IL-7 and TNF-α in the two groups obviously decrease, exhibiting that surgery significantly improves the joint inflammation. This is the clinical basis for the restoration of postoperative joint function. The comparison of the incidence rates of complications between the two groups suggests that there is a certain risk of inducing DVT using arthroscopic surgery, which has been mentioned in other reports and should be given attention to by clinical workers [26].

In summary, PKO, exhibiting a high safety profile, can remarkably improve the joint pain symptoms, knee joint function, quality of life and symptoms of KOA of patients with KOA. Therefore, PKO is worthy of clinical promotion and implementation. The innovation of this study lies in exploring the clinical effects of PKO on treating KOA based on pain degree, quality of life, joint function, inflammatory factor level and incidence rate of complications, performing the long-term follow-up on the treatment, and providing more detailed theoretical references for the clinical treatment of KOA. The deficiency of this study lies in the lack of observation of imaging indices, which need to be improved and expounded.

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