#### RESEARCH



# A modified suture technique using polydioxanone (PDS II) for capsule closure in total knee arthroplasty: a prospective randomized study compared with traditional suture technique

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#### Abstract

**Purpose** To describe and evaluate the modified suture technique using PDS II for capsule closure in Total knee arthroplasty. **Methods** One hundred-five patients with end-stage osteoarthritis of the knee received Total knee arthroplasty (TKA) in our department. The arthrotomy wounds were closed randomly utilizing either modified suture (the MS group, 53 patients) or traditional suture (the TS group, 52 patients) techniques. The time of suturing, rupture of the suture, water tightness, wound seepage and the days of hospitalization were recorded and compared between the two groups. Complications such as infection and rejection of the wound were also assessed.

**Results** Records indicated significantly shorter time of suturing for the capsule in the MS group  $(4.6 \pm 0.6 \text{ min})$  than in the TS group  $(16.8 \pm 1.1 \text{ min}, P < 0.001)$ . The mean time of hospitalization was also significantly shorter in the MS group (7.8 + 1.8d) than in the TS group (13.1 + 2.7d, P < 0.001). There were 51 cases in MS group and 42 cases in TS group showed good tightness, the rate of tightness in the MS group (51/53) was significantly higher than in the TS group (42/52, P = 0.015). The rate of postoperative wound seepage in the MS group (3/53) was significantly lower than in the TS group (11/52, P = 0.023). The rate of rupture of the suture in the MS group (0/53) showed no significantly difference compared with the TS group (3/52, P = 0.118). There were no complications such as infection and rejection occurred in both groups.

**Conclusion** The modified suture technique using PDS II appears to be a promising option for the capsule closure in TKA because it was associated with shorter surgical time, better water tightness, fewer wound see-page, shorter of hospitalization and relatively fewer complications.

Keywords Polydioxanone (PDS) · Water tightness · Suture technique · Total knee arthroplasty(TkA) · Wound seepage

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# Introduction

In recent years, Total knee arthroplasty (TKA) for treating of the end-stage arthritis of the knee developed rapidly. With the improvement of surgical techniques, doctors begin to pay more attention to postoperative complications and the fast recovery for patients [1]. The safe and effective closure of the incision is an important part of a successful TKA [2].

The traditional suturing of the capsule in TKA is implemented by simple interrupted suture with multiple knots, which is time-consuming [3] and creates imbalanced tension [4]. Studies have shown that the risk of incision complications increases by 9% with a 15 min extension of the operation time [5]. The imbalanced tension may leads to tissue ischemia, and the multiple suture knots may cause inflammation or scar formation in local tissue [6, 7]. Compared with the interrupted suture, continuous suture can simplify the suture process, shorten the suture time and provide better water tightness [8, 9]. In TKA, the wound is desirable to be suture closely, because seepage is one of the important factors of wound infection [10]. However, there is a fatal defect in continuous suture that once the suture rupture occurred the entire incision will split. Therefore, both of the suture materials and suture method are very important for the closure of the incision in TKA. The purpose of this study is to report a modified suture technique using PDS II in TKA. We hypothesize that the modified suture technique will be associated with shorter surgical time, better water tightness, fewer wound seepage, shorter hospitalization and relatively fewer complications.

## **Materials and methods**

#### **Patient selection**

This prospective study obtained the approval from our ethical Committee, and all patients signed informed consent before surgery. From April 2022 to April 2023, total of 105 patients with end-stage osteoarthritis of the knee were enrolled in the Department of Orthopaedics of Zigong Fourth People's Hospital. Inclusion criteria: (1) Patients aged from 60 to 80 years old (2) Patients with end-stage osteoarthritis of knee who had severe pain and dysfunction. Exclusion criteria: (1) Skin lesions or local infections in the incision area (2) Patients with severe knee deformities that the ordinary knee prostheses cannot be satisfied (3) The general condition of patients is poor, complicated with a variety of underlying diseases (4) Patients with hormone-dependent diseases, immune dysfunction and diabetes. Patients who meet the inclusion criteria were randomly assigned into MS group or TS group for total knee arthroplasty. Arthrotomies wound were closed by either modified suture or traditional suture techniques. The patients' demographics including the age, the gender and body mass index (BMI) are summarized in Table 1.

### Surgical techniques

Total knee arthroplasty (TKA) was performed by medial parapatellar approach. Prostheses were implanted and

**Table 1** Comparison of Patient Demgraphics  $(x \pm s)$ 

Group	n	Gender: M/F	Age (years)	BMI (kg/m <sup>2</sup> )	
MS	53	14/39	69.5 ± 4.4	25.0 ± 1.7	
TS	52	11/41	$68.8 \pm 4.6$	$25.6 \pm 1.9$	
P-value		0.686	0.425	0.087	

capsule sutures were performed after routine osteotomy. Keeping the knee in straight position when the capsule was sutured. The MS group: Capsule was closed by modified suture technique, the suture technique of PDS was shown in Fig. 1. The TS group. The capsule was sutured in "8" figure at the upper and lower margins of the patella, the remaining capsule was closed by simple intermittent suture.

After the capsule suture was completed, 10 cycles of 120° knee flexion were performed to observe whether the suture rupture occurred. Then, flexing the knee joint at 90° and injecting 20 ml tranexamic acid (Specification:1 g/10 ml) into the capsule for water tightness test (Fig. 2). Additional intermittent suture should be performed if there is fluid leakage. Subcutaneous suture was performed with absorbable sutures by simple intermittent suture, and cutaneous suture was performed with disposable skin stapler.

### **Post-operative management**

Antibiotic treatment with first-generation cephalosporin for 24 h to prevent infection. Nonsteroidal anti-inflammatory drugs (NSAIDs) such as celecoxib are used routinely for analgesia and dezocine is used intramuscular if necessary. Tranexamic acid was diluted to 100 ml intravenous infusion to stop bleeding at 3 h post-operatively, and rivaroxaban tablet was taken orally to prevent thrombus at 8 h post-operatively. On the second day after surgery, knee flexion and extension exercises were performed and patients were encouraged to walk early. The first dressing change is on the second day, the next dressing time is according to the wound seepage in the later stage, if there is no wound seepage any more, generally every 3 days to dress. Skin stapler is removed about 14 days after surgery depending on the healing situation.

## Follow-up and clinical evaluations

The suture time of capsule, suture rupture, water tightness test, incision complications such as infection and rejection, wound seepage and hospitalization days were recorded in the two groups. The commonly used criteria for wound seepage are: gauze with an area of seepage exceeding 2 cm by 2 cm and the seepage lasting for more than 72 h [11].

#### Statistical analysis

SPSS 25.0 statistical software was used for analysis. Measurement data were expressed as mean  $\pm$  standard deviation, and independent sample t test was used for comparison between groups. The statistical data were expressed as rates, and fisher test were used for comparison between groups, test level  $\alpha = 0.05$ .

Fig. 1 The modified suture technique of PDS. A Medial parapatellar approach of TKA. The red line indicates the arthrotomy incision B The first knot is sutured in "8" figure starting from the lower edge of the patella. Then, suture continuously from distal end to the proximal end, three single knots are tied when it is sutured back to the first knot. C Skip to the upper edge of the patella for a "8" figure suture. D Suture continuously from proximal end to distal end. E The reserved suture (the blue line in figure) between the two ends should be buried in each suture. Six single knots are tied when the suture return to the first knot. Sutured the last knot successively and cut the suture. F Intra-operative application of the modified suture technique



## Results

Among all patients with osteoarthritis who met inclusion criteria, 53 patients underwent modified suture and 52 patients underwent traditional suture of the capsule. There was no difference for age, the gender and BMI between the two groups (Table 1).

Records showed that the suture time of capsule was significantly shorter in the MS group  $(4.6 \pm 0.6 \text{ min})$  compared to the TS group  $(16.8 \pm 1.1 \text{ min})$ . The mean

hospitalization days was significantly shorter in the MS group (7.8 + 1.8d) than in the TS group (13.1 + 2.7d) (Table 2).

In water tightness test, there are 51 cases in MS group and 42 cases in TS group showed good tightness, and the rate of tightness in the MS group (51/53) was significantly higher than in the TS group (42/52). Rate of postoperative wound seepage in the MS group (3/53) was significantly lower than in the TS group (11/52). After the capsule suture completed, there were 0 cases in MS group (0/53) and 3 cases in TS group (3/52) occurred the suture rupture when the knee

**Fig. 2** The water-tightness test and wound see-page. **A** The knee joint was flexed at 90 degrees and 20 ml tranexamic acid was injected into the capsule for water tightness test. **B** Wound seepage of the first dressing change in MS group



Table 2	Comparison of
operatio	n-related indexes
between	two groups

Group	Suture time of capsule (min)	Hospitaliza- tion days (d)	Good water tightness [case (%)]	Wound seepage [case (%)]	Suture rupture [case (%)]	Infection or rejec- tion [case (%)]
MS(n=53)	$4.6 \pm 0.6$	7.8±1.8	51 (96.2)	3 (5.7)	0 (0)	0 (0)
TS $(n = 52)$	$16.8 \pm 1.1$	$13.1 \pm 2.7$	42 (80.8)	11 (21.2)	3 (5.8)	0 (0)
P-value	< 0.001	< 0.001	0.015	0.023	0.118	1

flexion and extension activities were performed, showing no significant difference between two groups. There were no complications such as infection or rejection occurred in two groups (Table 2).

# Discussion

Safe and effective suturing of incision in TKA can prevent postoperative infection and promote early recovery of joint function [12, 13]. Due to the limitation of suture materials and suture techniques, there are some potential problems such as local tissue ischemia, intractable pain and prolonged operation time [5]. In recent years, barbed suture has been favored by most people, which can significantly shorten the operation time and improve the surgical efficiency [3, 14]. However, the incision complications of barbed suture are relatively increased [15, 16], it has been reported that the structure of barbed suture may cut soft tissue, and there are weak points of the suture which easy to rupture [17]. The aim of this study was to describe an easily implemented suture technique of PDS II, which can simplifies the suturing process and still achieve the desired outcome in TKA.

PDS is characterized with a suitable elasticity, which can provide uniform tension along the incision direction after continuous suture [18]. Strength of PDS can be maintained for a long time after surgery, 70% of the strength was maintained after 2 weeks, 25% of the strength was still maintained after 6 weeks, and it was completely absorbed after 180 days [19]. In addition, PDS was associated with good biocompatibility, low price and easy to obtain [20, 21]. It has been widely used in many other surgeries, such as thoracic surgery [22], plastic surgery [23] and colon surgery [24], etc. In this study, PDS II was used for modified suture of the knee capsule, which was consistent with our expected hypothesis results. Compared with the traditional method, the modified suture method can simplify the suture process and shorten the suture time significantly (P < 0.001). Results showed that there were 0 cases in MS group (0/53) and 3 cases in TS group (3/52) occurred the suture rupture, showing no significantly difference between two groups (P = 0.118). The modified suture of PDS is a special continuous suture that will reserve sutures in the incision (blue line in Fig. 1). Reserved suture can act as a barrier to prevent the capsule from further rupture if soft tissue cutting occurs. In addition, because of the good sliding performance of PDS [25], the capsule can be sutured closely by small force which also has less effect on tissue cutting. A good balanced patella with an sufficient reconstruction of the joint capsule might avoid an apparent dehiscence of the medial joint capsule [26].

Persistent wound seepage may lead to periprosthetic joint infection [27, 28], studies have shown that TKA infection increases by 29% for each extended day of wound seepage [28]. Maintenance of water tightness and minimization of wound seepage are crucial aspects in TKA [13, 29]. Studies showed that the water tightness of continuous suture was better than traditional intermittent suture [8, 30]. In our study, the modified suture of PDS is indeed an improvement of continuous suture. Results showed that the rate of good tightness in the MS group (51/53) was significantly better than in the TS group (42/52, P = 0.015). The patients accept early knee flexion and extension exercise after surgery, the wound seepage was observed and recorded during ward rounds every day. The results showed that patients in the MS group had fewer wound seepage, and the rate of postoperative wound seepage (3/53) was significantly lower than that in the TS group (11/52, P = 0.023). The modified suture technique of PDS II is in line with the principle of closely suture [10] which can reduce the wound seepage and shorten the hospitalization days (P < 0.001).

The modified suture of PDS did not increase the risk of infection and rejection (P=1), compared with the traditional suture. Meyer et al. [31] believed that traditional intermittent suture will produce more knots, which may provide parasitical sites for bacteria, and increasing the risk of rejection and infection. By contrast, the modified suture will produce less knots, but the last knot is still too large, which needs to tie six single knots to avoid sliding. If we handled it improperly, the subcutaneous nodules may be touched, which will increase the discomfort of patient. To minimize the subcutaneous rejection, we sutured the last knot successively which can press the knot in the capsule (Figure 1E). Finally, there were no rejection or infection occurred in either group.

Nonetheless, there are some limitations in this study should be recognized. First, the included number of patients were not enough, additional cases are needed for further study. Second, rupture of the suture is affected not only by suture method but also by patella tracking in TKA. Patients with maltracking of the patella will show a higher tension of the medial joint capsule which may increase the probability of suture rupture. The surgeon must have the ability to adjust the patella tracking which reaches the condition of no thumb's test. Last, the follow-up time is relatively short, long term follow-up are needed to further confirm the efficacy of our technique in the future.

In conclusion, compared with traditional intermittent suture, the modified capsule suture technique of PDS II is characterized with shorter surgical time, better water tightness, fewer wound seepage, shorter of hospitalization and relatively fewer complications in TKA.

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**Data availability** The data that support the findings of this study are available on request from the corresponding author, [initials], upon reasonable request.

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

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

**Consent for publication** Written informed consent for publication was obtained from all participants.

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