



## Original article

## Outcome of Judet's quadricepsplasty for knee contractures and the effect of local infiltration of epinephrine on reducing blood loss

Akbar Jaleel Zubairi <sup>a, \*</sup>, Haroon Rashid <sup>a</sup>, Rizwan Haroon Rashid <sup>a</sup>, Moiz Ali <sup>b</sup>, Pervaiz Mehmood Hashmi <sup>a</sup><sup>a</sup> Section of Orthopedics, Department of Surgery, Aga Khan University Hospital, Karachi 74800, Pakistan<sup>b</sup> Aga Khan University Medical College, Karachi 74800, Pakistan

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## ABSTRACT

**Objective:** To evaluate the effectiveness of Judet's quadricepsplasty for treatment of knee contractures and to identify the effect of local infiltration of epinephrine on blood loss associated with this procedure.**Methods:** A retrospective cohort study was conducted in which all cases of knee contractures managed with Judet's quadricepsplasty from 1st January 2009 to 31st December 2013 were included and were divided into two groups. The epinephrine group included patients who were infiltrated with diluted epinephrine (1:400,000) along with xylocaine, around the operative field 15 min prior to the incision time, while the control group did not receive any infiltration. Judet's outcome, blood loss, drop in hemoglobin and required blood transfusion were noted for all patients and compared between both groups.**Results:** Most common preceding pathology identified for the development of knee contractures was periarticular fracture while ilizarov application was the most common etiology. Both groups were found similar in all preoperative characteristics except preoperative flexion contracture ( $p = 0.02$ ). All functional outcome measures including Judet's outcome were similar in both groups. In contrast, duration of surgery ( $p = 0.01$ ), blood loss ( $p = 0.02$ ), drop in hemoglobin ( $p = 0.01$ ) and number of transfusions ( $p = 0.03$ ) were significantly reduced in epinephrine group.**Conclusion:** Judet's quadricepsplasty is a useful procedure to increase the range of motion of rigid knees and local infiltration of epinephrine is effective in decreasing the amount of subsequent blood loss and transfusion requirements.

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## Introduction

Stiffness of the knee is a major problem which can restrict the functional capacity of the patient. It may even lead to a change in job and hobbies, thus limiting occupational and recreational opportunities. Also, the psychological impact it may impose on patients can result in embarrassment in various situations.<sup>1</sup> The most common causes of knee stiffness are complications following periarticular fractures which can often develop into periarticular and quadriceps fibrosis and subsequently deteriorate into a knee extension contracture.<sup>2</sup> Though extension contractures of the knee

are less common than flexion contractures, they are more prone to cause disability, especially in some Asian countries where kneeling down is an integral part of daily routine due to the prevalent social and religious customs.

Quadricepsplasty, an operative procedure, aims to release the contracture and increase the range of motion at the knee joint.<sup>3</sup> Though several techniques for quadricepsplasty have been described in the literature, yet primarily Thompson's and Judet's technique and their modifications prevail.<sup>4,5</sup> Thompson's method includes release of vastus medialis and lateralis at the patella while it is often related with high morbidity rates and great risk of developing extension lag.<sup>6</sup> Judet's technique which is based on sequential release of extensor mechanism without disruption of the vasti was described in 1956.<sup>7</sup> It is the more preferred option as it causes less damage to the quadriceps and provides greater increase in flexion. However, due to the extensive incisions and dissections involved, it is associated with significant blood loss.<sup>3</sup>

\* Corresponding author.

E-mail address: [akbar.zubairi@gmail.com](mailto:akbar.zubairi@gmail.com) (A.J. Zubairi).

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Local epinephrine infiltration has been used in multiple surgical specialties to reduce blood loss during surgery. It has been reported to be used successfully in various surgical procedures including liposuction, tonsillectomy, functional endoscopic sinus surgery, reduction mammoplasty, burn eschar excision with skin grafting and even total knee arthroplasty.<sup>8,9</sup> Epinephrine helps bring vasoconstriction in the infiltrated area and thus leads to decreased intraoperative and postoperative blood loss, postoperative edema, pain and bruising.<sup>10,11</sup> Since reports of postoperative complications and adverse effects attributed to epinephrine infiltration have been negligible, epinephrine infiltration is recognized as a safe and cost-effective method.<sup>11</sup>

Recently, epinephrine infiltration was adopted at our institute as a modality to reduce blood loss and surgical time, but there has been no report observing its effectiveness in relation to Judet's quadricepsplasty. Hence we formulated this study with the objective to evaluate the outcomes of Judet's quadricepsplasty, and to identify the effect of local epinephrine infiltration on blood loss, surgical time and postoperative complications.

## Materials and methods

A retrospective cohort study was conducted and all the cases of knee contractures managed operatively from 1st January 2009 to 31st December 2013 at our institute were reviewed. All of the cases managed with original Judet's technique were included, whereas cases managed with any other procedures or with known coagulation disturbances were excluded from this study. Medical record files were reviewed for demographics, operative procedure and pre- and post-operative parameters. Ethical Review Committee exemption was granted for this study. The procedures were performed by 2 separate surgeons while similar operative approach and postoperative rehabilitation protocol were followed.

## Patients

The study included 33 patients in total, 21 males and 12 females, with the mean age of (30.9 ± 11.1) years. They were divided into two groups: the epinephrine consisting of 12 patients and the control of 21. The epinephrine group included patients who were infiltrated with diluted epinephrine (1:400,000) along with xylocaine around the operative field for 15 min prior to the incision time while the control group did not receive any infiltration. The baseline characteristics for both groups are summarized in Table 1 and both groups were found to be similar in all characteristics.

## Surgical technique

Surgical technique involved sequential release of the extensor mechanism along with release of the intraarticular adhesions by using separate medial and lateral incisions. Initial intraarticular release was performed under tourniquet control which was released when the lateral incision was extended proximally. Flexion was measured at each step to determine whether further release was needed. The incisions were closed over suction drains and an anterior knee splint was placed with the knee in maximum possible flexion, avoiding stress on the suture line. Epidural analgesia was given for postoperative pain control. On the second postoperative day, the wound was redressed and the drains were removed. Active and passive range of motion exercises started after the epidural was discontinued. Patient was discharged on postoperative 4/5d, while overnight splinting was continued for 6 weeks.

**Table 1**  
Comparison of baseline characteristics between both groups.

Characteristics	Epinephrine (n = 12)	Control (n = 21)	p value
Age (years)	33.1 ± 12.2	28.7 ± 10.0	0.27
Sex (%)			0.78
Male	8 (66.7)	13 (61.9)	
Female	4 (33.3)	8 (38.1)	
Site (%)			0.26
Right	7 (58.3)	8 (38.1)	
Left	5 (41.7)	13 (61.9)	
ASA status (%)			0.36
Grade I	8 (66.7)	17 (81.0)	
Grade II	4 (33.3)	4 (19.0)	
Etiology (%)			0.64
Femoral fracture	4 (33.3)	9 (42.9)	
Limb lengthening	5 (41.7)	7 (33.3)	
Infection	2 (16.7)	3 (14.3)	
Degloving/burn contractures	1 (8.3)	2 (9.5)	
Duration of contracture (months)	27.7 ± 21.9	24.4 ± 23.0	0.70
Preoperative flexion (degrees)	29.4 ± 9.8	43.1 ± 17.6	0.40
Preoperative hemoglobin (g/L)	118 ± 12	114 ± 15	0.40
Duration of follow-up (months)	22.8 ± 9.7	18.4 ± 23.0	0.45

## Data collection and analysis

The degrees of flexion of the operated knees were noted pre-operatively, intraoperatively and at last follow-up with the definitive flexion gain and subsequent flexion loss calculated. Quadriceps muscle strength was noted in accordance with the Medical Research Council scale along with presence or absence of extension lag > 10°. Estimated blood loss at the time of surgery, drop in hemoglobin level and the number of transfusions administered were reviewed. Transfusion was undertaken when Hb < 80 g/l or signs of acute anemia were observed.

Follow-up clinic visits were conducted to observe whether complications arose and whether further intervention was needed. Outcomes were classified according to Judet's criteria with final flexion > 100° being excellent, 80°–100° good, 50°–80° fair and < 50° poor.

Data were analyzed using IBM SPSS version 20.0 with categorical and continuous variables expressed as percentage and mean ± standard deviation respectively. All of the baseline parameters and outcome measures were compared between both groups. Chi-square test was used to compare categorical variables while independent sample *t* test to compare continuous variables. Paired sample *t* test was used to compare difference between preoperative flexion and final flexion in the same group. Univariate analysis was used to determine the effect of preoperative characteristics on final Judet's outcome criteria. A *p* value of < 0.05 was considered to be a statistically significant difference.

## Results

The overall mean preoperative flexion was 36.3° ± 27.4° while final flexion at last follow-up was found to be 85.6° ± 27.3° with the difference being statistically significant (*p* = 0.01). Twenty five out of 33 patients (75.8%) achieved > 80° flexion and therefore were classified as either good or excellent according to Judet's criteria with 11 patients (33.3%) graded as excellent, 14 (42.5%) good, 4 (12.1%) fair and 4 (12.1%) poor. The most common etiology identified for these extension contractures was femoral fractures in 13 patients (39.4%), followed by limb lengthening 12 (36.3%), infection 5 (15.2%), and degloving/burn contractures 3 (9.1%).

Both groups had a similar duration of follow up, 22.8 months for epinephrine group and 18 months for the control group respectively (*p* = 0.45) and it was found that administering epinephrine

**Table 2**  
Comparison of range of motion between both groups.

Groups	Range of motion				
	Intraoperative flexion (°)	Final flexion (°)	Flexion gain (°)	Flexion loss (°)	Quadriceps strength (MRC Grading)
Epinephrine (mean ± SD)	122.9 ± 15.1	91.7 ± 22.5	52.1 ± 24.4	31.2 ± 16.0	4.4 ± 0.8
Control (mean ± SD)	114.8 ± 23.4	82.1 ± 29.6	59.8 ± 29.8	32.6 ± 19.3	4.4 ± 0.8
<i>p</i> value	0.29	0.34	0.45	0.83	0.90

Note: MRC: Medical Research Council.

had no significant effect on the outcomes. Flexion on the last follow-up, flexion gain and the quadriceps strength were found to be similar in both groups (Table 2). There was significant increase in flexion postoperatively in each group ( $p = 0.01$ ). Though one patient in the epinephrine group and two in the control ended up with an extension lag, the difference was statistically insignificant ( $p = 0.91$ ). When assessed in accordance with Judet's criteria, both groups were again found to be similar ( $p = 0.87$ ) as shown in Table 3.

In the epinephrine group, one patient developed a reflex sympathetic dystrophy (RSD), one septic arthritis, one superficial infection and one a deep wound infection. In the control group, one patient suffered a tibial tuberosity avulsion and 3 patients ended up with wound infections out of which 2 had superficial infection and one developed a deep infection.

Table 4 shows that a significant reduction in estimated blood loss ( $p = 0.02$ ) and drop in Hb levels ( $p = 0.01$ ) were noted in the epinephrine group. As a result, the mean transfusion requirement for the epinephrine group ( $0.33 \pm 0.65$  units) was found to be significantly lower than that for the control group ( $2.10 \pm 1.30$  units) with a  $p$  value of 0.03. In addition, duration of surgery was significantly lower in the epinephrine group ( $p = 0.01$ ).

In terms of effect of baseline characteristics on the final Judet's outcome, it was observed that none of the factors had significant effect except gender. Females were found to have significantly poorer Judet's score as compared to males ( $p = 0.03$ ), irrespective of which group they belonged to, as shown in Table 5.

## Discussion

Judet's quadricepsplasty has been proven effective in increasing the range of motion of rigid knees, and therefore has remained the mainstay treatment for knee contractures for over half a century.<sup>12</sup> Several studies have validated the results of this technique. Masse

**Table 3**  
Judet's outcomes in both groups.

Groups	Outcomes (n, %)			
	Excellent	Good	Fair	Poor
Epinephrine ( $n = 12$ )	4 (33)	6 (50)	1 (8)	1 (8)
Control ( $n = 21$ )	7 (33)	8 (38)	3 (14)	3 (14)
<i>p</i> value	0.87			

**Table 4**  
Comparison of blood loss and duration of surgery between both groups.

Groups	Blood loss and duration of surgery			
	Estimated blood loss (ml)	Drop in Hb (g/L)	No. of transfusions (units)	Duration of surgery (min)
Epinephrine (mean ± SD)	216 ± 126	15.4 ± 6.4	0.33 ± 0.65	93.3 ± 24.4
Control (mean ± SD)	429 ± 366	24.4 ± 12.3	2.10 ± 1.30	139.0 ± 31.5
<i>p</i> value	0.02	0.01	0.03	0.01

**Table 5**  
Comparison of Judet's outcomes between genders.

Gender	Outcomes (n, %)			
	Excellent	Good	Fair	Poor
Male ( $n = 21$ )	9 (43)	11 (52)	1 (5)	0 (0)
Female ( $n = 12$ )	2 (17)	3 (25)	3 (25)	4 (33)
<i>p</i> value	0.03			

et al<sup>2</sup> showed that the mean definitive flexion gain by Judet's technique was 72.1° and a total of 81% of the patients obtained the excellent or good outcomes according to Judet's criteria. Similarly, Ebraheim et al,<sup>13</sup> in their review of 12 femur fractures, showed that the mean postoperative flexion after Judet's quadricepsplasty was 91° with the mean flexion gain being 53°. Furthermore, there was no complication reported except an extension lag in only one patient. These results with respect to outcome measures are comparable to our study which reports mean final flexion at 85.6° with mean flexion gain of 47.6°. In terms of preoperative characteristics, the mean age of the study population, preoperative flexion contracture and duration of follow-up are also similar to those reported in prior studies.<sup>7,12,13</sup> It is however interesting to note that females had significantly poorer outcome than males, which has not been reported previously. It may be attributed to the social and cultural norms in this part of the world, as females are prone to be deprived of proper postoperative care and rehabilitation needed for better outcomes.

The extensive incision and dissection in the Judet's procedure may more likely lead to increased blood loss and thus bring about complications including surgical site infections, as have been reported previously.<sup>2</sup> Similar complications were noted in our study as well. Deep surgical site infection in each of the groups necessitated surgical debridement, while superficial wound infections in both groups were managed with oral antibiotics. It is important to note that both patients suffering deep infections were known to have chronic osteomyelitis, and we therefore believe that the occurrence of deep wound infection was in fact a reactivation of the underlying disease. Two complications were noted only in the epinephrine group, RSD and septic arthritis. RSD was managed with a sympathetic ganglion block whereas arthrotomy was done for septic arthritis. Similarly, tibial tuberosity avulsion was encountered only in the control group, and required surgical fixation. Modified approaches for open quadricepsplasty have

been tried to decrease complications yet with similar outcomes and rates of surgical site infections.<sup>14,15</sup> Endoscopic technique for quadricepsplasty was studied by Blanco et al<sup>16</sup> and various complications including deep vein thrombosis, scrotal edema and hemarthrosis were reported.

Despite various modifications of the procedure, there is very limited literature available on methods of decreasing blood loss and subsequent transfusion requirements during this surgery. In various other surgeries, epinephrine has been successfully used to reduce blood loss. Lombardi et al<sup>17</sup> proved the effectiveness of epinephrine in reducing blood loss in total knee arthroplasties in 2004. Epinephrine was again demonstrated to be effective in burn surgeries with Gacto et al<sup>11</sup> in a randomized control trial illustrating a greater decrease in blood loss at the donor sites after local infiltration of epinephrine compared to the control group. In our study, use of epinephrine was found to be associated with a statistically significant decrease in blood loss and transfusion requirements. At the same time, it made no difference in Judet's outcome and both groups had similar outcomes. Administering epinephrine was thus regarded as being capable of rendering a significantly shorter duration of surgery, possibly an indirect result of decreased blood loss which in turn reduced the time needed for its control.

This study shows that local infiltration of epinephrine is effective in decreasing the amount of blood loss and transfusion requirements without any adverse effect on the outcome. This reduced requirement of transfusion carries the advantage of decreased transfusion-related complications including transmission of blood borne infections, severe immunological reactions, etc. In addition, administering epinephrine is a more cost-effective option compared to blood transfusion, thus reducing the economic burden on health care system, especially in developing countries.<sup>18</sup> Since the use of epinephrine does not rely on surgical expertise, we believe that the results we achieved are reproducible by any surgeon. Nevertheless, the limitation of this study is that it is retrospective in nature and includes a limited number of cases as this procedure is relatively uncommon. Hence further prospective studies are required to better substantiate these results. As we have recently started using epinephrine, the epinephrine group included the most recent cases, which may be a source of bias as surgeon experience and learning curve may influence blood loss and surgical time.

In conclusion, based on the results, we can demonstrate that Judet's quadricepsplasty is an effective treatment for knee extension contractures and use of local infiltration of epinephrine proves to be a cost-effective method to significantly reduce the amount of blood loss associated with this procedure.

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