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A new surgical technique for the treatment of recurrent patellar dislocation: review of primary results

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Abstract

Introduction Surgical options used to treat recurrent patellar dislocations (RPD) in different countries include release of the lateral tendon retinaculum, tibia medialization, fixation of an autologous graft to the hip, transplantation of the ipsilateral gracilis tendon and medial patellofemoral ligament reconstruction. The methods may not completely eliminate the dislocation to ensure patellar stability and we undertook to develop a new surgical technique. **The objective** was to identify advantages and disadvantages of the new methodology for the treatment of RPD through comparative analysis. **Material and methods** 28 patients with RPD of varying degrees treated in the Department of Sports Trauma, State Institution "RSNPMCTO" the Ministry of Health of the Republic of Uzbekistan between 2015 and 2018 were reviewed. Dislocations were graded as average (grade 2; n = 3, 10.7 %) and grade 3 (n = 25; 89.3 %). Five (17.8%) of 28 patients had impaired m. vastus medialis and 23 (82.2 %) were diagnosed with impairment and defect of the retinaculum patella mediale. The patients underwent physical, laboratory, radiological and instrumentation (ultrasound, magnetic resonance imaging, diagnostic arthroscopy) examinations. **Results** Arthroscopic procedure of the knee joint with autoplasty patellar stabilization using the m. gracilis tendon and a biodegradable screw resulted in good outcomes (n = 27; 96.4 %) and a fair result in a patient (3.6 %) with grade 3 RPD due to synovitis, bursitis and pain in the knee joint; no poor results reported. **Conclusion** The patients could completely regain the limb functions through arthroscopic procedure of the knee joint with autoplasty patellar stabilization using the m. gracilis tendon and a biodegradable screw, optimization of surgical treatment strategy with regard to severity of displacement and injury to the soft tissues at the medial aspect of the patella.

Keywords: patellar instability, dislocation, recurrent dislocation, knee joint, surgical treatment

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INTRODUCTION

Patellar dislocation is one of the most common consequences of injury to the ligamentous apparatus of the knee joint resulting in the knee instability [1–7] and leading to the appearance and progression of severe degenerative changes in the joint [1, 5, 8]. The occurrence of patellar dislocation ranges between 3.1 and 35 %. Acquired recurrent patellar dislocation is often associated with trauma [9]. The extent and severity of injury to the patella retinaculum cannot be determined by clinical symptoms and radiography alone. More than 160 methods of surgical correction of knee joint instability and patellar dislocation are described in the literature [3, 8, 10–17] with high rate of poor outcomes (from 3.3 to 36.1 %) [18, 19]. Most optimal methods have not yet been determined [20, 21] to combine anatomical relevance and minimal trauma, pathogenetic justification and high functional efficiency [10, 21–23]. Arthroscopy is the preferred diagnostic and treatment minimally invasive method to allow confident identification of the extent of pathology, repair of the knee joint with examination and assessment of the suprapatellar pouch, synovial membrane, severity of fold impairment, tendency to fibrosis, contact with the patella, adhesions, free intra-articular bodies and determination of indications for treatment [22, 24–26]. Despite the notable successes achieved in the treatment of knee injuries of the joint, many unresolved issues like diagnostic criteria and causes of chronic instability and habitual patellar dislocation which allow choosing a method of treatment and rehabilitation, have not been fully determined. Indications and contraindications for arthroscopic treatment have not been developed [1, 17, 22, 24]. Anatomical and functional outcomes of recurrent patellar dislocations can be improved through optimization of surgical techniques depending on the extent of dislocation and injury to the soft tissues on the medial aspect of the patella.

The objective was to identify advantages and disadvantages of the new methodology for the treatment of recurrent patellar dislocation through comparative analysis.

MATERIAL AND METHODS

Retrospective analysis of 28 patients included 21 (75.0 %) female and 7 male (25.0 %) participants. Setting: department of sports traumatology at the hospital of the Medical Centre for Trauma and Orthopaedics, Ministry of Health of the Republic of Uzbekistan, sampling depth: 2015 to 2018. The patients were divided into 4 age groups: 18–25 years old, 25–35 years old, 35–50 years old and older than 50 years. There were 13 (46.4 %) patients aged 18–25 years, 14 (50.0 %) patients aged 25 to 35 years, and 1 (3.6 %) patient in the group of 35–50 years. Diagnosis was established with conventional radiography, MRI and ultrasound that showed the extent of patellar displacement and injury to the soft tissues at the medial aspect of the patella. The age of patients was not considered when choosing treatment strategy.

All 28 patients underwent a modified operation we developed and tested "Arthroscopic procedure of the knee joint with autoplasty patellar stabilization using the m. gracilis tendon and a biodegradable screw" that was patented with the Intellectual Property Agency of the Republic of Uzbekistan (No. IAP 05897 dated July 19, 2019). The Kujala Scale (1993) was used to assess the results of surgical treatment of recurrent patellar dislocation and complications developed in the early and late postoperative period. The Lysholm questionnaire was employed to evaluate the severity of pain in the anterior knee joint (KJ). The Kujala score is a frequently used subjective assessment tool in patients with pain in the anterior and medial knee including instability or luxation of the patella. It consists of 13 questions with 6 aimed at assessing the patient's functions (walking, running, jumping, using stairs, squatting, sitting for a long time), and the rest allow assessing the severity of symptoms characteristic of injury to the knee joint (pain, swelling, instability), patella, atrophy of the femoral muscles, limited flexion in the knee joint. Each of the answers to the questions posed corresponds to a certain number of points which are summed up calculating the results. The maximum score is 100 points indicating good condition and the minimum is 0 indicating severe changes in the anterior aspect of the knee joint. The Lysholm Scale (LyshlomKneeScore) was developed to evaluate the results of treatment in patients with a variety of knee disorders. The scale consists of eight items that measure: limp, the need for support, locking, instability, pain, swelling, stair climbing and squatting. Every question response has been assigned an arbitrary score on an increasing scale. Eight factors are rated to produce an overall score on a point scale of 0 to 100. Then an assignment is given as "excellent" for 95 to 100 points; "good" for 84 to 94 points, "fair" for 65 to 83 points, or "poor" for less than 65 points. Higher scores indicate a better outcome with fewer symptoms or disability.

The evaluation criteria were:

– the degree of patellar displacement;

– preoperative and postoperative angle of the facies patellaris;

– preoperative and postoperative patellar tendon lateralization angle;

– preoperative and postoperative angle Q;

– preoperative and postoperative Insall-Salvati index;

– preoperative and postoperative opening angle of the patella according to Wiberg-Baumgartl;

– preoperative and postoperative Merchant congruence angle;

– preoperative and postoperative angle of inclination of the patella;

– preoperative and postoperative patellofemoral index according to Laurin;

– the functional status of the patient based on the Kujala questionnaire;

– severity of pain in the anterior knee joint (KJ) evaluated with the Lysholm scale.

Statistical data processing The linear statistical analysis in Excel Microsoft Office 2007 Professional was used to calculate the arithmetic mean, standard error of the arithmetic mean, standard deviation. Comparative analysis of the significant differences between the groups was produced using the Student's t-test. Differences in variables in the study groups were considered significant at $p < 0.05$ (95 % confidence level).

Operating technique The articular surface of the patella was explored arthroscopically after processing the surgical field through standard portals and condition of the patella retinaculum, folds of the upper and lateral recessus, free intra-articular chondromic bodies, menisci and tendons

of the knee joint evaluated. A skin incision was made in the crow's foot area and the m. gracilis tendon 20–24 cm long exposed. A m. gracilis graft 18–22 cm long was harvested using special devices. A skin incision was made up to 4 cm on the medial surface of the patella, the extra-articular medial surface exposed using 0.4 cutters, and two tunnels formed at an angle of 45o with the ends connected forming a single tunnel. The optimal point for the tendon ends to be attached to the medial surface of the femoral epicondyle was identified to avoid injury to the growth zones in childhood and adolescence, and a horizontal channel formed. The tendon ends passed between the capsule and the superficial fascia through the patella tunnel using special tools and the distal ends were connected. Arthroscopically assisted lateral release was performed and the scarred external stabilizers of the patella excised with the patella mobilized. With the knee joint flexed to 150º, tension was applied to the ligatures of the m. gracilis tendon to achieve congruence in the patellofemoral joint. The tendon ends were fixed in a tunnel in the medial femoral epicondyle using a biodegradable screw with the patella physiologically positioned. With sutured wound a plaster cast was applied to the lower limb with the knee extended to 180º for a period of 4 weeks.

RESULTS

As mentioned above, the pathology was more common for females and for patients aged 18 to 35 years (n = 27, 96.4 %). Based on the studies conducted we offered a modified classification for the pathology that was registered with the Intellectual Property Agency of the Republic of Uzbekistan (No. DGU7638 dated December 27, 2019). There were no patients with patellar displacement grade 1. Patellar displacement grade 2 (medium) was observed in 3 (10.7 %) patients, and 25 (89.3 %) patients of 28 had grade 3 displacement (severe). Five (17.8 %) patients out of 28 had injury to m. vastus medialis and 23 (82.2 %) patients were diagnosed with injury and defect of the retinaculum patella mediale to be addressed with surgical treatment.

Radiological examination and MRI scanning showed an angle of the facies patellaris measuring 105.2 ± 0.68º (range, 102–116º) preoperatively and 145.9 ± 0.99º (range, 140–158º) postoperatively. Patellar tendon lateralization angle measured 45.8 ± 1.26º (range, 19–50º) preoperatively and 17.2 ± 0.15º (16–18º) postoperatively; Q angle was 34.8 ± 0,71º (24–40º) preoperatively and 16.3 ± 0.18º (15–18º) postoperatively, Insall-Salvati index measured 1.20 ± 0.003º (1.14–1.24º) preoperatively and 1.04 ± 0.002º (1.02–1.06º) postoperatively, opening angle of the patella according to Wiberg-Baumgartl measured 94.8 ± 0.7º (90–104º) preoperatively and 131.9 ± 1.1º (120–140º) postoperatively (Table 1). The measurements demonstrated normalization of parameters after the operation ($p < 0.001$).

Table 1 shows that the Merchant congruence angle averaged to 16.9 ± 0.19º (range, 15–19º) preoperatively and 8.03 ± 0.11º (7–9º) postoperatively, the angle of inclination of the patella was 1.18 ± 0.03º (0.8–1.5º) preoperatively and 2.0 ± 0.12º (1.9–2.1º) postoperatively, Laurin patellofemoral index measured 0.94 ± 0.02º (0.8–1.3º) and 1.59 ± 0.012º (1.5–1.7º) postoperatively.

Table 1

Radiological and MRI measurements of the knee joint before and after surgery performed with the technique offered (n = 28)

Angle	Preoperatively,º	Postoperatively,º
Angle of the facies patellaris	105.2 ± 0.68	145.9 ± 0.99
Patellar tendon lateralization angle	45.8 ± 1.26	17.2 ± 0.15
Q angle	34.8 ± 0.71	16.3 ± 0.18
InsallSalvati index	1.20 ± 0.003	1.04 ± 0.002
Opening angle of the patella according to Wiberg-Baumgartl	94.8 ± 0.7	131.9 ± 1.1
Merchant congruence angle	16.9 ± 0.19	8.03 ± 0.11
Angle of inclination of the patella	1.18 ± 0.03	2.0 ± 0.12
Patellofemoral index according to Laurin	0.94 ± 0.02	1.59 ± 0.012

Three (10.7 %) patients grade 2 patellar displacement and 18 (64.3 %) patients grade 3 patellar displacement showed excellent results rated with the Kujala Anterior Knee Pain Scale at a short term, 6 (21.4 %) %) patients grade 3 displacement demonstrated good results and 1 (3.6 %) patient had a fair result due to synovitis, bursitis and knee pain. No poor results were observed. Outcomes of 3 (10.7 %) patients grade 2 patellar displacement and 16 (57.2 %) patients grade 3 patellar displacement were rated as excellent on the Lysholm scale and 9 (32.1 %) patients grade 3 displacement had outcomes rated good due to patellar pain. Outcomes were assessed as excellent in 3 (10.7 %) cases grade 2 patellar displacement and 25 (89.3 %) patients grade 3 patellar displacement on the Kujala and the Lysholm scales at a long term (Table 2). The limp scored 5 and rated as excellent in all patients at a short term on the Kujala scale (Table 3); the need for support (tape, brace) was rated at an average of 4.78 ± 0.11 (range, 3–5); walking, 4.07 ± 0.17 points (3–5); using stairs, 9.21 ± 0.18 (range, 8–10); squatting, 4.67 ± 0.08 (range, 3–5); running, 9.21 ± 0.18 (range, 8–10); jumping, 9.46 ± 0.22 (range, 8–10); long stay in a sitting position with legs bent, 9.78 ± 0.11 (8–10); pain, 9.92 ± 0.07 (range, 8–10); edema, 9.57 ± 0.15 (range, 8–10).

Unstable patella was eliminated at a short term in all patients and the criterion was rated at 10.0 points. Hip muscle atrophy was rated at 4.07 ± 0.19 (3–5) with the Kujala questionnaire at a short term; limited ROM in the knee joint at a short term measured 4.28 ± 0.18 (3–5) with the total score for all criteria measuring 94.07 ± 0.92 (Table 3). Postoperative atrophy of the femoral muscles and limited flexion in the knee joint in 3 patients scored 4.92 ± 0.07 with the Kujala questionnaire at a long term period with the rest 11 criteria restored to normal values. Limp and the need for support rated 5.0 points on the Lysholm scale in all cases at a short and long terms. Joint instability was not observed at a short and long terms measuring 25.0 points. Pain was observed in 6 patients with the mean score of 21.78 ± 0.46 (range, 20–25) at a short term and 24.78 ± 0.17 (20–25) at a long term. Edema was observed in 3 patients due to synovitis and bursitis, with the outcome estimated at 9.42 ± 0.26 (range, 6–10) points at a short term and at 10.0 points at a long term due to eliminated inflammation symptoms in all patients. No pathological changes in the use of stairs were observed at a short and long term with 10.0 points; squatting scored 4.67 ± 0.08 (range, 4–5) in 3 patients at a short term and 4.85 ± 0.06 (4–5) at a long term. In this group, the overall score measured 94.3 ± 0.89 at a short term and 99.6 ± 0.18 at a long term. The average bed-day was 4.89 ± 0.33, the immobilization period was 19.7 ± 0.02 days (Table 3). The use of the method developed to treat recurrent patellar dislocations of different severity and injury to the soft tissues was practical to restore the knee joint and decrease postoperative complications in all patients.

Table 2

Outcomes of patients with recurrent patellar dislocation treated with the method offered (n = 28)

Evaluation criteria	Extent of displacement	Result				Total
		excellent	good	fair	poor	
The Kujala score, short term	1 (mild)	–	–	–	–	28 (100 %)
	2 (moderate)	3 (10.7 %)			–	
	3 (severe)	18 (64.3 %)	6 (21.4 %)	1 (3.6 %)	–	
The Kujala score, long term	1 (mild)	–	–	–	–	28 (100 %)
	2 (moderate)	3 (10.7 %)	–	–	–	
	3 (severe)	25 (89.3 %)	–	–	–	
The Lysholm Scale, short term	1 (mild)	–	–	–	–	28 (100 %)
	2 (moderate)	3 (10.7 %)	–	–	–	
	3 (severe)	16 (57.2 %)	9 (32.1 %)	–	–	
The Lysholm Scale, long term	1 (mild)	–	–	–	–	28 (100 %)
	2 (moderate)	3 (10.7 %)	–	–	–	
	3 (severe)	25 (89.3 %)	–	–	–	

Table 3

Short- and long-term results of the treatment of recurrent patellar dislocation using the Kujala and the Lysholm scale

	Kujala score		Lysholm scale	
	Short term	Long term	Short term	Long term
Limp	5	5	5	5
Need for support (patella, tape, brace)	4.78 ± 0.11	5		
Walk	4.07 ± 0.19	5		
Use of stairs	9.21 ± 0.18	10	10	10
Sqatting	4.67 ± 0.08	5		
Running	9.21 ± 0.18	10		
Jumping	9.46 ± 0.22	10		
Long stay in a sitting position with legs bent	9.78 ± 0.11	10	4.67 ± 0.08	4.85 ± 0.06
Pain	9.92 ± 0.07	10	21.78 ± 0.46	24.78 ± 0.17
Edema	9.57 ± 0.15	10		
Unstable patella (dislocation)	10	10		
Atrophy of femoral muscles	4.07 ± 0.19	4.92 ± 0.07		
Limited flexion	4.28 ± 0.18	4.92 ± 0.07		
Use of additional means of support			5	5
Locking			13.57 ± 0.43	15
Unstable joint			25	25
Swelling of the joint			9.42 ± 0.26	10
Total score	94.07 ± 0.92	99.8 ± 0.09	94.3 ± 0.89	99.6 ± 0.18
Bed/day	4.89 ± 0.33			
Immobilization period	19.7 ± 0.22			

Clinical example Female patient K., born in 1998, was admitted to the hospital on October 10, 2016 and discharged on October 13, 2016. She presented with dislocation of the left patella in the last 5–6 months due to a fall on the street. The patient could adjust the patella on her own 15–20 times and was diagnosed with recurrent dislocation of the left patella, secondary synovitis and admitted to the Sports Injury Department of the RSSPMCTO of the Ministry of Health of the Republic of Uzbekistan on October 10, 2016 for surgical treatment. MRI showed signs of injury and defect of the medial retinaculum of the patella, tendon of the lateral femoral muscle, secondary synovitis. Ultrasound of the knee joint exhibited dislocation of the left patella and lateral patellar displacement grade 3. Lateral position of the left patella was seen radiographically. Physical examination demonstrated hypermobility and lateral displacement of the left patella with no pain. Palpation of the left knee joint was painful with signs of fluctuation. Lateral patellar dislocation was seen with flexion of the left knee joint. ROM in the knee joint showed extension of 180º in the right and the left knee joints; flexion of 45º in the right knee joint, flexion of 90º in the left knee joint; range of motion was 140º on the right and 120º on the left; the circumference of the middle third of the right thigh was 47.0 cm, 46.0 cm in the middle third of the left thigh, 38.0 cm in the lower third of the right thigh, 36.5 cm in the lower third of the left thigh. The patient underwent arthroscopy of the left knee joint, autoplastic stabilization of the patella with the m. gracilis tendon using a biodegradable screw on 10/11/16. The patient was followed up for 3 days after the operation. The wound healed by primary intention. A splint was applied for 2 weeks. Physiotherapy was administered after removal of the cast. The patient could completely recover functionally, physically and radiographically at a short and long terms with no complications (Fig. 1).

Fig. 1 Patient K.: (a) preoperative AP radiological view of the knee joint; (b) preoperative appearance of the patient's knee joints; (c) preoperative radiograph of the knee joint; (d) skin incision at the site of the crow's foot to harvest the m. gracilis tendon; (e) the m. gracilis tendon graft harvested using special devices; (f) passing the graft through the patella tunnel using special instruments; (g) fixation of the tendon ends in the medial femoral epicondyle using a biodegradable screw; (h) appearance of the patient after 3 postoperative days; (i) appearance of the patient at a long term after surgery

DISCUSSION

A variety of methods offered recently by different schools to eliminate the recurrent patellar dislocation included proximalization of the tibial tubercle; release of the lateral muscle tendon retinaculum; Fulkerson osteotomy of the tibial tubercle with extensive lateral release; medialization of the tibia; osteotomy of the distal femur; fixation of an autologous graft to the femur; transfer of the ipsilateral m. gracilis tendon and reconstruction of the medial patellofemoral ligament; open wedge-shaped varus correction osteotomy of the distal femur for 20º valgus deformity of the knee. The techniques were shown to be effective in the treatment of lateral recurrent patellar dislocation in patients with a mature skeleton and severe contracture of the quadriceps femoris muscle [2–4, 7, 8, 10–13, 17, 22, 26–33]. Foreign authors reported reconstruction of

the medial patellofemoral ligament using a double-chain autograft of the m. semitendinosus sparing the femoral line with an open epiphysis, with correction of the osteotomized distal femur and soft tissue restructuring including lateral releases and providing acceptable short-term results in the treatment of patellar instability [34–37].

Authors from the Russian Scientific Center of Traumatology and Orthopedics named after Academician G.A. Ilizarov offered a method of reconstructive surgery on the extensor apparatus of the knee joint and medial displacement of the patellar tendon with a portion of the periosteum of the tibial tuberosity centering the patellar ligament along the axis and fixing it with absorbable suture material. Ilizarov external fixation was used for early patella exercising to protect the patellar tendon from stretching during knee flexion [20]. Good functional results confirmed by an electroneuromyographic examination of the muscles of the femur and the tibia were reported with the use of the Ilizarov apparatus [19]. Myofascioplastic methods without/with medial displacement of the patellar tendon depending on the extent of the lateral displacement were reported with the use of computer technology [20]. Russian authors [1, 18] reported the use of the myofascioplastic method for mild and moderate recurrent patellar dislocation without patellar tendon lateralization dissecting the fibrous capsule and tendon-ligamentous apparatus from the lateral aspect of the patella with the Friedland technique and strengthening the structures from the medial patella using the Bondarenko method. They also performed supracondylar corrective Trendelenburg osteotomy in combination with the above myofascioplastic method for mild and moderate patellar dislocation without patellar tendon lateralization in the presence of external torsion of the femur, axial deformities and flexion contracture of at least 150º [1, 18]. The authors used an original reconstructive surgery for the knee extensors with moderate and severe patellar dislocations that included dissection of the above structures from the lateral side of the patella with medial displacement of the musculus vastus lateralis and rectus muscles, without separating or cutting off the tendons, with the patellar tendon moved medially "up to alignment with the correct axis of the limb", and the tendon-ligamentous apparatus and fibrous capsule were longitudinally dissected on the medial aspect of the patella and sutured by duplicating flaps [1]. Another two types of surgical interventions reported included plastic surgery of the patellofemoral ligament in patients of the main group and transposition of the tibial tuberosity in control patients who had undergone arthroscopic examination of the involved joint [21]. Plasty of the patellofemoral ligament reconstruction was reported as an effective method and had a limited use due to dysplasia of the patellofemoral joint [21].

The authors from RNIITO named after R.R. Vreden offered a method of surgical treatment that included diagnostic arthroscopy to dissect a portion of the capsule in the lateral aspect of the knee joint and retinaculum was sutured medially with clamps applied to stabilize the patella [25]. No recurrence of patellar dislocation was observed with the use of the method in 38 patients [24]. Arthroscopic reinsertion can be used for lateral patellar dislocations, and semitendinosus or gracilis tendon graft can be employed to repair the medial patellofemoral ligament and restore the congruence of the patellofemoral joint and the biomechanics of the medial dynamic stabilizer, m. vastus medialis obliquus minimizing traumatic intervention [38, 39]. Terskov (1998) offered various surgical strategy including dissection of the lateral ligaments that would support the patella with soft tissue imbalance, bringing the high standing patella down, plastic surgery of the medial part of the knee joint capsule with aplasia of the medial portion that holds the patella depending on different symptoms in the patella imbalance syndrome [39]. S.V. Arkhipov (1985) [1] reported surgical treatment to be indicated for recurrent patellar dislocation with repeated displacements, impaired musculoskeletal function of the limb, chondromalacia of the patella stages II and III, progressive degenerative changes in the knee joint. Surgical treatments of recurrent patellar dislocation offered by different schools can result in common complications including patellar instability, repeated recurrent dislocation, arthrosis, inflammation and contractures.

The new method of surgical treatment of recurrent patellar dislocation we offered has a number of advantages demonstrated by the outcomes: patellar

fixation ensures the stability to allow soft tissues of the medial surface of the patella restore within a short period of time. The method is minimally invasive with a smaller amount of hemorrhage into the capsula articularis. The operation is sparing for the joint capsule and does not require long-term application of external fixators and allows early rehabilitation (physiotherapy, joint exercises). Patients can have early recovery. No complications were observed in patients who were treated with our method, so we can assume that the technique we developed can be considered effective.

CONCLUSION

Outcomes of surgical treatment of recurrent patellar dislocation of varying extent of displacement and injury to the soft tissue at the medial aspect of the knee joint offered and tested on a monocenter cohort demonstrated a significant restoration of the anatomy and function of the knee joint and the absence of major complications. The key aspects of the technology included a thorough preoperative planning considering the degree of displacement and injury to the soft tissues at the medial aspect of the patella, the use of arthroscopy of the knee joint, autoplasty stabilization of the patella with the m. gracilis graft and biodegradable screw. The use of the treatment technology can facilitate early rehabilitation and complete clinical and anatomical recovery of limb functions in the late postoperative period.

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