Clinical Observation of Sodium Hyaluronate Combined with Ropivacaine after Anterior Cruciate Ligament Reconstruction under Knee Arthroscopy

PENG CHEN*, DEFU YU, BIAO ZHANG AND TAO CHEN

Department of Orthopedics, Anhui No. 2 Provincial People's Hospital, Hefei, Anhui province 230000, China

The primary objective of this investigation was to assess the clinical effectiveness of utilizing sodium hyaluronate in conjunction with ropivacaine for postoperative management after arthroscopic anterior cruciate ligament reconstruction. From March 2019 to March 2021, a cohort of 150 patients with anterior cruciate ligament rupture who underwent anterior cruciate ligament reconstruction surgery were recruited for this study. The patients were randomly allocated into either the observation group or the control group, with each group comprising 75 cases. The control group received intra-articular injection of ropivacaine after surgery, while the observation group received intra-articular injection of sodium hyaluronate combined with ropivacaine after surgery. A comparative analysis was performed to compare the Lysholm knee score, visual analogue scale score, and the levels of tumor necrosis factor-alpha and interleukin-1 beta in joint fluid between the observation group and the control group. The observation group demonstrated a higher overall effective rate (93.3 %) compared to the control group (86.7 %), with statistical significance ($p<0.05$). No significant differences were found in preoperative Lysholm score, visual analogue scale score and joint fluid parameters between groups. The observation group showed significant improvements compared to the control group, as shown by a higher postoperative Lysholm score, lower visual analogue scale score ($p<0.05$) and reduced levels of inflammatory markers in joint fluid ($p<0.05$). Sodium hyaluronate combined with ropivacaine after anterior cruciate ligament reconstruction surgery under arthroscopy can promote knee joint function recovery, alleviate postoperative pain, suppress oxidative and inflammatory stress in the joint, and contribute to improving patient prognosis.

Key words: Anterior cruciate ligament reconstruction, sodium hyaluronate, ropivacaine, joint function recovery, arthritis

Anterior Cruciate Ligament (ACL) injuries, which are commonly seen in various knee joint injuries, have become more prevalent due to rapid economic development and an improved standard of living. A key function of the ACL is to maintain anterior stability in the knee joint[1]. When the ACL is injured, it can cause joint instability, leading to damage of the cartilage and meniscus within the joint. Over time, this can progress to post-traumatic arthritis. Arthroscopic ACL reconstruction, known for its minimally invasive nature, reduced pain, and fast recovery, is widely adopted for the treatment of ACL injuries[2]. However, after ACL reconstruction surgery, patients often experience varying degrees of pain, sometimes accompanied by joint effusion or even bleeding. In severe cases, joint adhesion may occur, delaying the recovery of joint function[3]. In order to alleviate pain, intra-articular injection of ropivacaine after ACL surgery has been reported. It has also been reported that injection of sodium hyaluronate can significantly reduce pain and complications. However, studies on the combined use of these two interventions are currently limited. Henceforth, the main aim of this research was to assess the efficacy of sodium hyaluronate combined with ropivacaine in postoperative care following arthroscopic ACL reconstruction, thus offering valuable insights for the treatment of ACL reconstruction[4]. The study population consisted of 150 patients who underwent ACL reconstruction surgery using arthroscopy at our hospital from March 2019 to March 2021. Inclusion criteria including the

***Address for correspondence**
E-mail: woshicpjiayou@163.com

patients diagnosed with knee joint ACL injury according to diagnostic criteria[5]; patients with indications for surgery and patients who were conscious, and able to cooperate and provide informed consent. Exclusion criteria have the patients with severe malnutrition, osteoporosis, or pathologic fractures; individuals with notable heart, liver or kidney ailments and patients who had recently received intra-articular drug injections. Through the use of a random number table, the participants were allocated into the control (n=75) and observation group (n=75). 41 male and 34 female participants were involved in observation group, with an average age of (38.13±7.82) y. Among them, 24 cases were attributed to traffic accidents, 31 cases by sports injuries, and 20 cases by other injuries. There were 27 cases of left knee injuries and 48 cases of right knee injuries. The control group comprised 43 males and 32 females, with an average age of (40.64±9.21) y. Among them, 25 cases were caused by traffic accidents, 35 cases by sports injuries, and 15 cases by other injuries. There were 30 cases of left knee injuries and 45 cases of right knee injuries. Baseline characteristics showed no significant differences between groups ($p>0.05$), indicating comparability. This research was conducted with approval of the hospital ethics committee. During the ACL reconstruction surgery, the patient is set in a supine position and receives combined spinal-epidural anesthesia. After ensuring satisfactory anesthesia, a tourniquet is used to maintain a bloodless field. Arthroscopy is performed through an anterolateral portal to assess the extent of the injury. Based on the patient's preferences, the autologous hamstring tendon is selected as the graft material. The graft is fixed using a Schuhli-Endobutton at the femoral end and an Anthrax interference Screw Polyetheretherketone (PEEK) screw at the tibial end. The incisions are sutured, and the puncture point below the patella medially is selected. In the control group, 10 ml of 0.5 % ropivacaine is injected intra-articular, whereas in the observation group, 50 mg (5 ml) of sodium hyaluronate and 10 ml of 0.5 % ropivacaine are injected into the joint cavity. The knee joint is flexed and extended appropriately to ensure the even distribution of the drugs within the joint, followed by compression bandaging. Patients return for a follow-up examination after 4 w of treatment. Clinical efficacy has the following criteria which includes; significant improvement when the Lysholm knee score increased by more than 60 %; effective when the Lysholm knee score increased by 25 % to 60 % and ineffective when the Lysholm knee score increased by <25 %[6]. Comparison of inflammatory markers in joint fluid including the Tumor Necrosis Factor-Alpha (TNF-α) and Interleukin-1 Beta (IL-1β). Comparison of knee joint function recovery and postoperative pain assessment based on the Lysholm knee score standard and the Visual Analogue Scale (VAS) score standard[7,8]. Mean±standard deviation (x±s) will be used to represent the quantitative data and independent sample t-tests will be conducted to compare the data between groups. Within-group comparisons will be conducted using paired-sample t-tests. Percentage (%) will be used to present the results of categorical data, and Chi-square (χ^2) tests will be applied for analysis. Statistical significance will be determined by $p<0.05$. At the 4 w postoperative mark, the observation group exhibited an overall effective rate of 93.3 %, while the control group had an overall effective rate of 86.7 %, demonstrating a statistically significant difference ($p<0.05$) as shown in Table 1. No statistically significant differences in IL-1β and TNF-α levels in joint fluid were observed before surgery ($p>0.05$). However, after 4 w following the surgery, the observation group displayed significantly decreased levels of IL-1β and TNF-α compared to the control group, reflecting statistically significant differences ($p<0.05$) as shown in Table 2. Prior to surgery, no statistical differences were found in Lysholm knee score and VAS score between groups ($p>0.05$). However, after 4 w postoperatively, the observation group displayed a significant improvement in Lysholm score compared to the control group, with a statistical difference ($p<0.05$). Moreover, the VAS score in the observation group significantly decreased in comparison to the control group, indicating a statistically significant difference ($p<0.05$) as shown in Table 3. ACL is crucial for maintaining knee joint stability. When this ligament is damaged or torn, it disrupts the knee joint's stability and can result in post-traumatic arthritis. In severe cases, it can lead to disability and significantly affect a patient's quality of life[9]. Arthroscopic ACL reconstruction is the main treatment approach for ACL injuries, offering advantages such as minimally invasive surgery and rapid recovery. It restores knee joint stability and kinematics, preventing the development of degenerative arthritis, and is widely adopted[10]. However, after ACL reconstruction surgery, patients often experience pain to varying

degrees, which can delay postoperative rehabilitation and functional recovery and lead to complications such as joint fibrous adhesion, stiffness, and recurrent intra-articular bleeding[11]. Intra-articular injection of ropivacaine is a common method for postoperative pain management after ACL surgery. Additionally, studies have shown that the exogenous supplementation of sodium hyaluronate can enhance therapeutic efficacy[12]. The main aim of this research was to evaluate the efficacy of sodium hyaluronate combined with ropivacaine in postoperative care following arthroscopic ACL reconstruction. The study findings revealed that the observation group showed a higher overall effective rate than the control group. Patients in the observation group also exhibited significantly higher postoperative Lysholm knee scores compared to the control group. These results suggested that the intra-articular injection of sodium hyaluronate combined with ropivacaine contributed to the improvement of knee joint function after ACL surgery. This finding is in line with a study conducted by Jiang *et al.*[13]. Intra-articular injection of sodium hyaluronate can alter the properties of synovial fluid, lubricate the joint, reduce tissue friction, and protect the articular cartilage. Hence, it is of paramount importance in the rehabilitation process following ACL reconstruction. The VAS scores in the observation group were significantly lower than those in the control group, suggesting that the intra-articular injection of sodium hyaluronate combined with ropivacaine aided in relieving postoperative pain. Ropivacaine inhibits sodium channels, blocks the conduction mechanism of nerve cells, and provides analgesia by blocking peripheral nerves. It also has anti-inflammatory effects, reducing inflammatory pain[14]. Sodium hyaluronate can cover the pain receptors, interact with pain mediators, and relieve pain[15]. The combination of sodium hyaluronate and ropivacaine after ACL surgery can enhance the diffusion and speed of ropivacaine, prolong the analgesic duration, and achieve better pain control. The tissue injury caused by ACL reconstruction surgery triggers oxidative and inflammatory stress, leading to an increased expression of inflammatory factors. This excessive expression can harm the cartilage matrix and impede the repair process. At the 4 w mark following the surgery, the observation group exhibited a notably reduction in the levels of IL-1β and TNF-α in the joint fluid compared to the control group. These results align with previous studies[16]. This demonstrates the important role of sodium hyaluronate in reducing inflammatory responses, altering the physicochemical properties of the joint fluid, and delaying the diffusion of inflammatory factors. In summary, for patients with ACL injury, intra-articular injection of sodium hyaluronate combined with ropivacaine after ACL reconstruction under arthroscopy is an effective treatment approach. This treatment can promote knee joint function recovery, alleviate oxidative and inflammatory stress reactions in the knee joint, and provide better pain control. It has significant clinical value in the management of ACL injuries.

TABLE 1: COMPARISON OF CLINICAL EFFICACY (RATE, %)

Group	Significant	Effective	Invalid	Overall effective rate
Observation	46 (61.3)	24 (32.0)	5 (6.7)	70 (93.3)[a]
Control	42 (56.0)	23 (30.7)	10 (13.3)	65 (86.7)

Note: Compared with control group, [a]p<0.05

TABLE 2: COMPARISON OF INFLAMMATORY INDICATORS OF JOINT FLUID (x±s)

Group	Time	IL-1β (ng/l)	TNF-α (ng/l)
Observation	Before	4.8±2.1	2.8±0.4
	After	1.6±0.6[a]	0.9±0.5[a]
Control	Before	4.5±1.4	2.6±0.3
	After	2.6±1.0[ab]	1.6±0.7[ab]

Note: Compared with before treatment within the group, [a]p<0.05 and comparison between groups, [b]p<0.05

TABLE 3: COMPARISON OF LYSHOLM SCORE AND VAS PAIN SCORE (x±s)

Group	Time	Lysholm scores (point)	VAS scores (point)
Observation	Before	48.2±8.8	7.0±1.4
	After	76.1±10.2[a]	1.9±0.7[a]
Control	Before	45.6±9.2	6.5±1.5
	After	63.2±11.3[ab]	3.7±1.2[ab]

Note: Compared with before treatment within the group, [a]p<0.05 and comparison between groups, [b]p<0.05

Conflict of interests:

The authors declared no conflict of interests.

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