

The intra-articular use of an hemostatic and non-adherent bicomponent for pain control, hemarthrosis, and knee range of motion after anterior cruciate ligament reconstruction

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RESUMEN

Introducción: las complicaciones en el postoperatorio reciente de la reconstrucción del ligamento cruzado anterior (LCA) son frecuentes. Entre estas: dolor, hemartrosis y dificultad para realizar el movimiento de flexión-extensión de rodilla. El objetivo de este trabajo es evaluar el uso del bicomponente carboximetilcelulosa-polisacárido B intraarticular poco después de la reconstrucción del ligamento cruzado anterior y comparar los resultados obtenidos para el control del dolor, la hemartrosis y la ganancia de movimiento de la rodilla con un grupo de control.

Materiales y métodos: ensayo clínico aleatorizado y prospectivo de treinta y dos pacientes divididos en dos grupos: reconstrucción del ligamento cruzado anterior con inyección intraarticular de un bicomponente carboximetilcelulosa-polisacárido B (n = 16) y sin el bicomponente (n = 16). El dolor, la hemartrosis y la amplitud de movimiento de la rodilla se evaluaron en la primera semana postoperatoria.

Resultados: el grupo de intervención (con bicomponente) presentó menos dolor al tercer (p = 0.017) y quinto (p = 0.029) día postoperatorio en comparación con el grupo control. La hemartrosis fue significativamente menor en el primer día postoperatorio (p = 0.001), y hubo una mejora significativa en el rango de movimiento en el séptimo día de la cirugía (p = 0.008) en este mismo grupo.

Conclusión: el uso de carboximetilcelulosa-polisacárido B intraarticular mostró resultados superiores para el control del dolor, la hemartrosis y la ganancia de movimiento de la rodilla en el período postoperatorio reciente (hasta siete días) después de la reconstrucción del LCA, en comparación con los pacientes del grupo control.

ABSTRACT

Introduction: complications in the recent postoperative period of anterior cruciate ligament reconstruction are common. Among them, pain, hemarthrosis, and difficulty of complete range of motion. The purpose of this study is to evaluate the use of the intra-articular carboxymethylcellulose – polysaccharide B bicomponent shortly after anterior cruciate ligament reconstruction, and to compare the results obtained for pain control, hemarthrosis, and knee range of motion with a control group.

Materials and methods: randomized, and prospective clinical trial of thirty-two patients divided into two groups: reconstruction of the anterior cruciate ligament with an intra-articular injection of a bicomponent carboxymethylcellulose-polysaccharide B (n = 16) and without the bicomponent (n = 16). Pain, hemarthrosis and knee range of motion were evaluated in the first postoperative week.

Results: the group with bicomponent presented less pain on the third (p = 0.017) and fifth (p = 0.029) postoperative day when compared to the control group. Hemarthrosis was significantly lower on the first postoperative day (p = 0.001), and there was a significant improvement in the range of motion on the seventh day of surgery (p = 0.008) in this same group.

Conclusions: the use of intra-articular carboxymethylcellulose-polysaccharide B showed superior results for pain control, hemarthrosis, and gain in the knee range of motion in the recent postoperative period (up to seven days) after anterior cruciate ligament reconstruction, when compared to patients from the control group.

INTRODUCTION

Anterior cruciate ligament (ACL) injury is frequent and causes instability, pain, and functional disability in the knee.¹ In general, arthroscopic reconstruction is chosen as the first choice.² Bone and soft tissues manipulation and use of saline to expand the joint to improve arthroscopic visibility can result in symptoms in the immediate postoperative period.¹⁻³

The incidence of postoperative complications can occur in up to 15% of patients. The most common are pain, he-

marthrosis, and arthrofibrosis.⁴ Hemarthrosis disrupts chondrocyte and extracellular matrix homeostasis, which can intensify pain and delay knee rehabilitation.^{5, 6} Arthrofibrosis is the result of the appearance of fibrotic adhesions. Adhesions are defined as abnormal fibrous connections between adjacent parts or structures of the body.⁷ Simple surgical manipulation of the knee can be considered a primary cause for the adhesion formation.^{8, 9}

There is no direct correlation between the patient and the possibility of preventing these symptoms. The bicomponent of specific proportion carboxymethylcellulose-polysaccharide B is a natural product that acts as a hemostatic and as a non-stick barrier. Carboxymethylcellulose is a product derived from cellulose with low molecular weight

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Recibido: Abril de 2021. Aceptado: Abril de 2021.

and highly soluble in water.¹⁰ The main function is to control adhesions and fibrosis through the formation of a film that mechanically isolates contiguous tissues, acting as an agent of scar reorganization. When crosslinking with the polysaccharide B, it is also able to act as a natural hemostatic, controlling local bleeding through the chemical integration between the hydrophilic particles of the polysaccharide and the blood cells. The proper combination of these two components allows carboxymethylcellulose to be absorbed quickly by enzymes in the human body, limiting its time of action. At the same time, the vegetable polysaccharide has a prolonged action, acting as an hemostatic agent for approximately forty days.¹⁰⁻¹²

The hypothesis of the study is that the use of this bi-component in the knee joint during ACL reconstruction, may help to control some of the usual complications of the early postoperative period. The purpose of the study is to evaluate pain, hemarthrosis, and range of motion of the knee in the first seven days after ACL reconstruction, through a randomized clinical trial, comparing a control group with that in which the bicomponent was used.

MATERIALS AND METHODS

This is a randomized, prospective clinical trial with thirty-two patients undergoing ACL reconstruction surgery. This study was evaluated and approved by the Ethics and Research Committee of this institution and registered in the Brazilian Registry of Clinical Trial. All patients signed an informed consent form.

Inclusion criteria were patients between eighteen and forty-five years old with isolated ACL injury submitted to anatomical reconstruction using quadruple hamstring tendons autograft, femoral fixation with cortical button and interference screw on the tibia. The exclusion criteria were patients with other injuries or previous surgery on the same knee, active infectious processes, autoimmune or systemic diseases, patient with previous coagulopathy and those who did not agree to participate in the study.

Patients were evaluated by physical examination (Lachman maneuver, anterior drawer test, and Pivot-shift test) and magnetic resonance imaging (MRI). With ACL injury confirmed, and fulfilling the inclusion criteria, patients were randomized using sealed envelopes.

Patients were included in two groups: Group 1 (n=16) - ligament reconstruction was performed without adding the anti-adherent barrier; and Group 2 (n = 16) - use of intra-articular carboxymethylcellulose-polysaccharide B bicomponent immediately after ligament reconstruction. All patients were operated on by the same surgeon (RMC), who knew which group each patient belonged to. However, the study was blind to the patient and the physician

who assessed and collected postoperative information.

Clinical and surgical protocol

All patients underwent spinal anesthesia, using a tourniquet with a pressure of 300 mm of mercury in the proximal region of the thigh during the entire surgical procedure. A 2-3 cm incision was made in the anteromedial region of the tibia for hamstrings tendons graft resection. After removal, a quadruple graft assembly was performed. The anatomical reconstruction was done with the completion of the femoral tunnel through the anteromedial portal. Incisions was sutured by planes, followed by a dressing. All patients was treated with diclofenac sodium (50 mg 8/8 hours for five days) and dipyron (500 mg 6/6 hours for seven days). All patients were discharged on the second postoperative day.

Bicomponent carboxymethylcellulose-polysaccharide B preparation

At the end of the ligament reconstruction, the pneumatic tourniquet was deflated and removed. Using a vacuum cleaner, the joint was aspirated and the incisions were sutured, except for the anterolateral portal. Through this portal, the surgeon introduced 5 ml from the bicomponent carboxymethylcellulose-polysaccharide B (Adhesionã, DMC, São Carlos, Brazil), in the selected patients from Group 1 (n = 16) followed by suturing the portal (fig. 1).

Clinical evaluations

All patients were examined and asked for the variables analyzed during the first seven postoperative days: in the first two days, still hospitalized, and in the subsequent ones by telephone contact, or during evaluation at the office. Three parameters were analyzed:

1. Pain: using the visual analogue pain scale (VAS),¹³ the patient was asked on the first (in the hospital), third (phone), fifth (phone) and seventh (at the office) postoperative days (fig. 2).
2. Hemarthrosis: the Cupens and Yates¹⁴ classification was used to measure hemarthrosis, applied on the first and seventh postoperative days (in the office) (Table 1).
3. Active range of motion (ROM) (difference between maximum flexion and maximum knee extension without external force) postoperatively. We evaluated in the hospital during the first day and in the office in the seventh day after surgery. ROM was measured with the patient in the supine position using a goniometer attached to the lateral epicondyle of the femur. The proximal arm of the goniometer was aligned with the midline of the femur, and as a reference the great trochanter. The distal arm was aligned with the fibula with the lateral malleolus as a reference.

Rehabilitation protocol

All patients underwent the same rehabilitation program. During the first week, the main purpose was to control joint effusion and edema, control pain and increase ROM up to 90°, through passive and active flexion and hyperextension exercises, patella mobilization, quadriceps strength gain with contraction isometric, ankle flexion and extension exercises to activate the sural triceps musculature.

Statistical analysis

Parametric statistical tests were used to assess pain, hemarthrosis, and ROM because the data are quantitative and continuous. In addition, we have a sample of more than thirty subjects, which by the Central Limit Theorem, ensures that the distribution tends to a normal distribution. To analyze and compare the variables pain, edema, and ROM, the t-student test was used. The sample calculation was performed to obtain 80% power and 95% significance. A loss of 10% of the sample was also considered. Finally, the expected N was thirty-two patients. The significance level was 5%.

RESULTS

The mean age was 30.1 years (min and max: 18-45 SD: 5.1). Demographic patient data can be visualized in Table 2.

Patients from Group 2 (with bicomponent introduction after ACL reconstruction) had less pain on the third ($p = 0.017$) and fifth ($p = 0.029$) postoperative day when compared to the control group (Table 3).

Patients in Group 2 showed a significant difference in the measurement of hemarthrosis after one day of surgery when compared to patients in Group 1. According to the used classification, the average was 3.19 for patients in Group 1, and 2.27 for patients in Group 2 ($p = 0.001$) (Table 4).

There was also an improvement in ROM in patients in Group 2 higher than patients in Group 1 after seven days of surgery ($p = 0.008$). The average ROM of patients in Group 2 after seven days was 94.9°, while the average of patients in Group 1 was 73.1° (Table 5).

Patients did not present other complications during the evaluated seven days after surgery. The presence of infection at the incision site, pioarthritis, and thromboembolic phenomena was evaluated, with no recorded cases.

DISCUSSION

The carboxymethylcellulose-polysaccharide B bicomponent was effective in controlling pain, improving range of



Figure 1: Bicomponent introduction into the knee joint after ACL reconstruction surgery. It is a syringe attached to a plastic cannula. The viscous content was fully introduced through this arthroscopic portal.

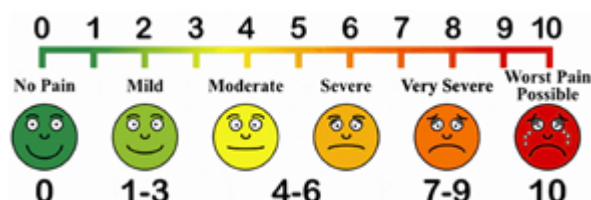


Figure 2: Visual Analog Scale. Through numbers, the patient responds subjectively to the pain corresponding to the moment evaluated.

TABLE 1. CUPENS AND YATES CLASSIFICATION FOR HEMARTHROSIS

Grade	Description
0	There is no detectable fluid
1	Presence of fluid with fluid wave
2	Palpable fluid in the supra patellar space
3	Balloon-shaped patella
4	Tense effusion

Although quite subjective, this classification allows measuring the severity of hemarthrosis inside the joint.

TABLE 2. GENERAL DATA INFORMATION

Variables	n (%)	p
Sex		$p < 0.05$
Male	23 (71%)	
Female	9 (29%)	
Laterality		$p > 0.05$
Right	19 (59%)	
Left	13 (41%)	
Age (Mean (min-max))	30.1 (18-45)	0.19

Data from all included patients, according to sex, age and knee side. Min: minimum; max: maximum.

motion and decreasing hemarthrosis in the early postoperative days after ACL reconstruction surgery.

ACL reconstruction surgery notably generates postoperative pain and discomfort which, ultimately, can lead to delay the beginning of rehabilitation and harmful futu-

TABLE 3. PAIN MEASURED IN PATIENTS FROM GROUPS 1 AND 2 OVER THE DAYS

	Pain	Average	Median	Standard Deviation	Min	Max	N	CI	P-value
Day 1	Group 1	5.31	7	3.03	0	9	16	1.48	0.242
	Group 2	4.33	4	0.98	3	6	15	0.49	
Day 3	Group 1	4.88	5	1.89	2	8	16	0.93	0.017
	Group 2	3.53	3	0.83	2	5	15	0.42	
Day 5	Group 1	3.75	3.5	1.73	1	7	16	0.85	0.029
	Group 2	2.53	2	1.13	1	4	15	0.57	
Day 7	Group 1	3	3	1.59	0	6	16	0.78	0.075
	Group 2	2	2	1.41	0	4	15	0.72	

There was an improvement in pain in Group 2 greater than the improvement in Group 1 after the third and fifth days of surgery. Min: Minimum; Max: maximum; N: number; CI: Confidence Interval.

TABLE 4. HEMARTHROSIS EVALUATION

	Hemarthrosis	Average	Median	Standard Deviation	Min	Max	N	CI	P-value
Day 1	Group 1	3.19	3	0.75	2	4	16	0.37	0.001
	Group 2	2.27	2	0.7	1	3	15	0.36	
Day 7	Group 1	1.69	2	0.95	0	3	16	0.46	0.332
	Group 2	1.4	1	0.63	0	2	15	0.32	

TABLE 5. ROM COMPARISON IN PATIENTS FROM BOTH GROUPS

	ROM	Average	Median	Standard Deviation	Min	Max	N	CI	P-value
Day 1	Group 1	55.3	47.5	33.8	0	115	16	16.6	0.337
	Group 2	65	70	18.8	30	90	15	9.5	
Day 7	Group 1	73.1	77.5	28.1	15	110	16	13.8	0.008
	Group 2	94.9	95	9	75	110	15	4.6	

ROM comparison in patients from both groups after one and seven days of surgery. There was an increase in ROM in Group 2 higher than in Group 1 after seven days of surgery ($p = 0.008$). Min: Minimum; Max: maximum; N: number; CI: Confidence Interval. ROM: range of motion.

re consequences.¹⁵ Perioperative and rehabilitation pain is also related to the appearance of arthrofibrosis, as demonstrated by Bosh et al.^{16,17} This is due to the inflammatory response generated by it and the consequent stimulation of fibrocytes. The present study evaluated the effect of the tested product on pain improvement in an immediate postoperative period (first, third, fifth and seventh day), using the visual analog scale. On the third and fifth day, there was a statistically significant improvement in pain compared to the control group.

Another quite common complication in the postoperative period of ACL reconstruction is hemarthrosis. In the carboxymethylcellulose-polysaccharide B component, the polysaccharide B is a natural hemostatic. For this reason, we believed that postoperative hemarthrosis would suffer a reduction in relation to the control group. In fact, on the first day after surgery, the reduction in hemarthrosis was significantly higher. Modified starch (polysaccharide B) has a hydrophilic function, and thus concentrates a high concentration of platelets, thrombin, fibrinogen and other proteins on the surface, accelerating the cascade and

healing and promoting more efficient hemostasis.¹⁸ Several methods have already been tested to decrease hemarthrosis. Many authors believed that the use of the closed drain would reduce postoperative pain and edema. However, Clifton et al., in a systematic review, demonstrated that there is no benefit from this practice.¹⁹ Tranexamic acid has also been used as an alternative to reduce the discomfort of patients undergoing this surgery. However, this procedure is not without risks. Patients must be selected correctly, excluding, for example, patients with previous thrombotic events.²⁰

Carboxymethylcellulose acts as a mechanical barrier, isolating the tissues from each other and, thus, reducing the chance of forming adhesions.²¹ The association of carboxymethylcellulose with hyaluronic acid (AH-CMC) has been used in an increasing number of abdominal surgeries such as hysterectomy and colectomy.²² A large number of studies have examined the effectiveness of AH-CMC in preventing adhesions in the past decade. Randomized studies and meta-analyses suggested that AH-CMC may reduce the risk of postoperative adhe-

sions.^{22, 23} In the knee, Kong et al.¹¹ evaluated thirty-one patients who underwent bilateral prosthesis, using AH-CMC in one of the knees. Although no healing or infection problem was found in the group submitted to the product, there was also no improvement in range of motion and pain compared to the control group.

We did not find in the literature the association of carboxymethylcellulose-polysaccharide B being used in the intra-articular knee to decrease pain, hemarthrosis, or ROM gain. A recently published study tested the bicomponent after removing hamstring grafts for ACL reconstruction. The result was satisfactory both in improving the range of motion and in relation to the edema generated at the site in a recent postoperative period.²⁴ This work corroborates our findings and the fact that the non-stick barrier and hemostatic function of the bicomponent are beneficial for a newly operated knee, when combined in a crosslinking reaction between these substances.

The main limitations of this study were the number of

evaluated patients, and the importance to evaluate a long term follow-up. In addition, there is only one registered trademark with this combination, which made it impossible for us to carry out other analyzes, or even the comparison between them.

CONCLUSION

The use of intra-articular carboxymethylcellulose-polysaccharide B showed superior results for pain control, hemarthrosis, and knee movement gain in the recent postoperative period (up to seven days) after anterior cruciate ligament reconstruction, when compared to patients from the control group.

We declare that there was no conflict of interest since the product was donated by the company DMC - Importação Ltda.

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