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Gianluca Camillieri
Fabrizio Margheritini
Gaetano Maresca
Pier Paolo Mariani

Postoperative bleeding following notchplasty in anterior cruciate ligament reconstruction: thermal radio frequency versus powered instrumentation

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G. Camillieri (✉) · F. Margheritini
G. Maresca · P. P. Mariani
Laboratory of Arthroscopy
and Joint Surgery,
Villa Stuart, Via Trionfale 5952,
Rome 00135, Italy

G. Camillieri · F. Margheritini
P. P. Mariani
University of Motor Science,
Department of Sports Traumatology,
P.zale Lauro de Bosis 15,
Rome 00100, Italy

Abstract This study compared postoperative bleeding during anterior cruciate ligament (ACL) reconstruction following notchplasty by power instrumentation with that following radiofrequency. Between January 1998 and April 1998 we prospectively divided 24 consecutive patients undergoing arthroscopic ACL reconstruction with bone-patellar tendon-bone autograft into two groups. Notchplasty was performed by powered instrumentation in group A (n=12) and by radiofrequency in group B (n=12). Two Redi-Vac suction drains were placed, one intra-articularly and the other subcutaneously at the harvest site and tibial tunnel. All drains were removed 48 h postoperatively. The first drainage measurement (end of surgery, 6 a.m. postoperative day 1) showed average total bleeding of 124.16 cc in group A and 65.41 cc in group B (P<0.001); per hour this was 10.21 cc in group A and 5.49 cc in group B (P<0.001). The second drainage measurement (6 a.m. postoperative day 2) showed average total bleeding of 44.55 cc in group A and 17.78 cc in group B (P<0.01); per hour this was 1.85 cc in group A and 0.74 cc in group B (P<0.001). Radiofrequency technology can be used when performing intercondylar notchplasty in ACL reconstruction. As a result of this technique postoperative intra-articular bleeding was significantly reduced.

Keywords Knee · Anterior cruciate ligament · Notchplasty · Bleeding

Introduction

Radiofrequency (RF) has been applied to many aspects of medical discipline, especially during the past 10 years. In orthopedics this new technology, which takes advantage of the RF thermal effect in denaturing proteins [1, 5], has been used mainly in shoulder arthroscopy. Several reports have been published on the treatment of multidirectional instability with capsular shrinkage as well as RF surgery of the subacromial space [1, 8, 10, 13, 14]. In knee surgery RF has been proposed for use in meniscal tears, treatment of cartilaginous lesions, lateral release, synoviectomy, and ligament reconstruction. In ACL surgery notchplasty [3, 6, 9, 12] is a well established and accepted technique for avoiding graft impingement. Bleeding which occurs during this procedure may cause complications such as hemarthrosis [16], postoperative pain, reduced range of motion, and increased infection. Reduced bleeding by RF notchplasty may play a preventive role on the over cited complications.

The efficacy and safety of RF notchplasty has not been previously reported, and the aim of our double-blind randomized study was to assess bleeding after notchplasty with powered instrumentation versus RF in ACL reconstruction.

Materials and methods

Between January 1998 and April 1998 we prospectively studied patients undergoing arthroscopic ACL reconstruction with bone-patellar tendon-bone autograft. The 24 consecutive patients (9 women, 15 men; mean age 24 years, 18–32) were randomized to receive notchplasty by with powered instrumentation (group A, *n*=12) or by bipolar RF (group B, *n*=12). Inclusion criteria consisted of the presence of an isolated chronic ACL lesion, the use of epidural anesthesia and the same postoperative analgesic medication. Exclusion criteria were the presence of an perioperative cartilaginous and/or meniscal lesion, a previously diagnosed blood disease, and the use of preoperative coagulation-interfering drugs.

One Redi-Vac suction drain was placed intra-articularly and one subcutaneously at the graft harvest site and tibial tunnel surface. All drains were removed about 36 h postoperatively when passive range of motion was started. The amount of drainage was measured and recorded at 6 a.m. on the first and second postoperative days. Epidural anesthesia was used in both groups and continued 24 h postoperatively for pain. A tourniquet was inflated to 250 mmHg preoperatively and released prior to wound closure for cauterization of any bleeding vessels. An identical ACL reconstruction technique was performed by the same surgeon (P.P.M.) in all cases. Notchplasty was performed on the roof and lateral aspect of the notch in both groups. In group A notchplasty used a motorized shaver (4.5 and 5.5) and custom-curved rasp. In group B an RF electrode was used (VAPR, Mitek, Ethicon), with a monopolar RF current of 340–450 kHz.

A soft compression bandage was applied before placing the limb in a postoperative brace. All patients received paracetamol-caffeine daily for analgesia; no other analgesics were given. The two groups had the same diet for the 2 days. Antithrombotic prophylaxis with 4000 IU enoxaparin (Clexane) was given subcutaneously 5 h preoperatively and for 3 days postoperatively.

Statistical analysis was performed with the Primer program for PC. Differences were compared using Student's *t* test, variance analysis, and regression analysis. A *P* value less than 0.05 was considered significant.

Results

Average tourniquet time was 38 min (range 32–43) in group A and 38.22 min (range 33–43) in group B. The average time from the end of surgery to the first drainage measurement (the morning of postoperative day 1) was 12 h 16 min±2 h 4 min (range 9 h 50–15 h 50 min) in group A and 11 h 54 min±2 h 49 min (range 8 h 50 min–16 h) in group B (NS). Mean drainage to the first measurement was 124.16 cc in group A and 65.41 in group B ($P<0.001$), i.e., 10.21 cc/h in group A and 5.49 cc/h in group B ($P<0.001$; Table 1). The period between the first and second drainage measurements (performed on postoperative day 2) was 24 h. Mean drainage at the second measurement was 44.55 cc in group A and 17.78 in group B ($P<0.01$), i.e., 1.85 cc/h in group A and 0.74 cc/h in group B $P<0.001$ (Table 1). There was no swelling, suture dehiscence, wound leakage, or complications due to the presence of drains in either group. No differences in range of motion exited 2 weeks postoperatively when sutures were removed or 1 month postoperatively.

Discussion

Postoperative hemarthrosis may have several negative effects after ACL reconstruction, including articular cartilage damage, synovitis associated with persistent postoperative pain, and intra-articular fibrosis, which may cause a decreased range of motion [17]. After ACL reconstruction using the patellar tendon, full knee range of motion is preferable. The presence of blood within the joint, particularly anteriorly, may produce increased and painful tension, especially during knee flexion. It is for this reason that the use of postoperative suction drains following joint procedures is well established [2, 4, 11, 15, 19, 20]. Cartilaginous and soft-tissue procedures, tunnel creation, and intercondylar notchplasty may cause intra-articular bleeding during ACL reconstruction, but bleeding is principally due to bleeding of cancellous bone.

The importance of intercondylar notchplasty [3, 6, 9, 12] is well supported in the literature. The absence of or an insufficient notchplasty may cause impingement of the graft in the roof area during extension, especially if the intra-articular emergency of the tibial tunnel is anterior as well. In other cases, contact between the lateral border of the notch and graft may cause rupturing of the new ACL. In ACL reconstruction the area involved in the lateral aspect of the notch and the roof is approximately 6–9 cm^2 wide. Intercondylar notchplasty is usually performed using powered instrumentation, such as shavers, burrs, or manual instrumentation, such as curettes and scalpels. This technique causes substantial bleeding and requires the use of a water pump or tourniquet to maintain a clear intra-articular view.

Research on new methods for reducing bleeding during arthroscopic notchplasty has led to a new tool for cauterizing, scarring, and shrinking soft tissues, especially in shoulder arthroscopy. This technology exploits the ability of bipolar RF energy to denature proteins. This process is accomplished by the thermal effect of the RF bipolar electrode on biological tissue [1, 5, 7, 8], in which heat progressively breaks the amino acid collagen bonds and reorganizes its structure with loss of volume and elicoidal shape. This effect is known as shrinkage, but if the electrode continues to produce heat, the proteins are totally

Table 1 Total and hourly bleeding during the first measurement period (end of surgery to 6 a.m. on postoperative day 1) and second measurement period (6 a.m. on postoperative day 1 to 6 a.m. on postoperative day 2; $P<0.001$)

	Total bleeding (cc)		Hourly bleeding (cc/h)	
	Group A	Group B	Group A	Group B
First period				
Mean±SD	124.2±40.8	65.4±29.7	10.2±3.2	5.5±2.5
Range	80–230	5–110	6.7–17.7	0.6–10.3
Second period				
Mean±SD	44.5±28.8	17.8±17	1.8±1.2	0.8±0.7
Range	10–100	5–60	0.4–4.2	0.04–2.5

denatured with a tissue „vaporization." Heat may be produced by a bipolar alternating current cauterizer, laser, or RF. Among these methods, RF has many advantages: (a) the RF current works at high frequency avoiding the stimulation of the muscular contraction; (b) RF can simultaneously cauterize and vaporize tissue without secondary bleeding; (c) it requires minimal training and no certification for laser use; (d) it minimizes risk of collateral damage; (e) the electrodes, composed by an active electrode, return electrode, and ceramic insulator, come in various shapes adaptable for different situations; (f) the RF electrode functions only directly ahead, creating a concentrated area of action; and (g) the power is variable and the amount of tissue removal can reach 48 mm^2/s.

RF technology is widely used in shoulder arthroscopy and has been indicated for meniscectomy, chondroplasty, ACL débridement, synovectomy, plica removal, meniscal cystic removal, and lateral release [10, 13, 14, 18]. Considering the above characteristics, it is possible to extend RF for use in intercondylar notchplasty. The energy and amount of heat produced by the RF electrode is able to denature bone proteins as well, with an additional hemostatic effect. Principles of this theory are demonstrated by the results of our study. In our study mean bleeding was 45% less using RF electrode than in powered instrument notchplasty. This statistically significant difference was seen in both the first period (end of surgery to 6 a.m. on postoperative day 1) and the second period (to 6 a.m. on postoperative day 2). This reduction in bleeding reduction means that secondary risks of postoperative hemarthrosis were eliminated.

Notchplasty using RF may require a longer period to perform than with a motorized shaver because the power is lower for fast bone removal, but research is being directed at developing RF machines with power ranges allowing more effective for bone vaporization.

Conclusion

RF technology can be used to perform intercondylar notchplasty in ACL reconstruction procedures. The technique is easy and does not require certification. The RF electrode minimizes tissue damage near the working area. As result of this technique, postoperative intra-articular bleeding in our study was reduced significantly (approx. 45%) in respect to motorized shaving notchplasty. The results of this study support performing RF technology for intercondylar notchplasty in ACL reconstruction procedures when minor bleeding is required.

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