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Does patellar rim electrocautery have deleterious effects on patellar cartilage?☆

Niloofar Namazi [a], Fereidoon Mojtahed Jaberi [a], Sara Pakbaz [b], Amir Reza Vosoughi [a,*], Mahrad Mojtahed Jaberi [c]

[a] Bone and Joint Disease Research Center, Department of Orthopedic Surgery, Chamran Hospital, Shiraz University of Medical Sciences, Shiraz, Iran
[b] Department of Pathology, Chamran Hospital, Shiraz University of Medical Sciences, Shiraz, Iran
[c] McGill University, Montreal, Quebec, Canada

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ABSTRACT

Background: Circumpatellar electrocauterization to destroy pain receptors during total knee arthroplasty without patellar resurfacing is commonly used to decrease postoperative knee pain. We aimed to evaluate the effect of denervation with electrocauterization on patellar cartilage.
Methods: Twenty rabbits were randomly assigned to two equally sized case and control groups. The rabbits in the case group underwent surgery via the anterior midline skin incision and medial parapatellar arthrotomy, followed by denervation electrocauterization at a depth of 1 mm and a distance of 3 mm from the outer border of the patella. In the control group, surgery was identical to that performed in the case group, but without patellar denervation. Twelve weeks after surgery, all rabbits were sacrificed. Range of motion, macroscopic evaluation of cartilage using modified Outerbridge scoring, and histopathological assessment using a modified histologic scoring system for cartilage were evaluated.
Results: Three rabbits died during the study. Nine cases and eight animals from the control group were included in the final evaluation. All rabbits had passive full range of motion. Mean Outerbridge score was 2.0 in the case group and 0.37 in the control group ($p = 0.002$). There were statistically significant differences in cellularity ($p = 0.016$), loss of matrix ($p = 0.004$), and clustering of chondrocytes ($p = 0.008$) between the two groups. Microscopic variables as a whole were statistically significant ($p = 0.001$).
Conclusions: Circumpatellar electrocauterization may result in cartilage destruction. So, we encourage caution in using routine electrocauterization in patients undergoing total knee arthroplasty.
Level of evidence: level II.

1. Introduction

Osteoarthritis is a considerable problem in people aged over 50 and is associated with a significant economic burden for health systems [1]. Total knee arthroplasty (TKA) seems to be a suitable method of complete pain relief in cases when non-steroidal anti-inflammatory drugs, physiotherapy, steroid injections, and hyaluronic acid have been shown to be ineffective. Anterior knee pain, which is reported in 4–49% of TKA cases, is a well-known complication of this surgery [2–7]. The actual cause of anterior knee pain following TKA remains unclear, but patient characteristics such as weight and pre-operative gait pattern [8,9], surgical techniques, patellar resurfacing [4,8,10], type of prostheses (fixed-bearing design) [11], tension of the peripatellar soft tissue [2], and damage to arterial supply via the infrapatellar fat pad [12] are known potential contributing factors.

Hyper-innervation of the degenerative cartilage via substance-P nociceptive afferent fibers has attracted more attention from researchers in recent years. Hyper-innervation, triggered by periodic short episodes of ischemia and induced by the release of neural growth factors, has been described as the primary pathogenic factor for anterior knee pain in patients without TKA [13–16]. To prevent hyper-innervation, thermal necrosis of patellar innervation by electrocautery has been suggested as a way of desensitizing the patella via the destruction of pain receptors [17]. Moreover, the effects of circumpatellar electrocauterization during TKA without resurfacing the patella on prevention of anterior knee pain remain unknown [18–22].

Sensory denervation of cartilage can result in morphological changes due to cartilage destruction [23]. To the best of our knowledge, few studies have been published about the possible consequences of electrocauterization denervation on patellar cartilage. Thus, we hypothesized that circumpatellar electrocauterization should not be routinely used for resolving anterior knee pain either in young patients with anterior knee pain or in patients following TKA without patellar resurfacing. Patellar rim electrocautery may result in secondary pain caused by cartilage destruction. The aim of this study was to investigate

☆ Study was carried out in Bone and Joint Disease Research Center, Department of Orthopedic Surgery, Chamran Hospital, Shiraz University of Medical Sciences, Shiraz, Iran.

* Corresponding author. Tel./fax: +98 711 6234504.
E-mail address: vosoughiar@hotmail.com (A.R. Vosoughi).

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the potential consequences of electrocauterization on the histopathology of patellar cartilage.

2. Materials and methods

2.1. Animals

The study was performed on 20 healthy male New Zealand rabbits with an average weight of 3.0 kg (range: 2.6–3.6 kg) at the Animal Laboratory of Shiraz University of Medical Sciences under the supervision of the ethics committee. Experimental subjects were kept under standard conditions including relative humidity with 14 h light and 10 h darkness per day, housing in 60 × 60 × 60 cm stainless steel cages with wire mesh floors, appropriate temperature, and with free access to water and food.

2.2. Surgery

The animals were randomly assigned to two equally sized groups (cases and controls) of 10 rabbits each. Anesthesia was induced using an intramuscular injection of 10 mg/kg ketamine (Ketalar, Parke Davis) and 8 mg/kg xylazine (Rompun, Bayer AC, Leverkusen, Germany). A 50-mg/kg dose of intramuscular cefazolin was administered pre-operatively for infection prophylaxis. After shaving and preparing the right knee of the rabbits, surgery was performed under sterile conditions by the same surgeon for all cases. Via the anterior midline approach, the skin was incised to expose the patellar ligament. After arthrotomy through a medial parapatellar approach, denervation was performed using a Valleylab electrocautery unit (Valleylab Inc., Boulder, Colorado, USA) with monopolar coagulation diathermy set to 50 W. This was done at a distance of 3 mm from the outer edge of the patellar cartilage at a depth of 1 mm in the rabbits of the case group. Thorough irrigation and suturing of the arthrotomy site and skin was done using nylon sutures. In the control group, surgery was exactly similar to the case group without patellar denervation by electrocautery. After the procedure, a 0.01-mg/kg intramuscular buprenorphine injection and 2 mg/kg of acetaminophen was dissolved in 100 mg/kg drinking water three times daily were prescribed as analgesics. Moreover, three doses of intramuscular cephazolin as prophylaxis were injected. Twelve weeks after surgery, the rabbits were killed with a 200-mg/kg pentothal dose.

2.3. Macroscopic evaluation

After sacrificing the animals, joint range of motion was evaluated using a goniometer by one of the authors blinded to the group assignment. The joint was opened using a knife and the patellar tendon was transected. Macroscopic evaluation of cartilage was conducted using a modified Outerbridge scoring system after exposing the patella [24] (Table 1).

2.4. Microscopic evaluation

After excision of the patella, samples were fixed in 10% neutral buffered formalin. Paraffin blocks were prepared. Sections for microscopic evaluation were cut into 6-μm transverse sections vertical to the articular surface in 5 mm distance of the cartilage border. These were stained with hematoxylin–eosin (H&E), toluidine blue, and safranin O based on standard laboratory procedures. Slides were evaluated using a modified histologic scoring system for cartilage, as shown in Table 2 [25,26]. The modification of the scoring system was due to the addition of safranin O staining and application of toluidine blue instead of Alcian blue. Toluidine blue and safranin O are cationic stains (basic dyes) that stain acidic proteoglycan present in cartilage tissues. These stains can be indicative of cartilage matrix proteoglycan depletion [27].

Table 1
Modified Outerbridge scoring of articular cartilage lesions by severity.

Grade	Modified Outerbridge
0	Intact cartilage
I	Chondral softening or blistering with intact surface
II	Superficial ulceration, fibrillation, or fissuring less than 50% of depth of cartilage
III	Deep ulceration, fibrillation, fissuring or chondral flap more than 50% of cartilage without exposed bone
IV	Full-thickness wear with exposed subchondral bone

Slides were reviewed by an experienced pathologist blinded to group assignment. Cartilage cellularity, loss of matrix (erosion of articular cartilage), clustering of chondrocytes, adhesion (pannus formation), metachromasia with toluidine blue, and cartilage staining with safranin O were all investigated and scored. Total microscopic score was calculated for each sample.

2.5. Statistical analysis

SPSS version 18.0 for windows was used for statistical analyses (SPSS Inc. Chicago, IL, USA). A Mann–Whitney test was used for Outerbridge scores and microscopic non-parametric variables. For statistical comparisons between the case and control groups, a p-value of less than 0.05 was considered to be significant. To minimize the possibility of Type I error, Bonferroni adjustment was performed.

3. Results

Of the 20 rabbits, one from the case and two from the control groups died during the study for unknown reasons. Nine case and eight control animals were included in the final analysis.

Evaluation of passive range of motion of the knee using a goniometer demonstrated full motion from 0° to 145–150° flexion in all rabbits with no significant differences observed between the two groups. There was no flexion contracture or flexion loss. Mean

Table 2
Modified histopathologic scoring system for cartilage.

Histopathologic scoring parameter	score
Cellularity:	
Normal cellularity	0
<10% of acellular cartilage	1
10–50% of acellular cartilage	2
>50% of acellular cartilage	3
Loss of matrix:	
No loss	0
<10% of eroded regions	1
10–25% of eroded regions	2
>25% of eroded regions	3
Clustering of chondrocytes:	
No clustering	0
<10% of chondrocytes in clusters	1
10–25% of chondrocytes in clusters	2
>25% of chondrocytes in clusters	3
Adhesion:	
No adhesion	0
Covering only margin of cartilage	1
Covering <50% of articular surface	2
Covering >50% of articular surface	3
Metachromasia with Toluidine blue:	
Normal	0
Slight and patchy loss of staining	1
Moderate loss	2
Severe loss	3
Safranin O staining:	
Normal	0
Slight and patchy loss of staining	1
Moderate loss	2
Severe loss	3