

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

International Journal of Surgery Case Reports

journal homepage: www.casereports.comRegeneration of ring-shaped lateral meniscus after partial resection of discoid meniscus with anterior cruciate ligament reconstruction[☆]Takashi Soejima^{a,*}, Tomonoshin Kanazawa^b, Kousuke Tabuchi^a, Kouji Noguchi^a, Takashi Inoue^a, Hidetaka Murakami^c^a Department of Orthopaedic Surgery, Kurume University School of Medicine, Kurume, Japan^b Department of Microanatomy, Kurume University School of Medicine, Kurume, Japan^c Department of Orthopaedic Surgery, Murakami Surgical Hospital, Tagawa, Japan

ARTICLE INFO

Article history:

Received 15 April 2013

Received in revised form 31 July 2013

Accepted 4 August 2013

Available online 25 September 2013

Keywords:

Meniscus
Regeneration
Ring
Knee

ABSTRACT

INTRODUCTION: The ring-shaped lateral meniscus is very rare. Although it is essentially known as a congenital anomaly, a central tear in an incomplete discoid meniscus or an old bucket-handle tear in a meniscus may be easily mistaken for a ring-shaped meniscus. We experienced a ring-shaped lateral meniscus that regenerated after partial resection of a discoid meniscus together with anterior cruciate ligament (ACL) reconstruction.

PRESENTATION OF CASE: A 37-year-old female patient still experienced unrelenting knee pain 6 months after ACL reconstruction and partial meniscectomy of a discoid lateral meniscus. A repeat arthroscopy was performed. The lateral tibial plateau was covered in the form of a ring by meniscus-like tissue. The meniscus-like tissue appeared to have regenerated inward toward the center from the stump after the partial meniscectomy and was connected from the anterior to posterior horn, forming an interhorn bridge. Partial meniscectomy was repeated. Histologically, the regenerated tissue was not meniscal, but comprised mature fibrocartilage; macroscopically; however, it was very similar to meniscal tissue. Two years after the initial operation, the patient had no complaints and experienced full return of function.

DISCUSSION: The reason for such regeneration is unknown, but may have been attributed to the specific intra-articular environment that developed after the ACL reconstruction.

CONCLUSION: This is the first report of regenerative development of a ring-shaped lateral meniscus. When a ring-shaped lateral meniscus is diagnosed, we must accurately determine whether it is a true congenital anomaly in consideration of the present case.

© 2013 The Authors. Published by Elsevier Ltd on behalf of Surgical Associates Ltd. All rights reserved.

1. Introduction

Ring-shaped menisci, which are characterized by the presence of an interhorn bridge, are rare. Watson-Jones¹ first reported a medial ring-shaped meniscus in 1930, and Noble² first reported a lateral ring-shaped meniscus in 1975. Watson-Jones¹ and Basmajian³ debated whether the origin of the ring-shaped meniscus is congenital or traumatic. Johnson and Simmons⁴ stated that the ring-shaped meniscus probably represents a locked bucket-handle tear that has been altered by time and pressure. On the other hand, Arnold⁵ stated that the ring shape is likely to be due to a developmental abnormality rather than a degenerative alteration

because ring-shaped menisci are a common feature in primates, especially at the lateral meniscus.⁶ The pathogenesis and origin continue to be debated.

We herein report an exceptional case of regeneration of completely ring-shaped meniscus-like tissue after partial resection of a discoid lateral meniscus with ACL reconstruction.

2. Presentation of case

A 37-year-old female patient twisted her right knee and presented to our institution. The Lachman test and pivot shift test were positive, and magnetic resonance imaging (MRI) confirmed the ACL injury and an intrasubstance horizontal tear of the discoid lateral meniscus. In the third month after the injury, the first arthroscopic surgery was performed. The lateral meniscus was thin and completely discoid (Fig. 1a). Partial meniscectomy was performed because the preoperative MRI showed an intrasubstance horizontal tear (Fig. 1b). Arthroscopic ACL reconstruction was also performed. Although the patient developed a large joint hematoma

[☆] This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial-No Derivative Works License, which permits non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.

* Corresponding author. Tel.: +81 942 353311; fax: +81 942 350709.

E-mail address: soejima@ACL.jp (T. Soejima).

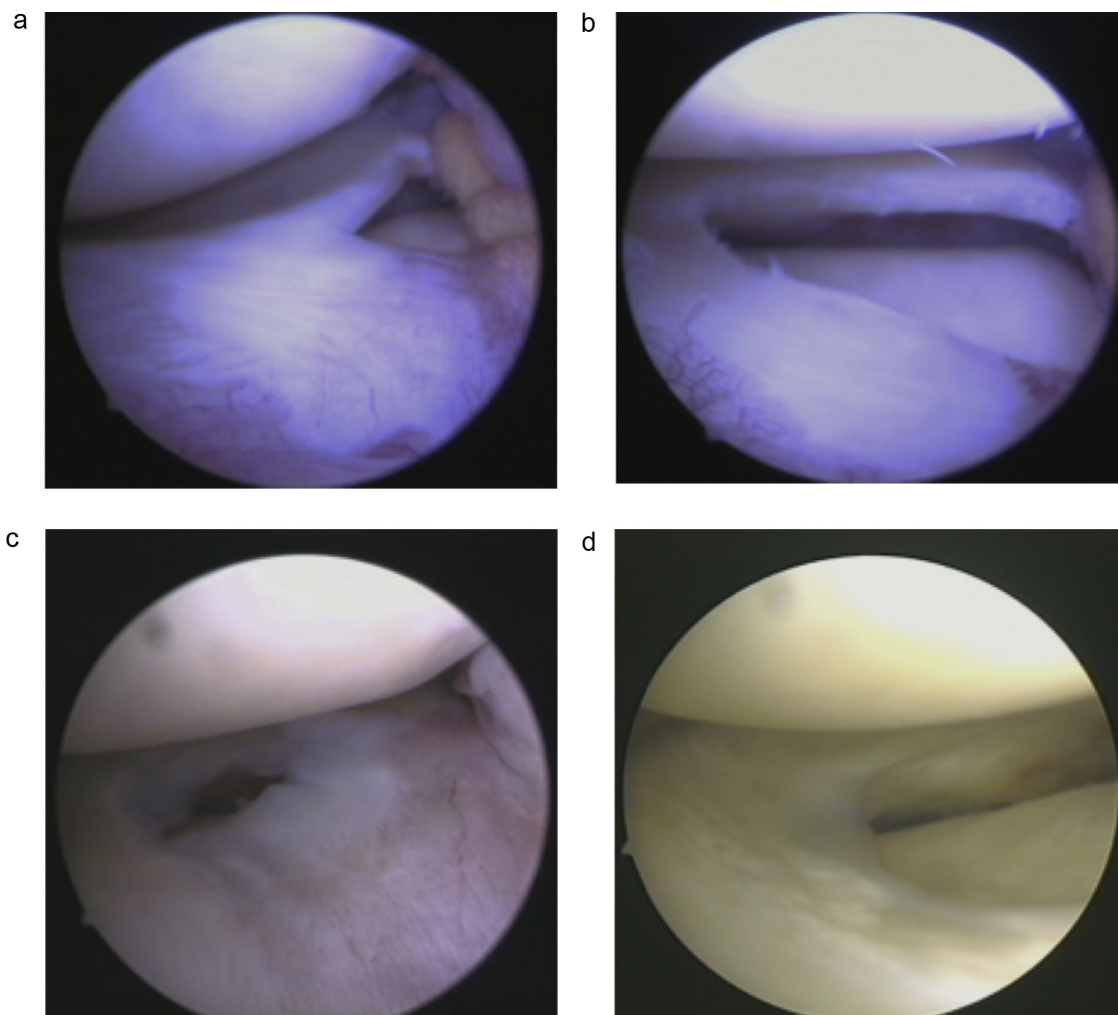


Fig. 1. Arthroscopic findings. (a) The lateral meniscus was a thin, completely discoid meniscus at the time of ACL reconstruction. (b) Partial meniscectomy was performed. (c) Re-arthroscopy 6 months after ACL reconstruction: a regenerated ring-shaped lateral meniscus had formed an interhorn bridge. (d) Final arthroscopy 12 months after ACL reconstruction: the lateral meniscus had a well-defined resected edge without an interhorn bridge.

postoperatively, aspiration was not performed. Following 10 days of immobilization in a slightly flexed position, range-of-motion training was started. Partial weight-bearing and full weight-bearing gaits were permitted at weeks 3 and 5, respectively.

Because the patient complained of unrelenting pain at the lateral site with deep knee flexion 6 months after the surgery, arthroscopy was performed. The lateral tibial plateau, excluding a portion of the center of the weight-bearing area, was covered in the form of a ring by meniscus-like tissue that was connected from the anterior to posterior horn, forming an interhorn bridge (Fig. 1c). Partial meniscectomy was repeated, resulting in symptom resolution.

A pathological section of the inner portion of the ring around the bridge was evaluated. New tissue in the form of a triangular cross section was very similar to a meniscus. In terms of histologic structure, hematoxylin-eosin (HE) staining (Fig. 2a) showed that the majority of the cells comprising the tissue were not fibroblasts, but chondrocyte-like round cells. Furthermore, this part was completely stained pale red with Safranin O, suggesting that it contained a higher amount of proteoglycan (Fig. 2b). Immunostaining revealed that it was densely stained for type I collagen (Fig. 2c) and was not stained for type II collagen (Fig. 2d). However, the fiber orientation was random/amorphous, and tie fibers were not found.

One year after the initial surgery, she readily accepted the recommendation to undergo removal of the fixation devices with simultaneous arthroscopy. The re-repeat arthroscopy

demonstrated that the lateral meniscus was in good condition without an interhorn bridge (Fig. 1d). Two years after the initial operation, the patient had no symptoms or complaints.

3. Discussion

In the present case, ring-shaped meniscus-like tissues regenerated inward toward the center from the stump formed from the partial meniscectomy of the discoid lateral meniscus and were connected from the anterior to posterior horn, forming an interhorn bridge. Histological findings revealed that this regenerated tissue was relatively similar to the normal meniscus, although there was a random/amorphous fiber orientation and absence of tie fibers. It was considered that new fibrocartilage grew on the intercondylar eminence. This tissue may transform into a meniscus over time. One possible cause of such a phenomenon is the intra-articular environment that develops after ACL reconstruction. During ACL reconstruction, soft tissue debridement triggers cytokine expression, and drilling of bone tunnels leads bone marrow mesenchymal stem cells to the joint. Because this patient developed a large joint hematoma, it is likely that clots containing a high abundance of bone marrow mesenchymal stem cells and cytokines formed in the dead space after the meniscectomy. These blood clots may have served as a scaffold for meniscus-like fibrous cartilaginous tissue

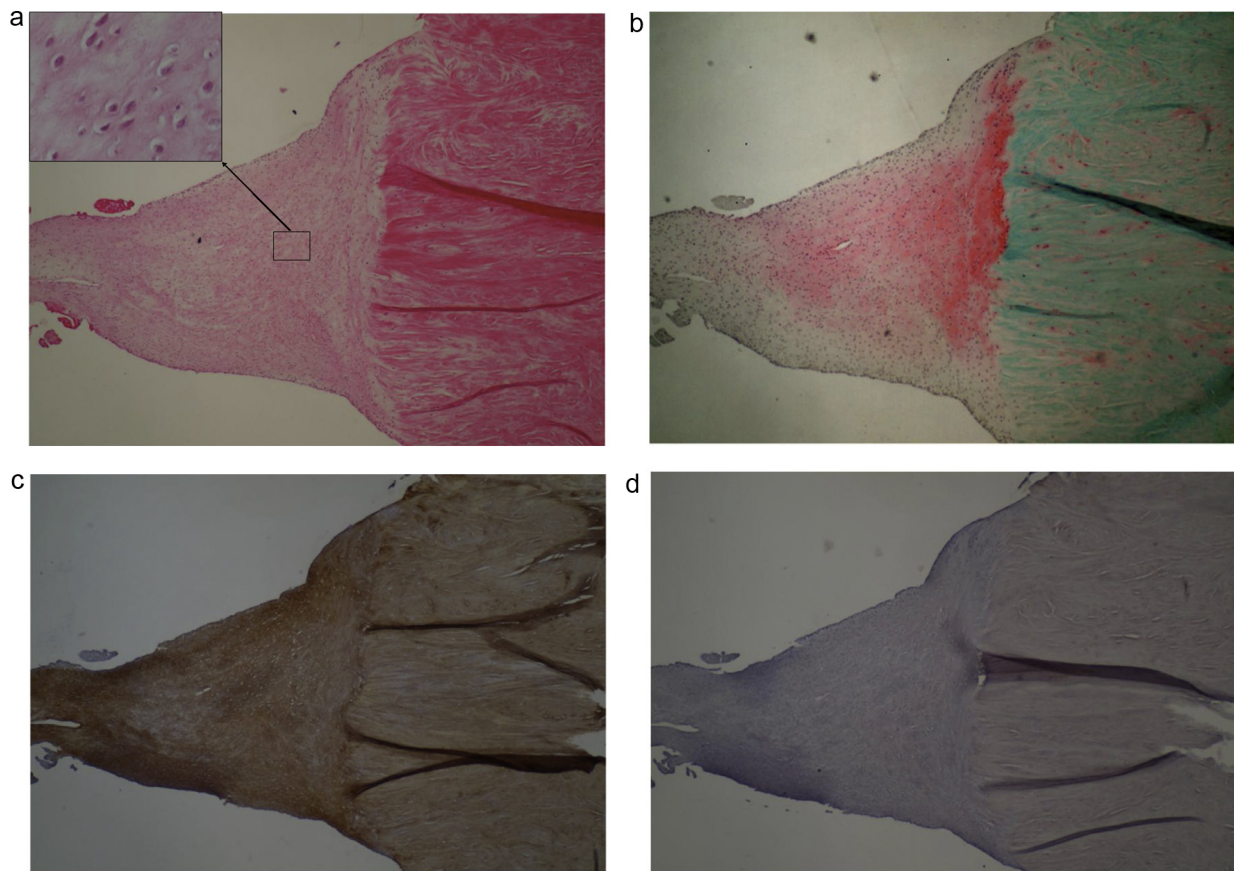


Fig. 2. Histopathologic findings. (a) HE staining showed formation of a triangular tissue that comprised chondrocyte-like round cells. (b) Safranin O staining showed a higher amount of proteoglycan. (c) The regenerated tissue was densely stained for collagen type I. (d) The regenerated tissue was not stained for collagen type II.

to emerge as a regenerated meniscus. Another possible cause is metaplasia of the ACL remnants. Remnants of the ACL left in the interhorn region may have metamorphosed to meniscus-like tissue because cells of the ACL have chondrogenic characteristics.⁷

There have been few reports^{5,8–10} of ring-shaped lateral menisci. Most authors reported it as a congenital anomaly because their patients had no symptoms and/or no history of a major traumatic episode. There are only two reports of a ring-shaped lateral meniscus combined with an ACL injury. Kim et al.¹¹ incidentally found a ring-shaped lateral meniscus 2 months after an ACL injury. He concluded that it was probably caused by a morphological anomaly based on the arthroscopy findings. Pandey et al.¹² reported a ring-shaped lateral meniscus that was mistaken for an incomplete discoid meniscus in a case of ACL injury. In the first arthroscopy, they found an incomplete discoid meniscus with a concomitant ACL tear, and the torn ACL stump was debrided; ACL reconstruction was not performed. A repeat arthroscopy 2 years later revealed a ring-type lateral meniscus. They concluded that the ring meniscus was overlooked because a re-examination of the lateral meniscus was not performed after debridement in the first arthroscopy. However, it is possible that tissue regeneration occurred between the two horns through the synovial reaction and the blood clots or through remnants of the ACL because the torn ACL stump was debrided during the first arthroscopy. If the oversight had not occurred, their case may have been identical to ours.

Kim et al.¹³ concluded that for the differential diagnosis of a ring-shaped meniscus, we should take a careful history of any traumatic events, consider the possibility of misinterpretation of the MRI findings, and probe carefully during arthroscopic operations. Furthermore, it must be kept in mind that the phenomenon found in our case is actually possible.

To prevent the occurrence of such phenomenon observed in our case, we should pay attention to curetting unnecessary remnants thoroughly during the surgery, avoiding accumulation of a large amount of hematomas during the perioperative period, and starting the exercise of range of motion immediately after the surgery.

4. Conclusion

We reported a patient who exhibited symptoms due to regeneration of ring-shaped meniscus-like tissue following ACL reconstruction and partial meniscectomy of a discoid lateral meniscus. The regenerated tissue was not a meniscus, but mature fibrocartilage. The reason for the regeneration is unknown, but may have been attributed to the specific intra-articular environment that developed after the ACL reconstruction. When a ring-shaped lateral meniscus is diagnosed, we must judge carefully whether it is really a congenital anomaly in consideration of our case.

Conflict of interest

None declared.

Funding

None.

Ethical approval

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Author contributions

T. Soejima is a primary surgeon who performed the first and second operations. T. Kanazawa is a pathologist performed immunohistologic evaluations and provided specialized knowledges. K. Tabuchi is a doctor in charge of patient care at the time of the second hospitalization. Assisted in writing case. Proofread and review draft several times. K. Noguchi is a second surgeon jointly performed the second operation. Performed literature search. Also assisted in processing digital image. T. Inoue is a doctor in charge of patient care at the time of first hospitalization. M. Hidetaka is a second surgeon jointly performed the first operation.

References

1. Watson-Jones R. Specimen of internal semilunar cartilage as a complete disc. *Proc R Soc Med* 1930;**23**(1588):9.
2. Noble J. Congenital absence of the anterior cruciate ligament associated with a ring meniscus. *J Bone Joint Surg Am* 1975;**57**(1165):6.
3. Basmajian JV. A ring-shaped medial semilunar cartilage. *J Bone Joint Surg Br* 1952;**34**(638):9.
4. Johnson RG, Simmons EH. Discoid medial meniscus. *Clin Orthop* 1982;**169**(176):9.
5. Arnold MP, Kampen AV. Symptomatic ring-shaped lateral meniscus. *Arthroscopy* 2000;**16**(852):4.
6. Albertsson M, Gillquist J. Discoid lateral menisci: a report of 29 cases. *Arthroscopy* 1988;**4**(211):4.
7. Furumatsu T, Hachioji M, Saiga K, Takata N, Yokoyama Y, Ozaki T. Anterior cruciate ligament-derived cells have high chondrogenic potential. *Biochem Biophys Res Commun* 2010;**391**(1142):7.
8. Wang Q, Liu X, Liu S, Bai Y. Double-layered lateral meniscus. *Knee Surg Sports Traumatol Arthrosc* 2011;**19**(2050):1.
9. Atay ÖA, Aydingöz Ü, Dral MN, Tetik O, Leblebicioğlu G. Symptomatic ring-shaped lateral meniscus: magnetic resonance imaging and arthroscopy. *Knee Surg Sports Traumatol Arthrosc* 2002;**10**(280):3.
10. D'Lima DD, Copp SN, Colwell Jr CW. Isolated lateral ring meniscus. Case report. *Am J Knee Surg* 1995;**8**(117):8.
11. Kim SJ, Jeon CH, Koh CH. A ring-shaped lateral meniscus. *Arthroscopy* 1995;**11**(738):9.
12. Pandey V, Dinesh KVN, Acharya KKV, Rao PS. Ring meniscus mistaken for incomplete discoid meniscus: a case report and review of literature. *Knee Surg Sports Traumatol Arthrosc* 2010;**18**(543):5.
13. Kim YG, Ihn JC, Park SK, Kyung HS. An arthroscopic analysis of lateral meniscal variants and a comparison with MRI findings. *Knee Surg Sports Traumatol Arthrosc* 2006;**14**(20):6.

Open Access

This article is published Open Access at scimedirect.com. It is distributed under the [IJSCR Supplemental terms and conditions](#), which permits unrestricted non commercial use, distribution, and reproduction in any medium, provided the original authors and source are credited.