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Technical Note

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A Hybrid Technique Using a Biocomposite Scaffold for Rotator Cuff Repair: Technical Note

Ki-Choul Kim[1], Jae-Wook Park[1], Jae-Sung Yoo[1*]

[1]Department of Orthopaedic Surgery, Dankook University College of Medicine, Cheonan, Republic of Korea

***Correspondence author:** Jae-Sung Yoo, MD, PhD, Department of Orthopaedic Surgery, Dankook University College of Medicine, Manghyang-ro 201, Dongnam-gu, Cheonan, Chungnam 31116, Republic of Korea; Email: osarthro@dkuh.co.kr

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Abstract

The high retear rate following arthroscopic repair of large to massive rotator cuff tears remains a major clinical challenge. Recently, biocomposite scaffolds such as BioBrace have attracted increasing attention because they are designed to promote biologic healing through bio-induction while simultaneously providing immediate mechanical support at time zero.

In this technical report, we describe a hybrid augmentation technique intended to maximize the potential advantages of BioBrace. This technique is based on a repair-first strategy in which stable primary rotator cuff repair is achieved before scaffold fixation. The scaffold is subsequently secured using the remaining suture limbs, enabling partial integration with the repair construct while establishing a secondary load-sharing configuration.

Previous biomechanical studies evaluating patch fixation techniques have suggested that repair-first hybrid constructs may provide superior structural stability compared with conventional repair constructs.

In conclusion, a repair-first hybrid augmentation technique using a biocomposite scaffold may reduce mechanical stress at the suture-tendon interface while creating a favorable biologic environment for tendon healing. Further clinical studies are warranted to validate the clinical efficacy and structural benefits of this approach.

Keywords: Rotator Cuff Tear; Biocomposite Scaffold; Biobrace; Hybrid Technique; Patch Augmentation

Abbreviations

RCT: Rotator Cuff Tear; MRI: Magnetic Resonance Imaging

Introduction

Rotator cuff tears are among the most common causes of shoulder pain and functional impairment, with their prevalence increasing with age [1,2]. In particular, large to massive tears remain challenging to treat, as high rates of structural failure have been reported even after arthroscopic repair, ranging from approximately 34% to 94% [3,4]. Such failure not only compromises functional recovery but also increases the likelihood of revision surgery, representing a persistent clinical concern.

Failure following rotator cuff repair is generally attributed to two principal mechanisms. The first is mechanical failure at the suture-tendon interface, where excessive tension may lead to suture pull-through, particularly in the early postoperative period. The second is insufficient biological healing at the tendon-bone interface [5,6]. Early retears, most commonly occurring within the first 3 to 6 months after surgery, are predominantly mechanical in nature, highlighting the importance of achieving adequate time-zero strength to protect the repair during this vulnerable phase [6,7].

Rotator cuff retear remains a significant clinical challenge following surgical repair, particularly in large to massive tears where structural failure rates have been reported to be high [3,4]. To address these challenges, patch augmentation has been introduced as an adjunct to rotator cuff repair and a variety of biomaterials have been investigated. Biological scaffolds may facilitate tissue regeneration but generally provide limited initial mechanical support. In contrast, structural grafts such as acellular dermal matrices can enhance initial fixation strength, although their capacity for biological integration is variable and complications have been reported [8-10]. Consequently, there remains a need for strategies that can simultaneously provide mechanical stability and support biological healing.

From this perspective, a strategy that first establishes a stable primary repair and subsequently augments it using a biocomposite scaffold may represent a rational approach to improving structural integrity. However, there is currently limited literature describing how this repair-first hybrid augmentation concept can be practically implemented using BioBrace™.

Therefore, the purpose of this technical report is to describe a repair-first hybrid augmentation technique using a triple-row rotator cuff repair construct combined with a biocomposite scaffold. After completion of the primary repair, the scaffold is secured using the remaining suture limbs to reinforce the repair construct and create a secondary load-sharing mechanism. This approach may enhance initial mechanical stability and promote a favorable biologic environment for tendon healing.

Surgical Technique

This technique consists of a hybrid augmentation approach in which a biocomposite scaffold (BioBrace™; CONMED, Largo, FL, USA) is applied following rotator cuff repair using a construct based on the biomechanical principles of a triple-row suture-bridge configuration. Triple-row-based repair has been reported to increase footprint coverage and contact pressure while improving load distribution, thereby enhancing mechanical stability.

In the present technique, a stable primary rotator cuff repair is first established, followed by scaffold augmentation using a repair-first hybrid configuration.

All procedures were performed under general anesthesia with the patient in the beach-chair position. After establishing a posterior portal for diagnostic arthroscopy, a lateral portal was created for visualization and instrumentation. The torn rotator cuff was debrided and the footprint was prepared with decortication to promote a favorable healing environment (Fig. 1).
A single triple-loaded medial-row anchor (Y-Knot RC, CONMED, Largo, FL, USA) was placed at the medial aspect of the footprint. The six suture limbs from this anchor were individually passed through the rotator cuff tendon in a mattress-like configuration with independently passed limbs, with each limb placed separately to achieve secure fixation across the tendon. Adequate tendon mobilization was performed to allow tension-free reduction (Fig. 2).

An additional anchor (Y-Knot RC, CONMED, Largo, FL, USA) was then placed at the lateral aspect of the footprint. Four suture limbs were passed through the tendon to further secure the cuff and improve tendon-bone contact. These four suture limbs were subsequently fixed using a knotless lateral anchor (MultiFix S, Smith and Nephew, Andover, MA, USA), thereby creating central compression across the footprint and establishing the initial suture-bridge construct (Fig. 3).

After completion of the primary repair, the biocomposite scaffold (BioBrace™) was trimmed to adequately cover the repaired tendon and positioned over the footprint. The remaining six suture limbs from the medial-row anchor were then utilized for scaffold fixation. These limbs were divided into two groups of three and secured laterally in a suture-bridge configuration using two additional lateral-row anchors (MultiFix S, Smith and Nephew), thereby completing the construct in a repair-first hybrid fashion (Fig. 4).

In this configuration, the scaffold is applied after completion of a stable primary repair rather than being incorporated into the initial repair construct. It functions as a secondary load-sharing structure connected to the repair construct, rather than serving as a simple onlay covering. This configuration allows redistribution of mechanical stress at the suture-tendon interface while also providing a matrix that may support tissue ingrowth and remodeling (Fig. 5).

Postoperative Rehabilitation and Follow-up

Postoperatively, the shoulder was immobilized in an abduction brace for approximately 6 weeks. During this period, active motion of the elbow, wrist and hand was allowed immediately after surgery, whereas active shoulder motion was restricted to protect the repair construct.

Passive forward elevation was initiated at 4 weeks postoperatively within a tolerable range of pain. After brace removal at 6 weeks, gradual progression to active range of motion exercises was permitted.

Strengthening exercises using elastic bands were introduced at 10 to 12 weeks after surgery and exercise intensity was progressively increased according to the patient's recovery status. Return to activities of daily living was generally allowed after 3 months, whereas return to sports activities or heavy labor was permitted after approximately 6 months.

Routine postoperative follow-up evaluations were performed at 2 weeks, 6 weeks, 3 months, 6 months and 12 months after surgery. Clinical assessment included pain, range of motion, shoulder strength and functional recovery. Follow-up imaging using magnetic resonance imaging or ultrasonography was selectively performed at approximately 6 to 12 months postoperatively to evaluate tendon integrity and scaffold incorporation when clinically indicated.

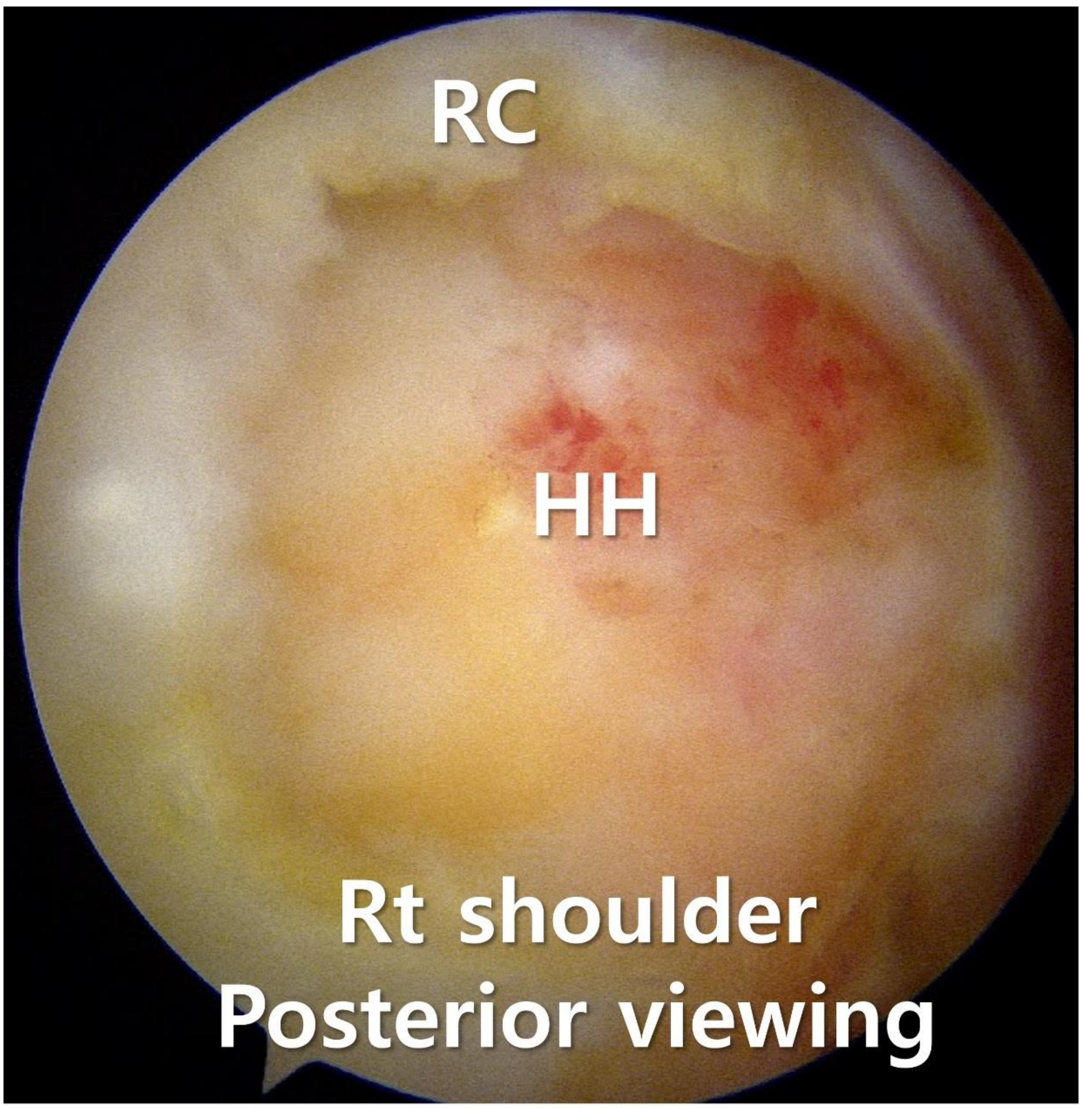

Figure 1: Arthroscopic view of a large rotator cuff tear with preparation of the footprint. Degenerated tendon tissue is debrided and the greater tuberosity footprint is decorticated to create a bleeding bone bed that facilitates tendon healing. HH; Humeral Head, RC; Rotator Cuff.

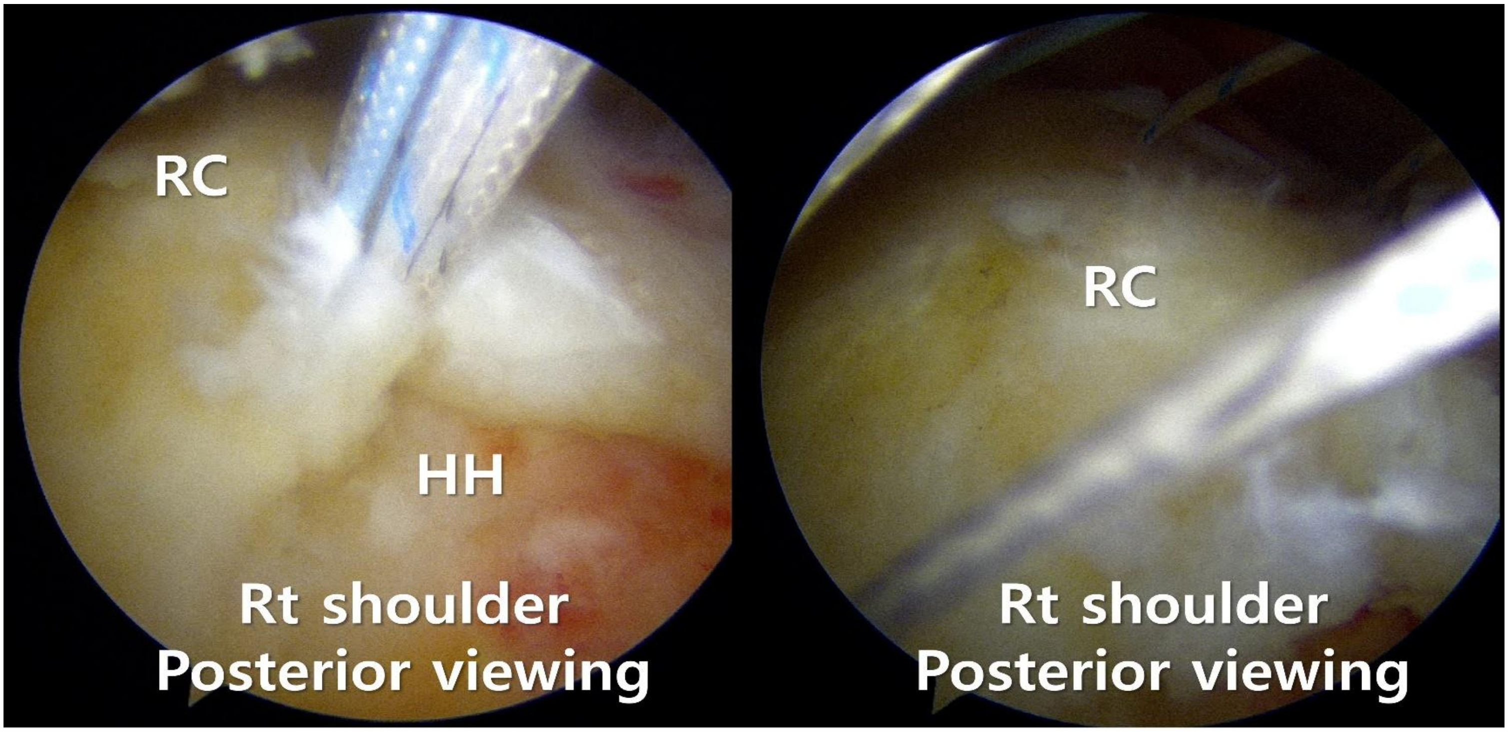

Figure 2: Medial-row anchor placement and primary cuff repair. A single triple-loaded suture anchor is inserted at the medial aspect of the footprint and six suture limbs are individually passed through the rotator cuff tendon in a mattress configuration. The tendon is mobilized and reduced to the footprint to achieve a tension-free primary repair. HH; Humeral Head, RC; Rotator Cuff.

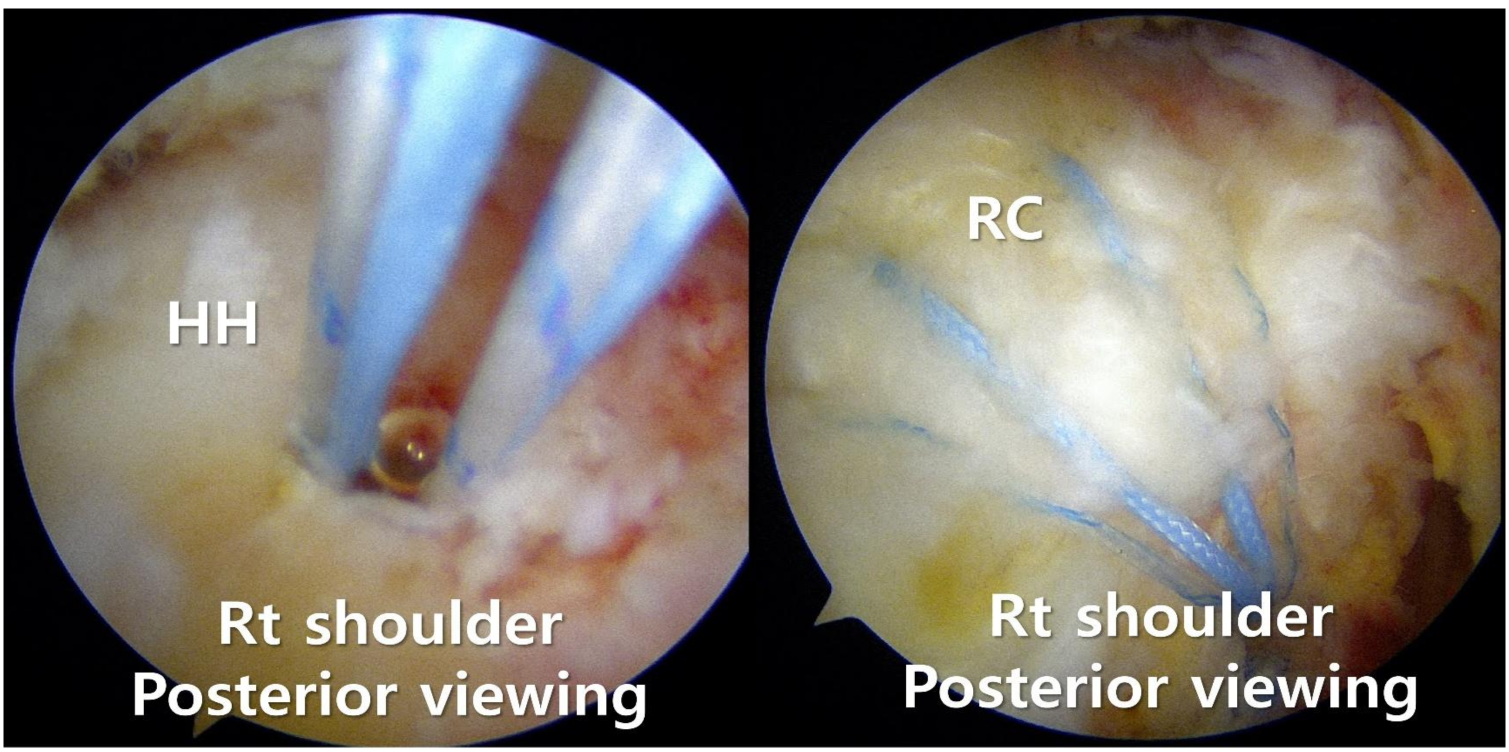

Figure 3: Triple-row-based construct with central lateral fixation. An additional lateral-row anchor (Y-Knot RC, CONMED, Largo, FL, USA) is placed at the lateral aspect of the footprint and four suture limbs are passed through the rotator cuff tendon to enhance tendon-bone contact. These four suture limbs are subsequently secured using a knotless lateral anchor (MultiFix S, Smith and Nephew, Andover, MA, USA), creating central compression across the footprint and establishing the initial suture-bridge construct. HH; Humeral Head, RC; Rotator Cuff.

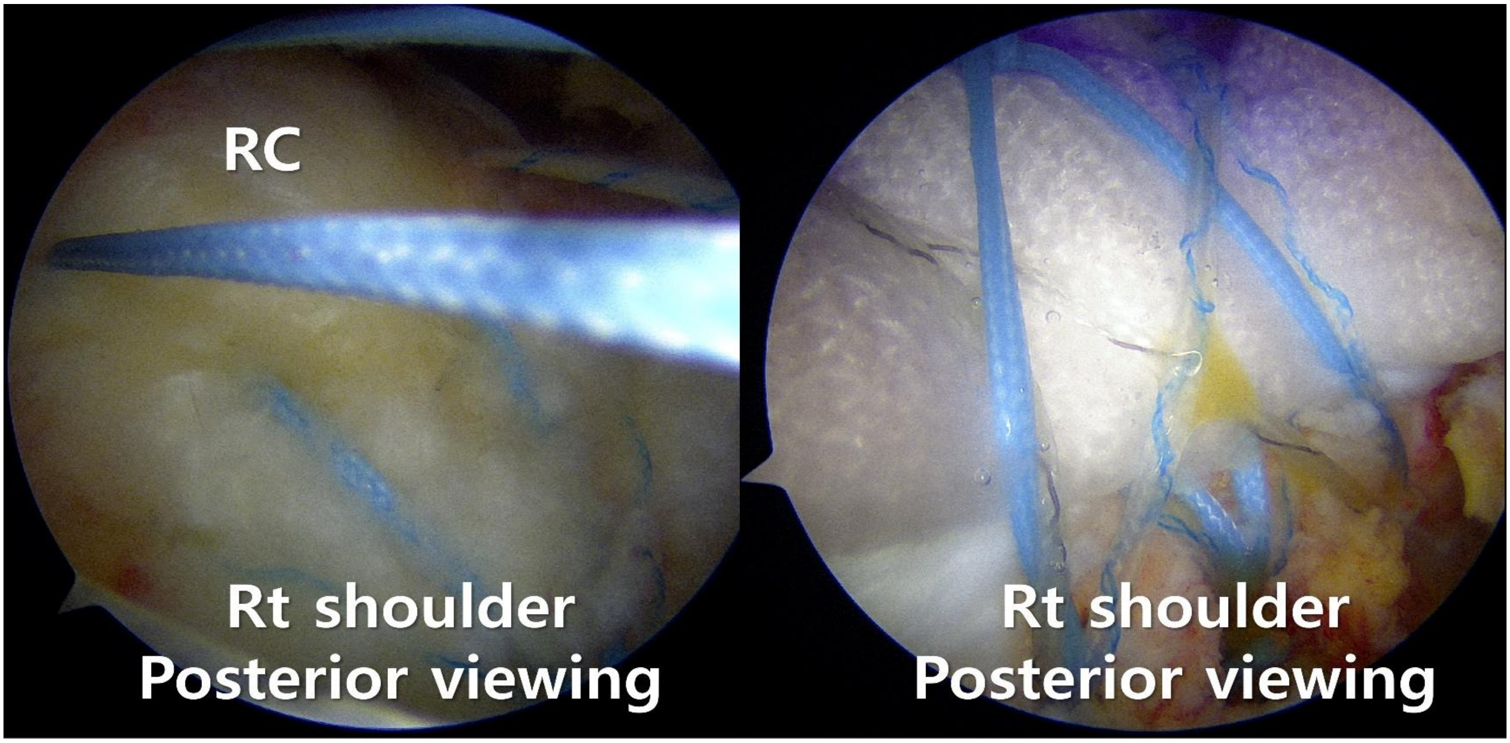

Figure 4: Repair-first hybrid augmentation using a biocomposite scaffold (BioBrace™). After completion of the primary rotator cuff repair, the scaffold is trimmed to adequately cover the repaired tendon and positioned over the footprint. The remaining six suture limbs from the medial-row anchor are then utilized for scaffold fixation. These limbs are divided into two groups of three and secured laterally in a suture-bridge configuration using two additional lateral-row anchors (MultiFix S, Smith and Nephew, Andover, MA, USA), thereby completing the construct in a repair-first hybrid fashion.

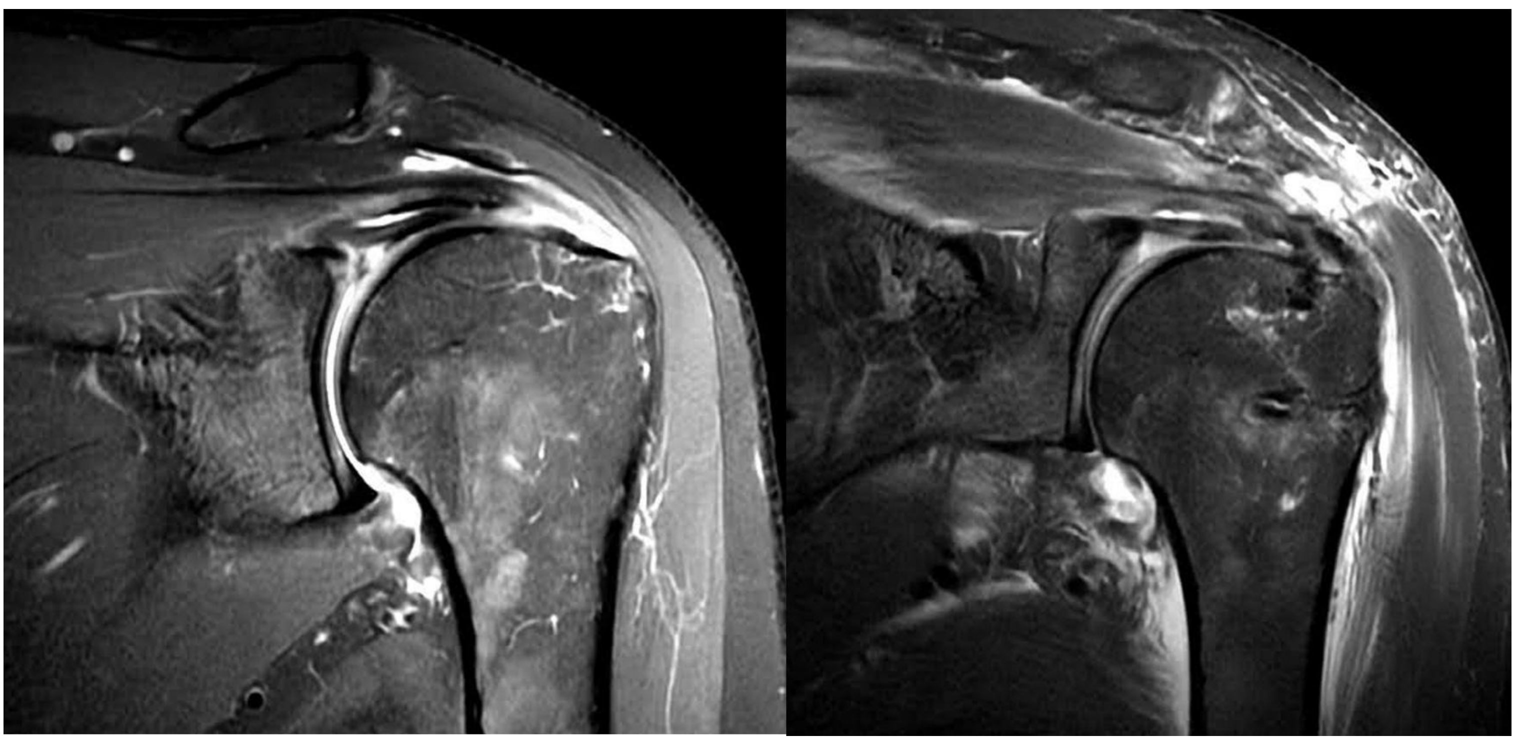

Figure 5: T2-weighted coronal magnetic resonance imaging of the shoulder. (A) Preoperative image demonstrating a large rotator cuff tear with tendon retraction; (B) Postoperative image showing restoration of tendon continuity after repair, with the overlying scaffold visible at the repaired cuff.

Discussion

Recent developments have focused on biocomposite scaffolds designed to address both mechanical and biological aspects. BioBrace™ (CONMED, Largo, FL, USA) is composed of a highly porous type I collagen matrix reinforced with bioresorbable poly(L-lactide) microfilaments. This construct is intended to provide initial mechanical support while facilitating host tissue ingrowth and remodeling [11,12]. These characteristics suggest a potential role in addressing the limitations associated with purely biological or purely structural augmentation materials.

In addition to scaffold characteristics, the method of fixation is a critical factor influencing the effectiveness of patch augmentation. Previous biomechanical studies have demonstrated that fixation technique significantly affects structural stability. In particular, Jung, et al., described a hybrid technique that demonstrated superior biomechanical performance compared with conventional repair constructs [13]. Importantly, in this context, the hybrid technique does not refer to a simple combination of different fixation methods. Rather, it is defined as a repair-first strategy in which the rotator cuff is initially repaired, followed by augmentation using the remaining sutures to secure the patch. This configuration allows the patch to function as a secondary load-sharing structure while minimizing stress concentration at the suture-tendon interface [13]. Lee, et al., demonstrated that triple-row suture-bridge constructs provide superior biomechanical strength compared with conventional techniques [14].

Currently available patch materials can be broadly categorized into those primarily intended for mechanical reinforcement and those aimed at promoting biological regeneration. Acellular dermal matrix-based grafts, including human allografts and xenograft dermal matrices, have been widely used to enhance load-sharing across the repair site and improve initial mechanical stability [15,16]. Similarly, synthetic scaffolds based on poly(L-lactide) have been explored for their ability to increase time-zero biomechanical strength [17]. However, these materials primarily function as structural supports and are not specifically designed for active tendon-like tissue induction.

In contrast, bioinductive collagen implants are intended to improve the biological environment for healing. Devices such as Regeneten® (Smith+Nephew, Andover, MA, USA) have been reported to promote host tissue ingrowth, collagen deposition and increased tendon thickness [19]. Nevertheless, their relatively low intrinsic mechanical strength limits their ability to provide structural reinforcement immediately after implantation.

From this perspective, BioBrace™ (CONMED, Largo, FL, USA) represents an approach that aims to address both mechanical and biological aspects within a single scaffold. As a biocomposite construct composed of a type I collagen matrix reinforced with bioresorbable poly(L-lactide) microfilaments, it is designed to provide initial mechanical support while facilitating tissue ingrowth and remodeling [11,12]. However, whether these theoretical and preclinical advantages translate into improved clinical outcomes remains to be determined.

Importantly, the effectiveness of patch augmentation depends not only on the material itself but also on the method of fixation. Jung, et al., demonstrated that biomechanical outcomes vary significantly depending on fixation strategy [13]. In their study, the so-called hybrid technique showed superior mechanical performance compared with both standard repair and integrated patch techniques. Importantly, in this context, the hybrid technique should not be interpreted as a simple combination of fixation methods, but rather as a repair-first approach in which the rotator cuff is first repaired and the patch is subsequently secured using the remaining sutures. This configuration allows the patch to function as a secondary load-sharing structure while reducing stress concentration at the suture-tendon interface [13].

The present technique is based on this concept. By completing a stable primary repair prior to scaffold fixation, this approach may minimize stress concentration associated with integrated techniques while providing more effective load sharing compared with simple onlay augmentation. In addition, the use of remaining suture limbs for scaffold fixation enables controlled integration without compromising the integrity of the primary repair construct [13,14]. The primary repair in this technique is performed using a construct based on the biomechanical principles of the triple-row suture-bridge configuration described by Lee, et al. [14]. This approach allows improved footprint coverage and more uniform load distribution, which have been associated with enhanced mechanical stability. By combining a robust primary repair with subsequent scaffold augmentation, the present technique aims to optimize both the structural integrity of the repair and the potential contribution of the scaffold.

Limitations

From a technical standpoint, several considerations are important for successful application of this approach. First, achieving a tension-free primary repair is essential, as excessive tension may compromise both fixation strength and biological healing [5,6]. Second, accurate and individualized passage of suture limbs through the tendon is critical to ensure balanced load distribution. Third, the scaffold should be positioned to adequately cover the footprint without excessive tension, allowing it to function effectively as a secondary load-sharing structure. Conversely, premature incorporation of the scaffold into the primary repair or excessive tightening of sutures may increase stress concentration and negate the potential advantages of the hybrid configuration.

Taken together, the key feature of this technique lies in performing a strong primary repair followed by scaffold fixation using the remaining sutures, thereby creating a secondary load-sharing construct rather than a simple covering layer. Given the combined mechanical and biological characteristics of biocomposite scaffolds, this repair-first hybrid augmentation approach may offer a strategy to address both mechanical overload and insufficient biological healing, which are recognized contributors to rotator cuff repair failure.

Nevertheless, as this report describes a surgical technique, its clinical effectiveness remains to be established. Further studies, including prospective comparative trials, long-term imaging follow-up and evaluation of structural integrity and functional outcomes, are required to validate the potential benefits of this approach.

Conclusion

This technical report presents a repair-first hybrid augmentation technique using a biocomposite scaffold for rotator cuff repair. By applying the scaffold after completion of a stable primary repair, this approach is intended to preserve the integrity of the repair construct while introducing an additional load-sharing mechanism. This technique may represent a practical strategy for managing large to massive rotator cuff tears. Further clinical studies are required to evaluate its impact on structural integrity and functional outcomes.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Acknowledgement

The authors have no acknowledgments to declare.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

This technical report describes a surgical technique and does not include identifiable patient information. All procedures were performed in accordance with institutional guidelines. The study was reviewed by the Dankook University Medical Center Institutional Review Board and was deemed exempt from approval.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

J.S.Y. conceived and designed the study. K.C.K. and J.W.P. contributed to surgical technique development and manuscript preparation. All authors reviewed and approved the final manuscript.

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