Technical Note

Dynamic Biceps Rerouting for Irreparable Posterior-Superior Rotator Cuff Tear

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Abstract: Irreparable posterior-superior rotator cuff tear (IPSRCT) is a common clinical condition. Many methods of transfer of the long head of the biceps (LHB) have been developed to augment the shoulder superiorly, with the best method using the LHB still being pursued. In this article, we introduce a special method using the LHB to address IPSRCT: arthroscopic dynamic LHB rerouting. The main steps of this technique include opening the native bicipital groove, creating a new bicipital groove through the greater tuberosity, rerouting the LHB into the new bicipital groove without LHB fixation, and side-to-side rotator cuff repair over the LHB. Our clinical experience indicates this technique can be easily and safely performed according to certain guidelines. We think the introduction of this technique will bring special insight to superior shoulder augmentation in case of IPSRCT.

In the treatment of an irreparable posterior-superior rotator cuff tear (IPSRCT), the long head of the biceps (LHB) is a target structure that can be made use of. There are various methods reported to make use of the LHB, which can be classified as LHB rerouting, LHB transfer after tenotomy, in situ use, and LHB use as a free graft. LHB rerouting means changing the passage of the LHB while keeping both its proximal glenoid attachment and distal muscular connection intact. To treat a posterior-superior rotator cuff tear (RCT), LHB rerouting is specially defined as pulling the LHB out of the native LHB groove and relocating it posteriorly and laterally to a new groove through the greater tuberosity.

Compared with LHB transfer after tenotomy and use as a free graft, LHB rerouting may have the advantage of pressing the humeral head dynamically because there is tension or contraction force within the structure. Compared with in situ use of the LHB, relocating the LHB through the greater tuberosity may be beneficial for the LHB to exert higher depression force.

LHB rerouting can be classified as either static or dynamic rerouting, in which fixation of the rerouted LHB to the greater tuberosity is either performed or not. Theoretically, dynamic rerouting, which means rerouting the LHB without fixation, may be more beneficial than static rerouting in terms of the transferred LHB undergoing the best humeral head−depression effect through muscle contraction and tendon micromotion.

Previously, only arthroscopic static LHB rerouting was described.[1] Thus, we would like to introduce an arthroscopic dynamic LHB rerouting technique. The main steps of this technique include opening the native LHB groove, creating a new LHB groove through the greater tuberosity, relocating the LHB to the new groove, and creating a soft-tissue cover above the rerouted LHB through side-to-side rotator cuff repair.

Surgical Indications

The indications for biceps rerouting are a U- or V-shaped IPSRCT (Fig 1A) and a reparable RCT combined with obvious enlargement or hypertrophy of the proximal LHB. The relative indications for LHB rerouting are other kinds of IPSRCTs.

LHB enlargement, which is commonly combined with RCT, may indicate use-induced structural compensation to rotator cuff dysfunction, which means the LHB enlarges owing to the increased requirement for humeral head depression by the LHB tendon along

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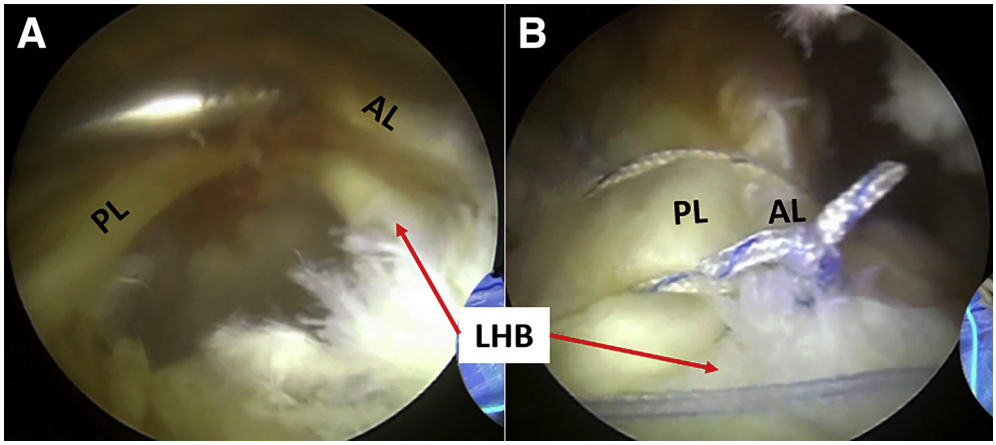

Fig 1. U-shaped irreparable rotator cuff tear before (A) and after (B) transfer of long head of biceps (LHB) and side-to-side rotator cuff repair (right shoulder arthroscopically viewed from lateral portal). (AL, anterior leaf of rotator cuff; PL, posterior leaf of rotator cuff.)

with rotator cuff dysfunction. In case of LHB enlargement, preservation of the LHB and retention of its humeral head–depressing function by rerouting the LHB may be beneficial to the restoration of shoulder function.

Surgical Procedures

Intra-articular and Subacromial Debridement

Routine posterior, anterior, and lateral portals are created. Intra-articular debridement is performed through anterior and posterior portals. Subacromial debridement and decompression are performed through posterior and lateral portals (Table 1).

Table 1. Step-by-step Surgical Procedures in Dynamic Biceps Rerouting for Irreparable Posterior-Superior Rotator Cuff Tear

1. Intra-articular debridement, subacromial debridement, and subacromial decompression are performed.
2. A switching stick is placed into the anterior subdeltoid space to elevate the anterior deltoid.
3. A far-lateral portal is created. Debridement is performed in the anterolateral subdeltoid space.
4. At the proximal edge of the insertion of the pectoralis major, the LHB that goes inferior to its insertion is found.
5. A far-anterior portal is created. Debridement in the anterior subdeltoid space and rotator interval release are performed.
6. The transverse humeral ligament is released to expose the LHB underneath.
7. The proximal aponeurosis of the pectoralis major is released by approximately 2 cm.
8. The LHB is ligated at the proximal edge of the pectoralis major with a PDS suture for later traction.
9. A new LHB groove is fabricated through the greater tuberosity.
10. The LHB is pulled out of the native LHB groove and located in the new LHB groove.
11. Another PDS suture is placed around the proximal part of the LHB.
12. The LHB is pulled posteriorly to expose the anterior edge of the new LHB groove.
13. Two double-loaded suture anchors are placed at the anterior edge of the new LHB groove.
14. Side-to-side rotator cuff repair is performed above the transferred LHB.

LHB, long head of biceps; PDS, polydioxanone.

Elevation of Anterior Deltoid

With the arthroscope placed into the subacromial space for observation, a switching stick is placed into the anterior subdeltoid space to elevate the anterior deltoid. The arthroscope is placed into the anterolateral subdeltoid space through the lateral portal (Video 1).

Locating LHB at Proximal Edge of Pectoralis Major

On the lateral midline of the upper arm, a far-lateral portal is created at a distance of 7 cm from the lateral edge of the acromion. A shaver is placed through the far-lateral portal to perform debridement in the anterolateral subdeltoid space.

The shaver is used to press against the humerus to perform proximal-to-distal sliding, from the lateral to the anterolateral side of the humerus. The superior edge of the insertion of the pectoralis major is detected when resistance is felt during this maneuver. In this position, the LHB that goes inferior to the pectoralis major insertion is found.

Debridement in Anterior Subdeltoid Space and Rotator Interval Release

A far-anterior portal is created over the anterior route of the LHB, facing the proximal edge of the pectoralis major. Debridement is performed in the anterior subdeltoid space to remove all inflammatory or hypertrophied synovial tissues. Rotator interval release is performed through the far-anterior portal.

Opening Native LHB Groove

With the arthroscope placed through the lateral portal and a radiofrequency wand or a shaver placed through the far-anterior portal, the transverse humeral ligament is released to expose the LHB underneath (Fig 2). The proximal aponeurosis of the pectoralis major is released by approximately 2 cm to facilitate posterolateral

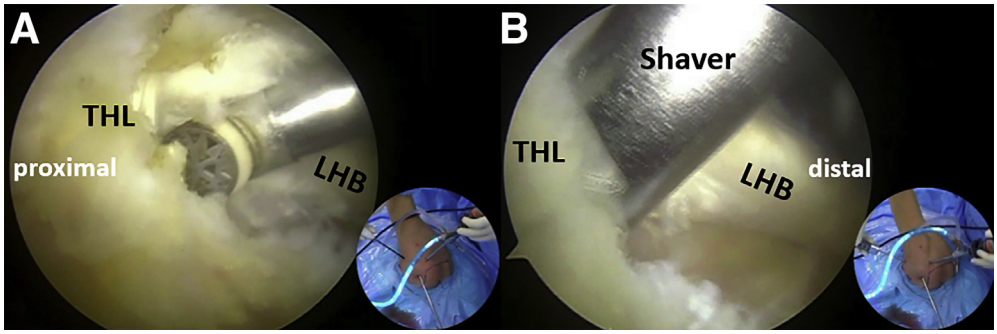

Fig 2. Opening transhumeral ligament (THL) with radiofrequency wand (A) and shaver (B) (right shoulder arthroscopically viewed from lateral portal). (LHB, long head of biceps.)

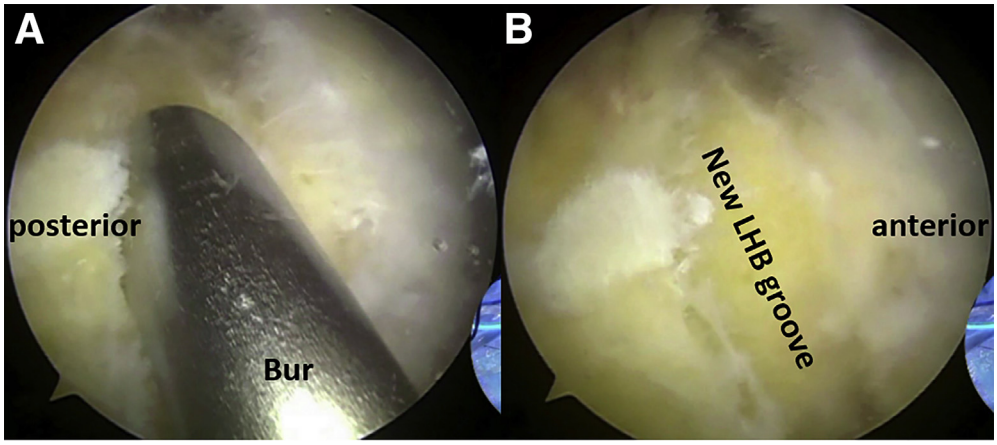

Fig 3. Creation of new bicipital groove through greater tuberosity (B) with arthroscopic burr (A) (right shoulder arthroscopically viewed from lateral portal). (LHB, long head of biceps brachii.)

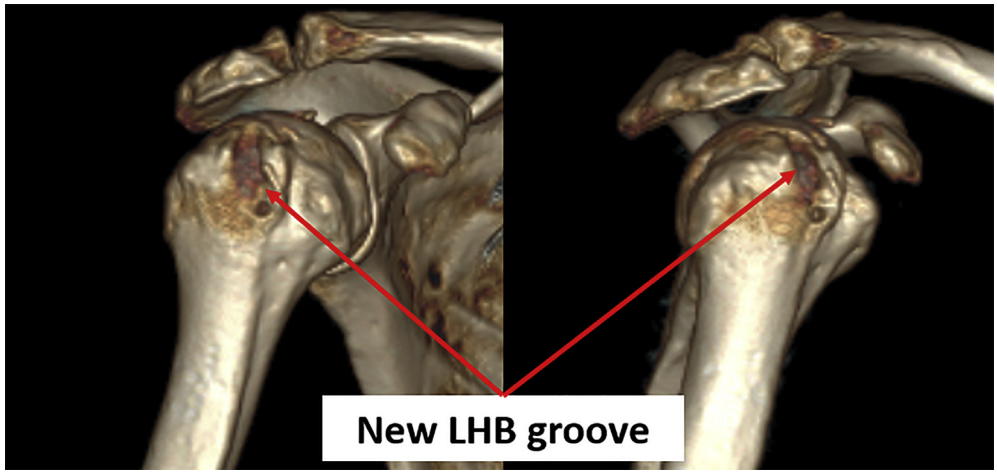

Fig 4. Computed tomography scans of new bicipital groove (right shoulder). The groove is created through the greater tuberosity, with slight anterior deviation distally. (LHB, long head of biceps.)

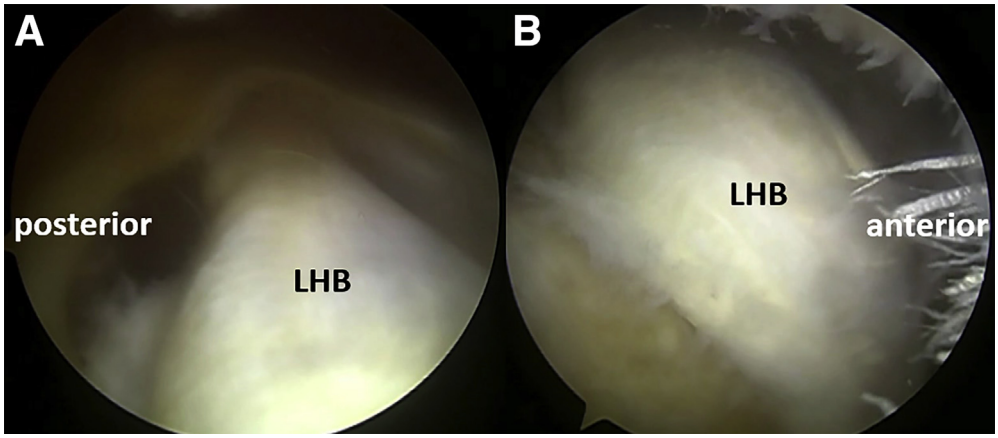

Fig 5. Rerouted long head of biceps (LHB) (right shoulder arthroscopically viewed from posterolateral portal). It is centralized in the rotator cuff tear (A) and passes through the greater tuberosity (B).

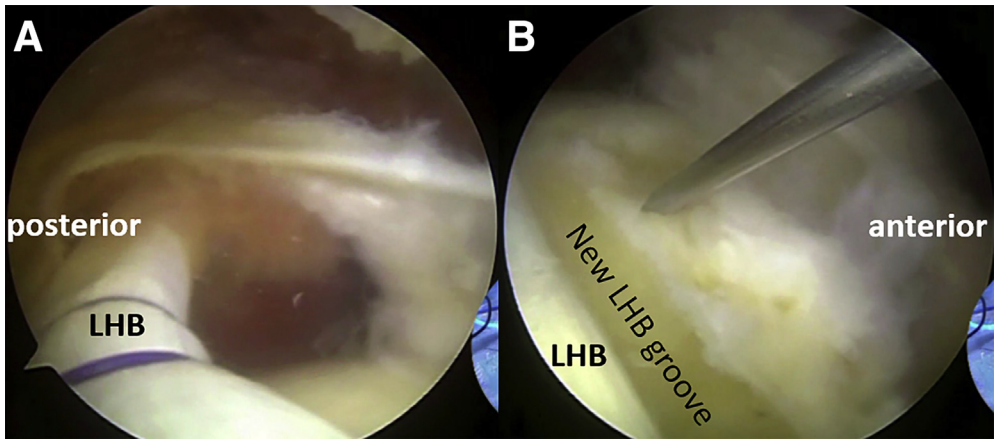

Fig 6. By pulling the long head of the biceps (LHB) posteriorly (A), the anterior edge of the new bicipital groove is exposed (B) (right shoulder arthroscopically viewed from posterolateral portal).

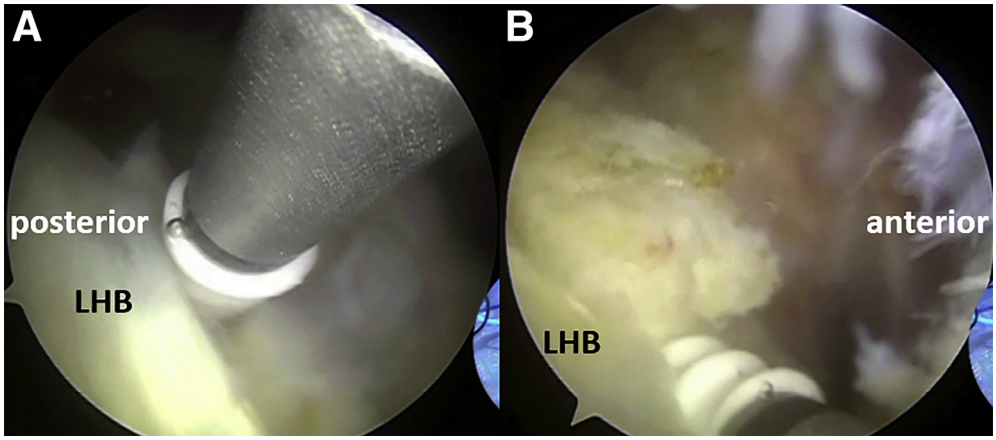

Fig 7. Placement of suture anchors (right shoulder arthroscopically viewed from posterolateral portal). The suture anchors are placed at the anterior edge of the new bicipital groove, with one located at the most proximal site (A) and the other located at the lateral tip of the greater tuberosity (B).

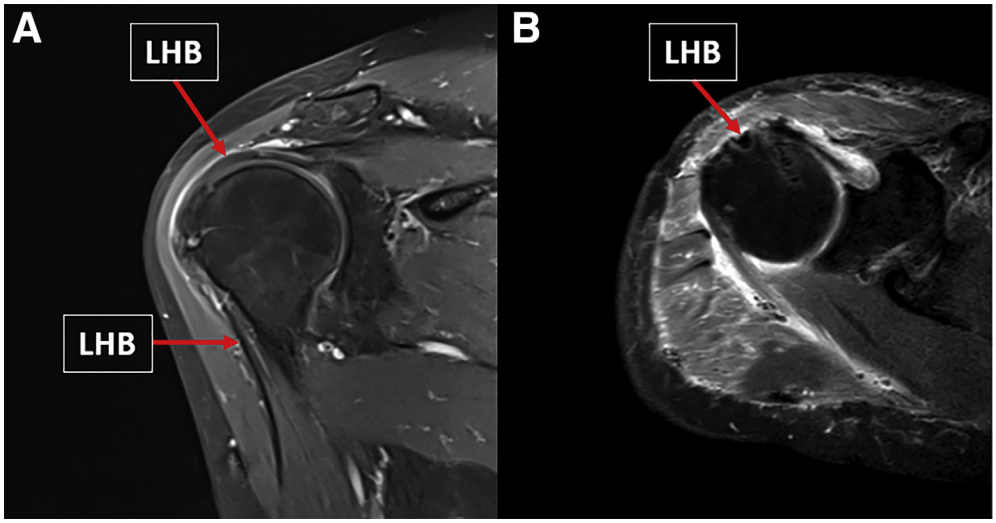

Fig 8. Rerouted long head of biceps (LHB) on magnetic resonance imaging (right shoulder): oblique coronal (A) and transverse (B) views.

transfer of the LHB. The LHB is ligated at the proximal edge of the pectoralis major with a polydioxanone suture for later traction.

Fabricating New LHB Groove

A longitudinal groove, located in the middle of the RCT with a depth and width that can accommodate the enlarged LHB, is created from the cartilage edge of the humeral head, through the greater tuberosity, to a site approximately 2 cm distal to the tip of the greater tuberosity. The new LHB groove deviates slightly anteriorly at its distal end (Figs 3 and 4).

Table 2. Pearls and Pitfalls of Dynamic Biceps Rerouting for Irreparable Posterior-Superior Rotator Cuff Tear

Using the Posterior or Anterior Leaf of the rotator Cuff to Cover the Bicipital Groove Depends on the Movability of the 2 Leaves. When the Movability of the Anterior Leaf is Greater, the Suture Anchors are Placed at the Posterior Edge of the new LHB Groove to Bring the Anterior Leaf over the new Groove.
Dynamic rerouting is mainly indicated for U- or V-shaped large or massive rotator cuff tears but is also indicated for other kinds of rotator cuff tears when a groove cover can be created. It is unsuitable for rotator cuff tears in which a groove cover cannot be created, in which condition static biceps rerouting may be more suitable.
The superior part of the aponeurosis of the pectoralis major should be released. Otherwise, posterior transfer of the LHB may be hindered.
The size of the groove should be slightly larger than the size of the LHB. Otherwise, micromotion of the LHB within the groove may be hindered.
When a remnant rotator cuff connection between the native and new LHB grooves exists, this part of the rotator cuff is detached with a thin layer of cortical bone to allow posterior transfer of the LHB. The detached rotator cuff is subsequently reattached by side-to-side rotator cuff repair.
In case of a combined SLAP lesion, SLAP repair is first performed, before LHB transfer.

LHB, long head of biceps.

Rerouting LHB

The distal traction suture is pulled out through the posterior portal. The LHB is pulled out of the native LHB groove and located in the new LHB groove (Fig 5).

Placement of Suture Anchors

Another polydioxanone suture is placed around the proximal part of the LHB. The LHB is pulled posteriorly to expose the anterior edge of the new LHB groove (Fig 6). Two double-loaded suture anchors are placed at the anterior edge of the new LHB groove, with one located at the most proximal site and the other located at the lateral tip of the greater tuberosity (Fig 7).

Side-to-side Rotator Cuff Repair Above Transferred LHB

With the sutures from the suture anchors, side-to-side repair of the rotator cuff to bone is performed. The posterior leaf of the torn rotator cuff is pulled over the LHB to the anterior edge of the new LHB groove to create a cover above the transferred LHB and the new LHB groove (Figs 1B and 8).

Table 3. Advantages and Disadvantages of Dynamic Biceps Rerouting for Irreparable Posterior-Superior Rotator Cuff Tear

Advantages
The LHB can be easily used.
Creating the groove cover and performing rotator cuff repair can be realized through 1 step: side-to-side rotator cuff repair.
Disadvantages
The bottom of the new LHB groove is not as hard and smooth as the native groove, which may hinder the micromotion of the LHB within the groove.
Pain originating from the LHB may not be relieved owing to LHB preservation.
The LHB occupies the footprint area, which may hinder the healing of the rotator cuff to the greater tuberosity.

LHB, long head of biceps.

Table 4. Risks of Dynamic Biceps Rerouting for Irreparable Posterior-Superior Rotator Cuff Tear

During opening of the Transverse Humeral Ligament to Expose the LHB with a Radiofrequency Probe, the Biceps Tendon may be cut Inadvertently.
When the newly created bicipital groove is too close to the native groove, fracture of the greater tuberosity between the 2 grooves may occur.
In case of severe regional osteoporosis, the lateral anchor may be pulled out.
Too forceful side-to-side merging of the rotator cuff may result in suture cutting through the rotator cuff.

LHB, long head of biceps.

Discussion

In the treatment of IPSRCTs, the LHB is a neighboring structure that can be easily made use of. Apart from LHB rerouting, in situ use of the LHB has long been reported, in which the rotator cuff converged with or was repaired to the LHB without any disruption or rerouting of the LHB tendon.[2] Transferring the LHB transversely after release of its glenoid attachment is a way to amend the rotator cuff defect at the cost of losing its connection with the glenoid and humeral head.[3] Transferring the LHB tendon to the greater tuberosity after distal tenotomy is appealing because this kind of procedure mimics superior capsular reconstruction. There are various ways to perform LHB transfer after distal tenotomy. The LHB tendon can be used as a single-string,[4,5] double-string,[6] or triple-string structure.[7] The simplest way is to cut out the LHB tendon and use it as free graft tissue.[8] All these methods try to bridge the rotator cuff or glenoid and the humeral head (rotator cuff or superior capsular reconstruction).

Static biceps rerouting can be considered an advanced superior capsular reconstruction, with more tension within the reconstructed structure compared with routine superior capsular reconstruction. The nature of dynamic LHB rerouting is neither rotator cuff reconstruction nor superior capsular reconstruction. This special procedure may take effect through the establishment of a dynamic humeral head—depressing structure.

Compared with other manners of using the LHB tendon in irreparable rotator cuff repair, dynamic LHB rerouting may be the simplest way. Apart from routine manipulation of rotator cuff repair, all we need for dynamic LHB rerouting is to open the native LHB groove, create a new groove, and relocate the LHB in the new groove. Pearls and pitfalls are listed in Table 2. One critical step is releasing the proximal part of the aponeurosis of the pectoralis major to facilitate posterior transfer of the LHB.

The advantages and disadvantages of this technique are listed in Table 3, and the risks are presented in Table 4. The main disadvantage of this technique is that pain originating from the LHB or related pain may not be relieved owing to LHB preservation. Regarding the clinical results after use of the LHB in the repair of IPSRCTs, high-quality assessment in large series with long-term follow-up is still lacking. Further studies are needed to compare all the different aforementioned methods using the LHB.

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