JSES Reviews, Reports, and Techniques 4 (2024) 588–593

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Reverse total shoulder arthroplasty for proximal humerus fracture: tuberosity repair technique

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ARTICLE INFO

Keywords:
Reverse shoulder
Arthroplasty
Proximal humerus fracture
Tuberosity repair
Cerclage

Level of evidence: Technical Note

Proximal humerus fractures are common injuries that can be treated nonoperatively or operatively. Operative treatment options include open reduction and internal fixation (ORIF), hemiarthroplasty, or reverse total shoulder arthroplasty (RSA). RSA has recently increased in popularity, especially for patients greater than 65 years old, with data supporting good functional outcomes and implant survival.[5,7,9] RSA is likely superior to ORIF in terms of both reoperation rate and patient function for older patients.[4,12] Tuberosity healing after RSA for proximal humerus fracture has been associated with improved shoulder range of motion and patient-reported outcome when compared to tuberosities that do not heal or for which no repair is attempted.[8,10] Yet RSA presents unique challenges for the surgeon, one of which is obtaining reduction and stable fixation of the greater and lesser tuberosities so that they heal in an anatomic position. In light of these data and the importance of tuberosity repair and healing, the purpose of this article is to describe our technique for tuberosity repair after RSA.

Indications

- Comminuted proximal humerus fractures (more specifically, three- and four-part proximal humerus fractures and fracture dislocations) in patients at risk of failing ORIF, eg, older patients with poor bone quality.

Contraindications

- Fracture pattern more amenable to nonoperative treatment, ORIF, or hemiarthroplasty.
- Patients medically unfit for surgery.
- Active infection.
- Pathologic fracture requiring extensive bony resection.

Alternatives to the technique

There are various other techniques for tuberosity repair after RSA for proximal humerus fracture.[3,6] In a biomechanical model, Erickson et al compare two types of repair, one that anchors the repair through prefabricated eyelets in the prosthesis, and another that does not. Of the various repair techniques, the technique that anchors the repair using the eyelets in the humeral stem is most similar to ours but does not use a cerclage tensioning system nor a circumferential suture configuration.[3]

Description of the technique

An equipment list is presented in Table I. The steps listed here begin after the definitive glenosphere is implanted and after humeral broaching and trialing are complete.

As a case example, preoperative and postoperative images of a 78-year-old woman with a left proximal humerus fracture dislocation are shown in Fig. 1 and demonstrate greater and lesser tuberosity reduction after RSA using the technique described in this article.

Institutional review board approval was not required for this technique article.

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https://doi.org/10.1016/j.xrrt.2023.09.006
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Table I
Equipment list.

Item	Count
#2 braided nonabsorbable white sutures with closed loop end (TigerLink; Arthrex, Naples, FL, USA)	4
#2 braided nonabsorbable blue sutures with closed loop end (FiberLink; Arthrex, Naples, FL, USA)	2
FiberTape cerclage suture (FiberTape with pretied knot and nitinol passing wire)	2
FiberTape Cerclage Modular Instrument Set, containing suture passer and reusable tensioner (Arthrex, Naples, FL, USA)	1
Humeral component with slots for suture fixation (Univers Revers Suture Cup; Arthrex, Naples, FL, USA)	1
Free needle	1

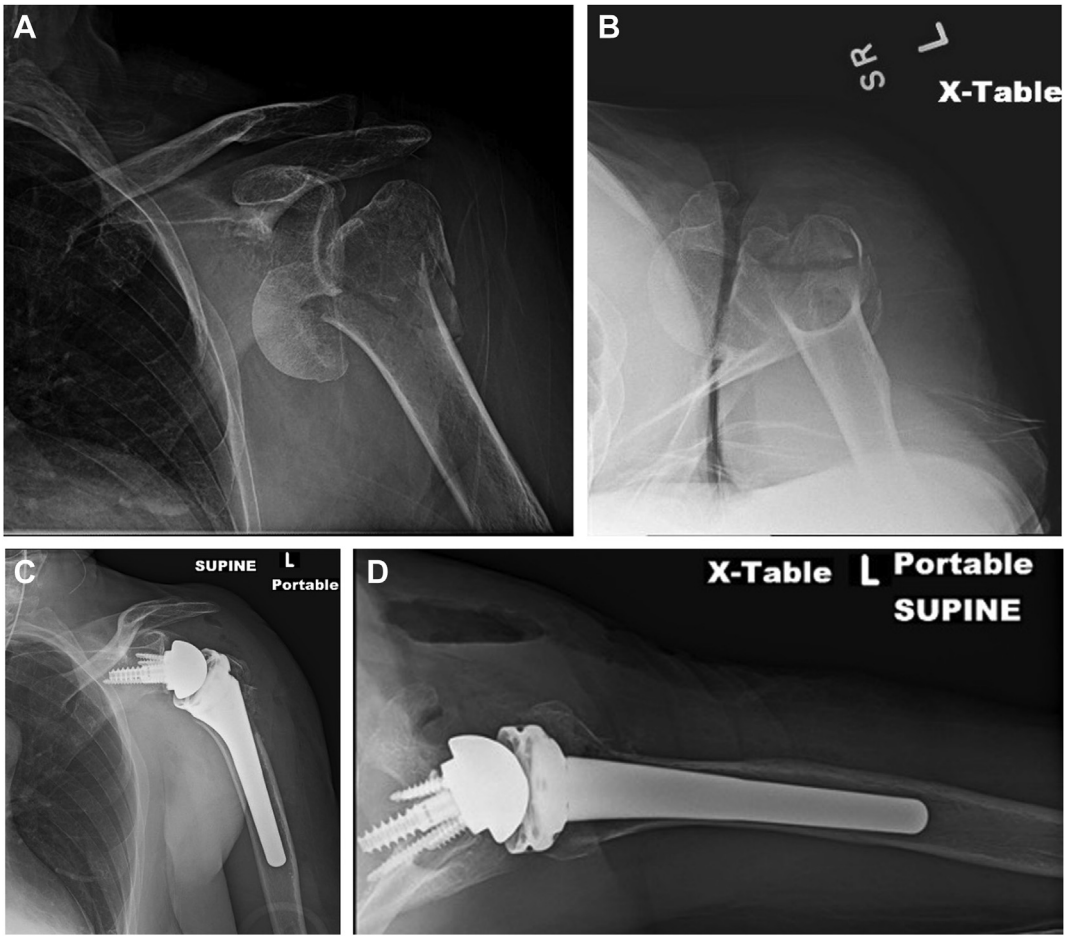

Figure 1 (**A, B**) Preoperative radiographs of a 78-year-old woman with a left proximal humerus fracture dislocation. (**C, D**) Postoperative radiographs demonstrate greater and lesser tuberosity reduction after RSA. *RSA*, reverse total shoulder arthroplasty.

Step 1. Place one of the FiberTape cerclage sutures around the most proximal extent of intact humerus

After passing the FiberTape (Arthrex, Naples, FL, USA) cerclage, cut the looped end to create two FiberTape limbs. Take both limbs and pass them through the nitinol loop, which allows passage of the two limbs through the pretied knot in the cerclage system. Tension the cerclage, tie a half-hitch over the pretied knot, and tension the cerclage a second time. Clamp the two FiberTape limbs and set them aside. Each limb will later pass through the superior portion of the rotator cuff at the bone-tendon junction.

Step 2. Prepare the greater tuberosity for FiberTape passage with two FiberLink and two TigerLink sutures

The greater tuberosity is prepared with two Tigerlink (Arthrex, Naples, FL, USA) passing sutures in the posterior rotator cuff and two FiberLink passing sutures in the superior rotator cuff (sutures #1 through #4, Fig. 2). The passing sutures are passed through the tendon at the bone-tendon junction. Ensure that the looped end of each suture is superficial to the tuberosity.

Step 3. Prepare the humeral implant for suture passage

Two TigerLink passing sutures are placed through the eyelets within the humeral component (Univers Revers; Arthrex, Naples, FL, USA) (sutures #5 and #6, Fig. 3). This will allow for the passage of FiberTape through the eyelets and eventually for the fixation of the tuberosities to the prosthesis. Tuberosity fixation that incorporates the humeral component has been shown to increase construct strength.[3] The humeral component can now be implanted. The shoulder is reduced and assessed for stability and range of motion before the surgeon proceeds to the next step.

Figure 2 Top: Image of the left shoulder. Bottom: Inset from top image showing TigerLink and FiberLink configuration. The greater tuberosity is prepared with two Tigerlink passing sutures in the posterior rotator cuff and two FiberLink passing sutures in the superior rotator cuff (labeled sutures #1 through 4 above). These passing sutures are passed through tendon at the bone-tendon interface so that the looped part of the suture is superficial to the tuberosities. They will be used to pass FiberTape from each of the two FiberTape cerclage systems through the rotator cuff.

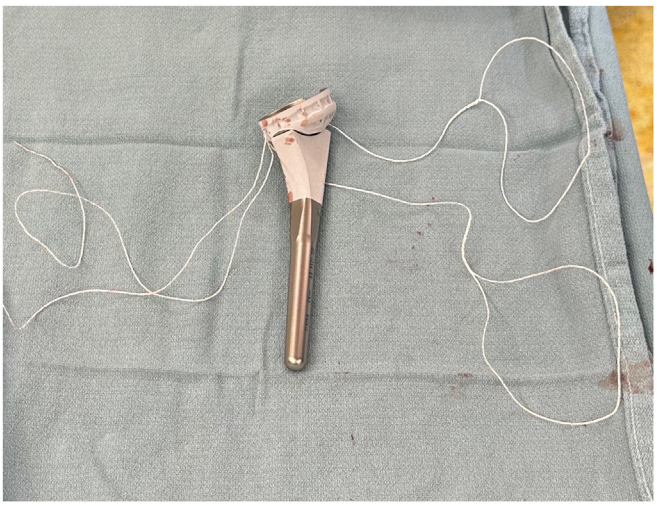

Figure 3 Two #2 braided nonabsorbable white sutures with closed loop (Tigerlink; Arthrex, Naples, FL, USA) are passed through the slots within the humeral component (Univers Reverse; Arthrex, Naples, FL, USA). They are labeled as suture #5 and suture #6. This will allow for passage of FiberTape through the slots of the humeral component and eventually fixation of the tuberosities to the prosthesis.

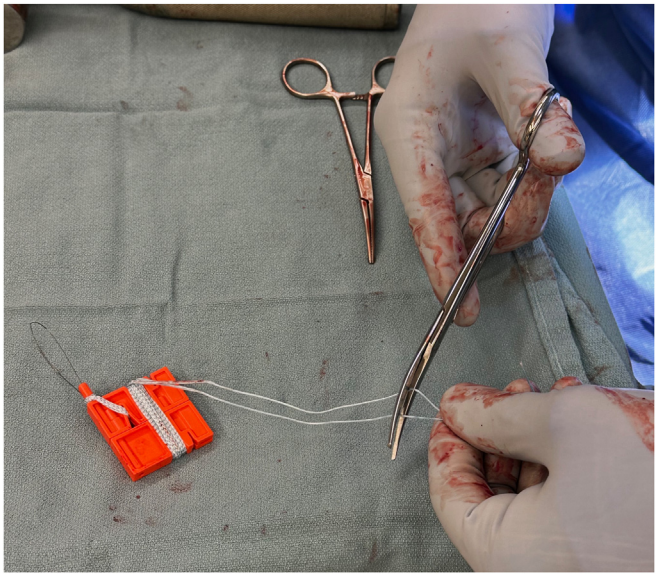

Figure 4 The Fibertape cerclage (Arthrex, Naples, FL, USA) has a looped end ie, cut. Note the nitinol wire on the plastic cartridge ie, used to pass the FiberTape through the pretied knot.

Step 4. Pass FiberTape from the cerclage system through the posterior rotator cuff

Cut the looped end of the second FiberTape cerclage to create two FiberTape limbs (Fig. 4). One limb is passed through the first TigerLink passing suture. The FiberTape will pass through the inferior portion of the posterior rotator cuff (suture #4, Fig. 5). This process is repeated for the superior portion of the posterior rotator cuff (suture #3, Fig. 5).

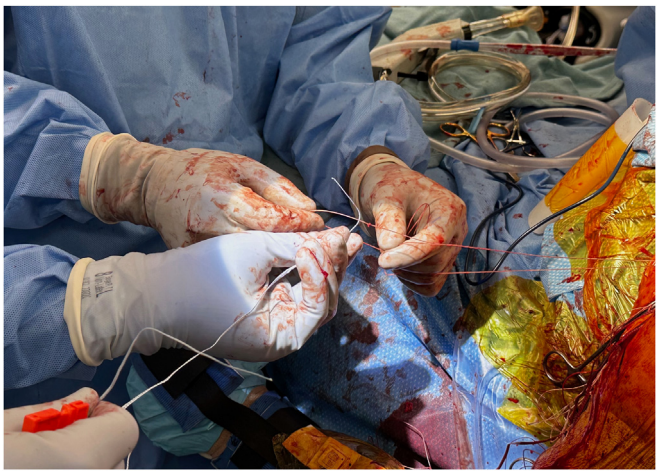

Figure 5 One limb of the FiberTape from the cerclage is passed through the first TigerLink passing suture (suture #4). The FiberTape will pass through the inferior portion of the posterior rotator cuff. This process is repeated for the superior portion of the posterior rotator cuff (suture #3).

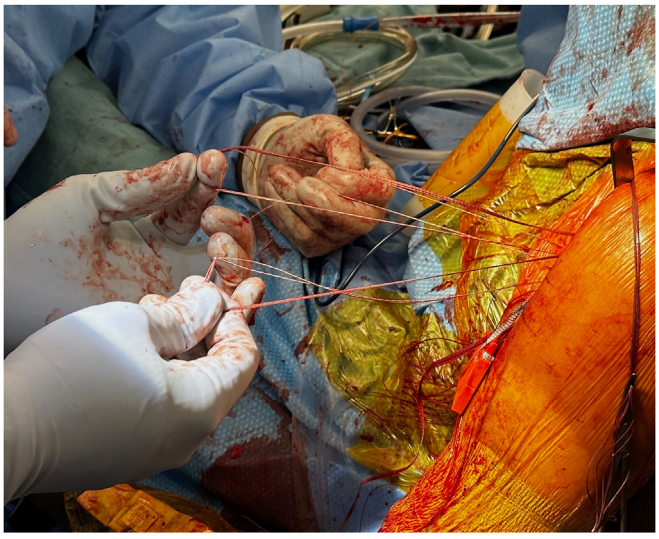

Figure 6 The FiberTape is now through the posterior rotator cuff and is loaded in the TigerLink that itself was preloaded through the humeral stem (suture #5 and #6). This allows passage of each limb of the FiberTape around the prosthesis, through the eyelets of the prosthesis.

Step 5. Pass FiberTape from the cerclage system around the humeral component

One limb of the FiberTape, now through the posterior rotator cuff, is loaded into a TigerLink that was preloaded through the humeral component (suture #5, Fig. 6). The FiberTape is passed around the humeral component. The process is repeated for the second limb of FiberTape (suture #6, Fig. 6).

Step 6. Pass FiberTape from the cerclage system through the anterior rotator cuff

A free needle is used to pass one limb of the FiberTape through the anterior rotator cuff at the bone-tendon junction (Fig. 7). The free needle is used to pass the second limb distal

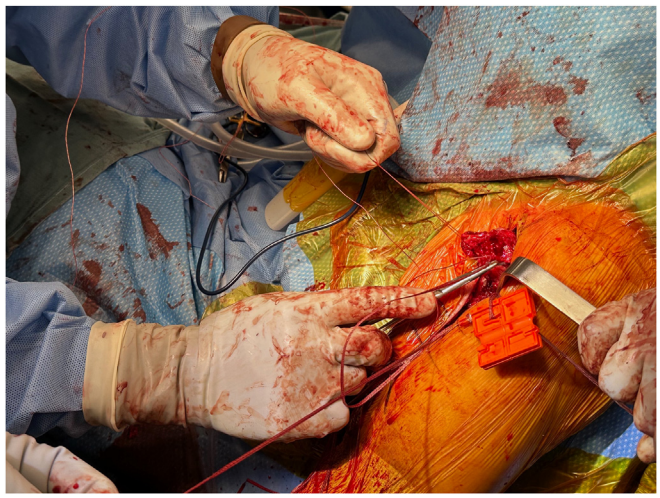

Figure 7 Each limb of FiberTape is now passed with a free needle through the subscapularis. The FiberTape is placed at the bone-tendon junction. One limb is passed inferiorly, and one limb is passed superiorly. Note the use of a #0 Polysorb traction stitch on the lesser tuberosity.

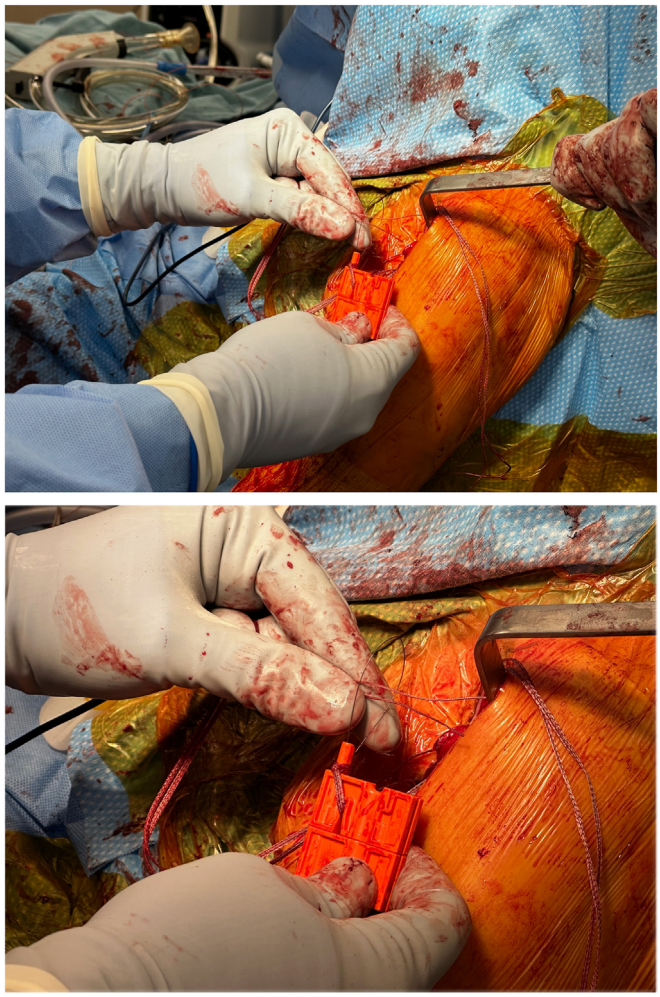

Figure 8 Top and bottom. The two limbs of the FiberTape that will be used for fixation of the anterior and posterior rotator cuff are passed through the pretied knot from the cerclage system.

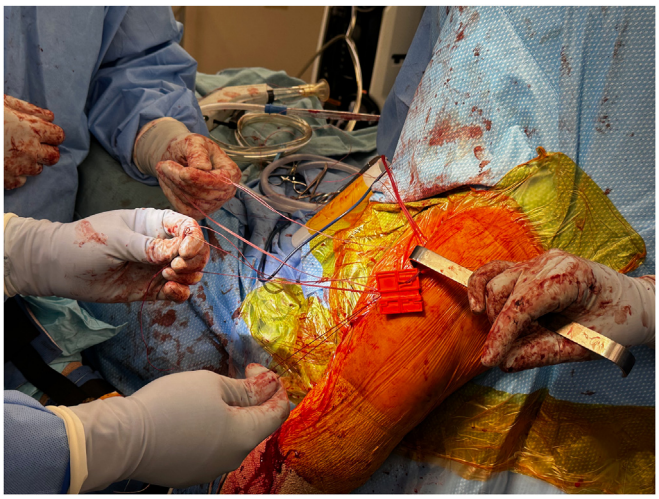

Figure 9 The FiberTape cerclage that was placed around the humerus is now passed through the superior rotator cuff using the two prepositioned FiberLink passing sutures that were placed in the superior rotator cuff (suture #1 and #2).

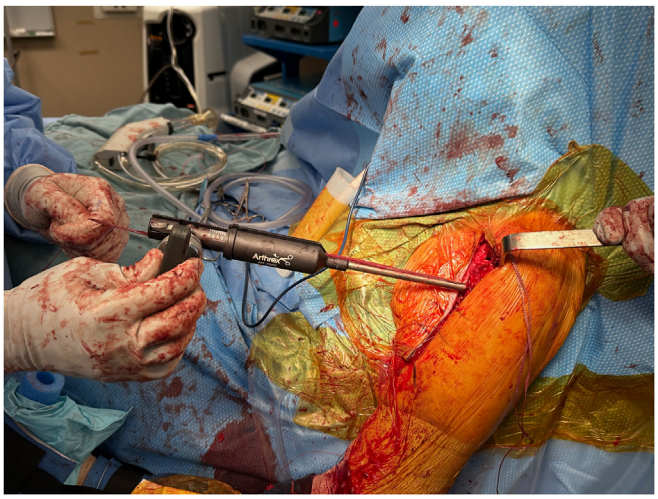

Figure 11 The tensioner is used to secure the cerclage. The tensioner is used twice, once after initial passing of the FiberTape through the pretied knot and again after the surgeon ties one half hitch over the pretied knot.

Figure 10 Autograft is prepared by morcellating cancellous bone from the humeral head. The graft is placed at the base of the stem before reduction and fixation of the tuberosities.

Figure 12 Final fixation construct after the limbs from the circumferential cerclage (posterior and anterior rotator cuff and associated tuberosities) are secured to the limbs from the superior rotator cuff. The rotator interval is not closed.

to the first. Take both limbs and pass them through the nitinol loop, which allows passage of the two limbs through the pretied knot in the cerclage system (Fig. 8). Clamp the FiberTape and set aside.

Step 7. Pass FiberTape through the superior rotator cuff

Each of the two limbs of FiberTape from the cerclage around the humerus is now passed through the superior rotator cuff using the FiberLink passing sutures (sutures #1 and #2, Fig. 9). Clamp the two limbs of the FiberTape and set aside.

Step 8. Place autograft about the humeral component

The humeral head has been morcellated and is used to augment healing (Fig. 10). It is placed about the humeral stem, where the stem meets the humeral shaft.

Step 9. Reduce the tuberosities and obtain fixation using the cerclage tensioner

Take the cerclage that has been passed through the greater and lesser tuberosities and tension the suture, gently manipulating the tuberosities into anatomic position. Use the tensioner device to tension the cerclage (Fig. 11). Tie a half hitch in the cerclage and tension the suture again. The greater and lesser tuberosities are now repaired, with fixation in both the posterior and anterior aspects.

Step 10. Obtain fixation of the superior aspect of the greater tuberosity

The FiberTape limbs that were passed through the superior rotator cuff are now tied to the limbs of the FiberTape from the cerclage that secures the posterior and anterior aspects of the tuberosities. The repair is now complete (Fig. 12). The shoulder joint is taken through a range of motion to ensure stability of the repair. There should be no movement of the tuberosities in relation to the implant after repair is complete.

Discussion

This technique paper describes our approach for tuberosity repair after RSA. A stable and durable repair is important for tuberosity healing, which in turn is important for patient outcomes after RSA. Range of motion is one such patient outcome that has been shown to be superior in patients with healed compared to unhealed tuberosities.[2,10] Importantly, patient-reported outcomes may also be higher for patients with healed tuberosities.[1] Some evidence suggests this is not the case, with similar Constant scores and American Shoulder and Elbow Surgeons scores for patients with tuberosities that heal vs. those with tuberosities that do not heal.[11] Current research is limited by small sample sizes, variable tuberosity repair techniques, variation in prosthesis design, and variation in baseline patient medical and social status, all of which make comparing groups difficult. In the absence of perfect data, we believe obtaining tuberosity reduction, stable fixation, and healing is important for patients undergoing RSA for acute proximal humerus fractures and have presented our technique for achieving this.

Conclusion

RSA for proximal humerus fractures in properly selected patients can be an excellent treatment option. Among many factors that contribute to the success of treatment is tuberosity repair. Our technique for repair is a reproducible way for the surgeon to obtain stable tuberosity fixation after RSA for proximal humerus fracture.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: Jonah Hebert-Davies reports being Consultant Depuy/Synthes, Arthrex. The other author, his immediate family, and any research foundation with which he is affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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