JSES Reviews, Reports, and Techniques 2 (2022) 354–359

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Belt and suspender technique for bipolar bone loss in shoulder instability

Johnny Abboud, MD[a,b,*], Mohamad K. Moussa, MD[c,d], Mohammad O. Boushnak, MD[e,f], Mohammad Jawad H. Rahal, MD[a,b], Nicolas Robial, MD[a,b]

[a]University of Strasbourg, Faculty of Medicine, Strasbourg, France
[b]Department of Orthopedic Surgery and Traumatology, Hôpitaux Civils de Colmar, Colmar, France
[c]Department of Orthopedic Surgery, Grand Hôpital de l'Est Francilien – Site de Meaux, Meaux, France
[d]Faculty of Medicine, University of Paris, Paris, France
[e]Université Libre de Bruxelles, Brussels, Belgium
[f]Department of Orthopedics and Traumatology, ULB Erasme University Hospital, Brussels, Belgium

ARTICLE INFO

Keywords:
Glenoid track
Hill-Sachs
Latarjet
Remplissage
Shoulder instability
Bipolar bone loss

Level of evidence: Level IV

Bipolar glenohumeral bone loss is a challenging condition to address in patients with recurrent anterior shoulder instability. In this category of patients, most isolated soft-tissue procedures such as remplissage or infraspinatus capsulotenodesis are associated with high risk of failure and instability recurrence. Even bony procedures such as Latarjet may fail to provide absolute stability, and instability may eventually recur. For a better understanding of the cause of failure in this particular type of patient, we may refer to the glenoid track concept which has been described as a useful tool for surgical planning. In fact, Latarjet procedure alone may leave a place for engagement of the Hill-Sachs defect on the anterior glenoid resulting in an off-track situation and secondary glenohumeral instability. In this technical note, we present the combination of arthroscopic remplissage and an open Latarjet procedure to treat patients with bipolar glenohumeral bone loss with good results at 31-month follow-up. Our aim is to propose these techniques as a possible rescue procedure for highly unstable shoulders combining engaged Hill-Sachs lesion and glenoid bone loss of more than 25%. We believe this technique would be a good option for patients who present other risk factors of recurrence such as past medical history of epilepsy, laxity, and psychiatric illnesses.

Customized treatment strategies are required to address bipolar glenohumeral bone loss.[4,9]

On the humeral side, it is crucial to determine the size, orientation, on- or off-track, and the engagement of the humeral head defect.[3,11]

On the glenoid side, the size of the bone loss determines the choice of the treatment.[3,11]

Although Latarjet procedure can be a choice in all types of bone loss, some advocates of Bankart procedure propose reserving this technique for bone loss more than 25%, while performing remplissage and Bankart repair for off-track lesions with glenoid loss of less than 25%.[3]

For large off-track Hill-Sachs lesions, Latarjet alone is insufficient, and glenoid track length after coracoid graft may still be inferior to the length of the humeral defect, knowing that the new glenoid track length is GT = (0.84*D) – (bone loss), and in this case, Hill-Sachs defect will engage the anterior glenoid leading to dislocation.[11,16] Epilepsy, substance abuse, and instability index severity score (ISI score) are taken into consideration prior to surgery.

This technical note describes the combination of open Latarjet as a belt and arthroscopic remplissage as a suspender to prevent recurrent instability. This technique is reproducible with minimal loss of external rotation ensuring stability after a mean follow-up period of 31 months in well-selected patients.

Technical note

Surgical technique

Under general anesthesia, the patient is positioned in 40° beach chair position; the intervention includes 4 steps:

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

*Corresponding author: Johnny Abboud, MD, Department of Orthopedic Surgery and Traumatology, Hôpitaux Civils de Colmar, France.
E-mail address: abboud.johnny.md@gmail.com (J. Abboud).

https://doi.org/10.1016/j.xrrt.2022.03.004

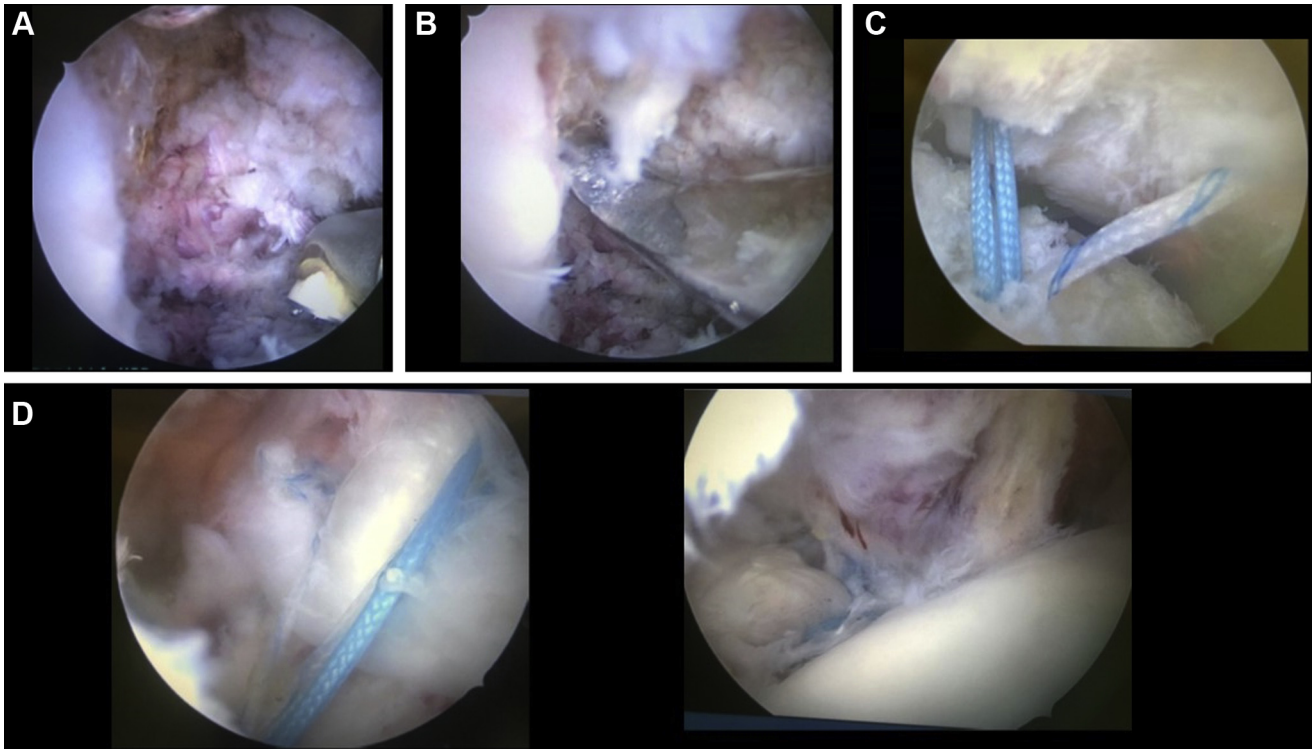

Figure 1 Different steps of the surgical technique: (**A**) Hills-Sach lesion identified; (**B**) preparation of the lesion; (**C**) 2 FASTIN Anchors of 5-mm diameter (DePuy Synthes) inserted in the valley of the lesion medial and adjacent to the articular defect, and 4 suture threads are passed through the infraspinatus tendon and left in a place; (**D**) completing the remplissage by tying the infraspinatus by the end of the second arthroscopy time.

Precapsulotomy time: open deltopectoral approach and coracoid osteotomy

With the deltopectoral approach and reclination of the cephalic vein medially, clavipectoral fascia is opened, CAL was released laterally leaving a 1-cm stump attached to the coracoid, and the pectoralis minor origin sectioned. Osteotomy of the coracoid was performed using curved osteotomes at the junction of the vertical and horizontal parts followed by decortication of its inferior aspect.

First arthroscopic time

Arthroscopy is started as usual by using a regular posterior 30° viewing arthroscope to inspect the glenohumeral joint and to view the Hill-Sachs lesion (Fig. 1, *A*). Using a posterolateral portal and with the aid of a shaver or burr, abrasion of the humeral defect is done (Fig. 1, *B*). Two FASTIN Anchors of 5-mm diameter (DePuy Synthes, Blackpool, United Kingdom) are inserted in the valley of the lesion medial and adjacent to articular defect (Fig. 1, *C*).

Then, benefiting from the clear anatomy of the anterior deltopectoral approach, and before doing any type of capsulotomy, we will create an anterior portal in the rotator interval; four suture threads are passed through the infraspinatus tendon and left in place; these sutures will not be tightened until the end of the intervention.

Subscapularis splitting capsulotomy time: ctransfer

This stage will mark the end of the first arthroscopy time. The intervention will continue by drilling 2 holes in the coracoid bone with a 3.2-mm drill and opening of the subscapularis muscle at the 2/3 superior and 1/3 inferior junction in line with its fibers. T-capsulotomy and intraarticular Fukuda retractor are used to expose the anterior glenoid. The labrum and the periosteum are excised, and decortication is done creating a bleeding cancellous surface.

Drilling of the glenoid is performed at the 5-o'clock position in a right shoulder parallel to the glenoid articular surface till its posterior cortex using a 3.2-mm drill.

Two half-threaded malleolar screws were used for positioning of the coracoid harvest and fixation in a compression fashion controlling the rotation of the graft.

Capsulorrhaphy and second arthroscopy time

Capsulorrhaphy by suturing the capsule and lifting it from an inferior to a superior position and reinforcing it by the CAL stump

The remplissage was completed by tying the infraspinatus to the Hill-Sachs lesion.

The operated arm is put in an arm sling for 4 weeks with immediate postoperative passive range of motion; from week 5, active range of motion is started.

Results and application

Table I presents the demographics characteristics of patients included in the study. The mean age of the participants is 42 years. Sixty percent were female, and 40% were male. Two patients (40%) had epilepsy in their medical history, and all patients have a high ISI score of 5.

The shoulder functional assessment scores in all operated patients at long-term follow-up are shown in Table II. Results demonstrate a mean Constant score of 85, a mean QuickDASH score of 6.7, a mean Walch-Duplay score of 85, a mean Rowe score of 96, and a mean subjective shoulder value score of 89. These results are considered to be relatively high functional scores.

On the other hand, we did not note any instability episode on any operated patient. Physical examination did not reveal any loss of external rotation. In Figures 2-5, we present preoperative

Table I
Demographic characteristics of all operated patients included in the study.

Patient	Sex	Age (yr)	ISI score
1	♀	51	5
2	♀	41	5
3*	♂	32	5
4	♀	42	5
5*	♂	45	5
Mean		42	5

ISI, instability index severity score. The asterisk "*" describes patient with epilepsy; ♂ for male and ♀ for female.

Table II
Different shoulder functional assessment scores in all operated patients at long-term follow-up.

Patient	Follow-up (mo)	Constant score at last follow-up	Quick DASH at last follow-up	Walch-Duplay score at last follow-up	Rowe score at last follow-up	Subjective shoulder value
1	39	85	6.8	90	95	100
2	37	90	6	80	90	90
3*	36	65	18	55	95	65
4	30	89	0	100	100	95
5*	13	98	2.3	100	100	95
Mean	31	85	6.7	85	96	89

The asterisk "*" describes patient with epilepsy.

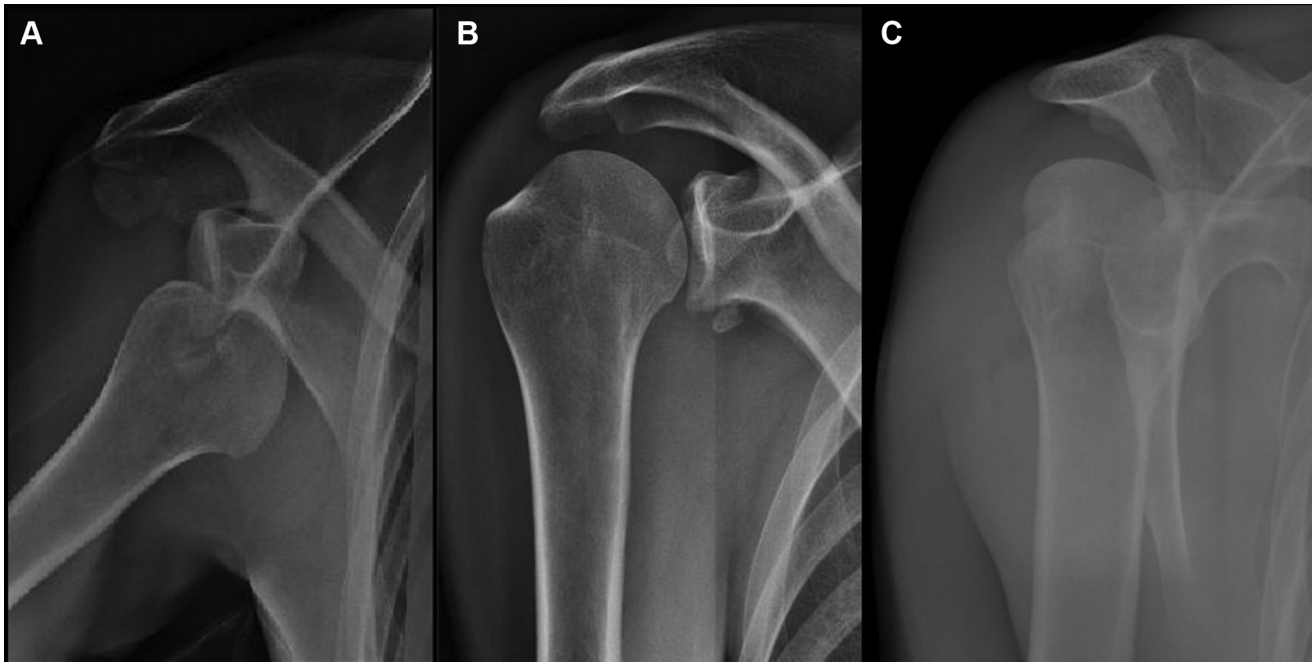

Figure 2 (**A**) Anteroposterior radiography showing *right* anterior shoulder dislocation; (**B**) after closed reduction, anteroposterior radiography showing glenoid fracture; and (**C**) Hill-Sachs lesion is well seen on Lamy Y view.

radiographs and scanner, postoperative radiographs, and long-term physical examination follow-up of 1 of our patients.

Saliken et al published a similar all-arthroscopic technique with good results, but with the disadvantages of being technically demanding and causing minimal decrease in external rotation.[14] Our technique could have the benefit of not affecting external rotation.

Discussion

Prediction of humeral head defect engagement as well as postoperative glenoid track length helps the surgeon select the appropriate treatment for bipolar bone loss at the glenohumeral joint, in order to achieve a stable shoulder free of episodes of instability; nonengaging Hill-Sachs lesions are not parallel to the articular surface of anterior glenoid and, therefore, does not lead to instability when the arm is in abduction external rotation, whereas engaging humeral head defects are parallel to the articular surface and thus engages in this functional position.[15]

As reported by Yanamoto et al, the glenoid track equals 0.84 multiplied by the inferior glenoid width minus anterior glenoid bone loss; then we add the coracoid graft length of planified Latarjet-alone procedure[15,16]; if the calculation is superior to the humeral defect width, it shows an on-track situation, which means

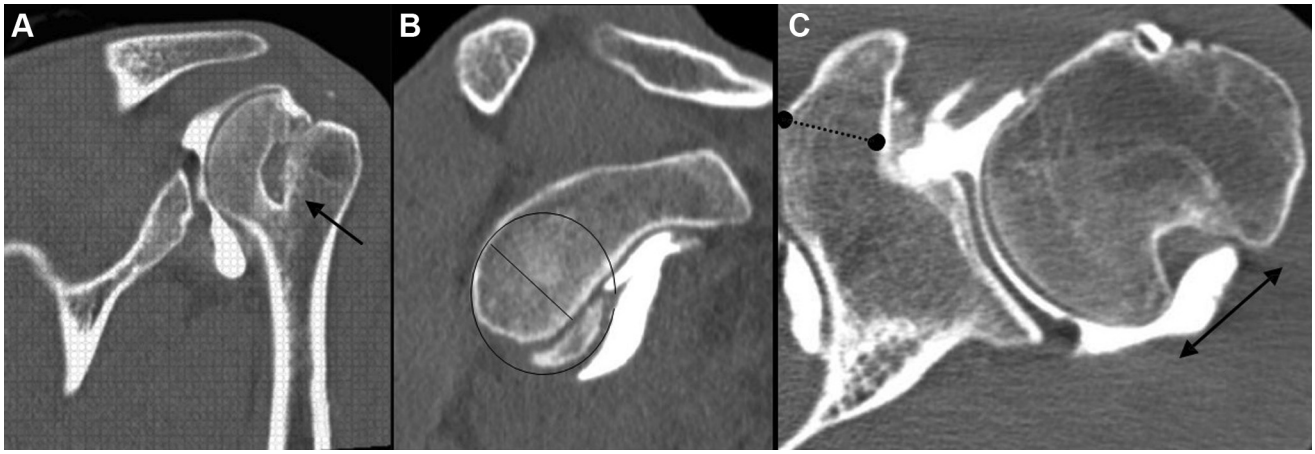

Figure 3 (**A**) Coronal computed tomography cut showing a deep Hill-Sachs lesion (⟵). (**B**) Sagittal view showing anterior bone loss with remaining glenoid face of 19 mm (⃠), and (**C**) the axial cut elucidates Hill-Sachs interval measuring 35 mm (⟷) and the coracoid 10 mm (•⋯⋯•). The projected glenoid track (19 + 10 = 29 mm) would be smaller than the Hill-Sachs interval (35 mm) leaving an off-track situation after Latarjet-alone intervention.

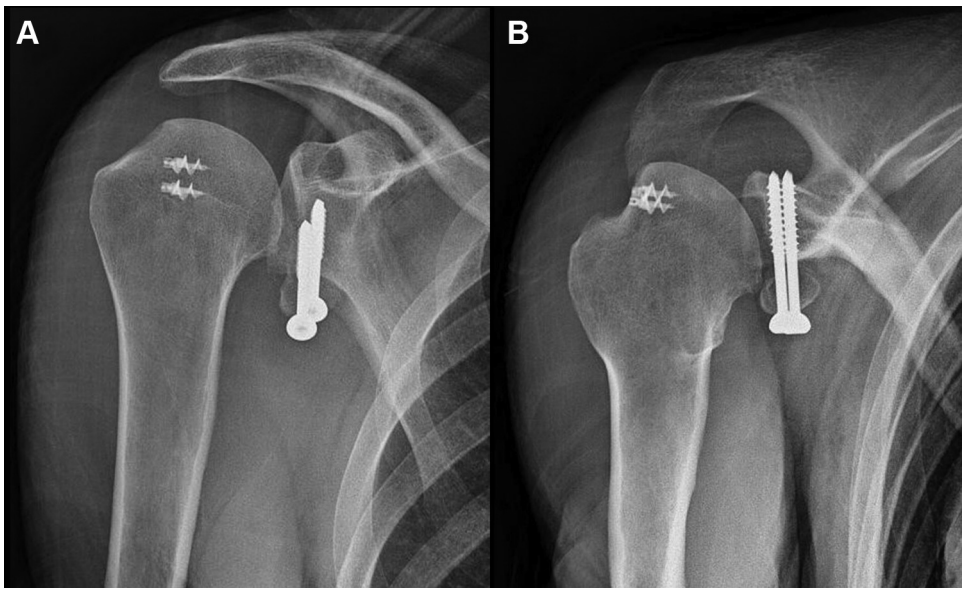

Figure 4 (**A**) Day 1 and (**B**) 1-year postoperative anteroposterior view showing Latarjet with 2 malleolar screws fixing the coracoid to the anterior glenoid and remplissage with 2 anchors at the humeral head.

no engagement of the Hill-Sachs lesion postoperatively on the anterior glenoid and thus Latarjet alone is sufficient. If it shows an off-track situation, which means the humeral defect width is superior to the new glenoid track with added coracoid length, then supplementing arthroscopic remplissage to open Latarjet prevents anterior dislocation.[15,16]

Another trigger to combine both techniques is the patient itself: During history collection and physical examination, we identify any substance dependence such as alcoholism state, we search for episodes of epilepsy, and we rule out hyperlaxity. Higher rates of recurrence of shoulder instability are found in patients with epilepsy even with proper medical treatment which stimulates our group to adjunct remplissage to Latarjet even though Ersen et al in 2017 showed similar stability scores with Latarjet alone done for epileptic patients in comparison to nonepileptic patients.[6]

The ISI score is calculated preoperatively, and our patients (Table I and Figures 1-3) showed a minimal score of 4, which incites our group to combine these 2 techniques.[7]

Reviewing the literature, Ranne et al first described this technique in 2013, then Katthagen et al in 2016 and Saliken et al in 2017 added the Bankart repair in a 3-in-1 all-arthroscopic intervention which is technically demanding, with prolonged intervention duration and potential loss of external rotation.[8,13,14]

According to Mook et al, in patients with more than 25% glenoid bone loss, Latarjet alone may lead to an off-track situation and, therefore, instability because the glenoid track length after coracoid graft is inferior to the Hill-Sachs width.[11,12] In these cases, adding remplissage will prevent instability in external rotation. We showed postoperative (Fig. 4 and Table I)

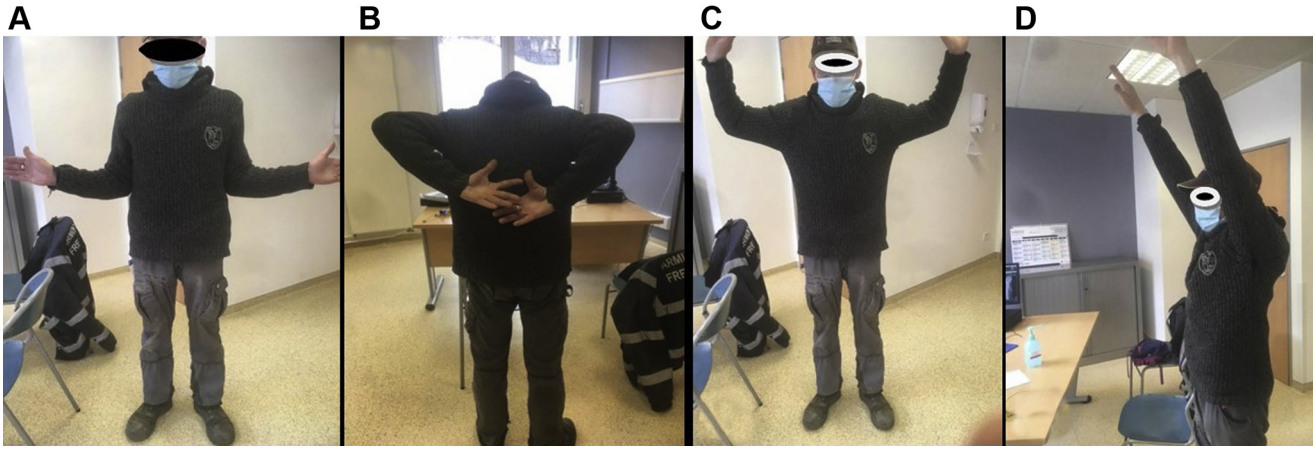

Figure 5 (**A**) Normal right shoulder external rotation at RE1 position 70°; (**B**) internal rotation L1 as well as (**C**) external rotation in RE2 position 90°; and (**D**) normal active anterior elevation to 170°.

stability scores similar to those in the 3-in-1 all-arthroscopic Bankart repair, remplissage, and Latarjet by Saliken et al[14]; in addition to that, our work is less technically demanding with a normal learning curve in contrast to the all-arthroscopic intervention. Open dual grafting techniques, humeralplasty, and rotational osteotomy are all described techniques for humeral bone defect treatment, but each with the risk of graft nonunion, hardware loosening, humeral head necrosis, and dislocation recurrence, respectively.[1,2]

Based on the review of the literature from Millett et al who preferred open approach in shoulder instability and our experience, especially when there is bone loss, we stuck to the same philosophy and opted the open Latarjet approach.[10]

Complications of the Latarjet procedure may be up to 20% if we add recurrence, coracoid fracture, osteolysis, and nonunion.[5]

Conclusion

We believe that the combination of open Latarjet and arthroscopic remplissage may provide a good stability, when dealing with bipolar bone loss in well-selected patients, without causing a loss in rotational motion. This technique is simple, reproducible, and economizes operative time, in comparison to all arthroscopic interventions. It may help in avoiding the risk of allograft nonunion, resorption, or necrosis as in open grafting techniques. Finally, complications of the Latarjet procedure may reach up to 20%, when we take into consideration all recurrence, coracoid fracture, osteolysis, and nonunion. That is why, according to our results, it may be appropriate to propose this technique for well-selected patient such as psychotic patients, epileptic patients, patients affected with hyperlaxity disorder, and patients with an ISI score of 5.

Disclaimers:

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Acknowledgment

The authors thank the secretariat of Orthopedic Surgery Department at the Hôpitaux Civils de Colmar for facilitating the work of data collection and patients' recruitment in this difficult situation of COVID-19, as well as Adèle Kauffmann for her help.

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