原　　著

Evaluation of arthroscopic reconstruction of the coracoclavicular ligament for distal clavicle fractures

Orthopaedics Department, Tane General Hospital

Kei Fujiwara, Kenichi Matsumura, Sho Tamura, Taizo Shirouchi, Hirokazu Nagai

Abstract

Distal clavicle fractures account for 15％ of all clavicle fractures. These fractures are caused by damage to the coracoclavicular ligament, and the Craig classification is often used. We encountered a few cases of Craig classification type 2b distal clavicle fracture in which the trapezoid ligament was intact, but the conoid ligament was torn. Although there are some established surgical treatments, such as those using a hook plate or tension band wiring, we performed arthroscopic reconstruction of the coracoclavicular ligament using FiberTape and the Dog Bone Button for Craig Type 2b fractures. This procedure is often performed for acromioclavicular joint dislocations.

This study aimed to evaluate shoulder function and the position of the clavicle postoperatively and evaluate and discuss the position and changes in the bone tunnel in the clavicle and the coracoid process.

All patients sustained falling injuries and complained of shoulder pain and difficulty in upper limb elevation. We performed this arthroscopic reconstruction procedure for 22 shoulders of 22 patients consisting of 5 females and 17 males from February 2015 to September 2020 in our hospital and excluded 8 cases in which the follow-up period was less than 6 months. We followed up on an average of 10.8 months postoperatively.

The results at the final follow-up showed satisfaction with shoulder functional scores, such as the Japanese Orthopaedic Association shoulder score. The distal clavicle fracture site's position was less than 50％ of the dislocated position from the intact anatomical position in all cases. The distance of the bone hole from the clavicle's distal edge was approximately 35 mm, and the size change of the bone hole at 5 months postoperatively was about 1.3 mm wider in diameter than the size of the bone hole in the operation.

We discussed these results by referring to previously published studies and essays. It is essential to know the bone tunnel's accurate physiological position for reconstruction, and more cases should be assessed. We concluded that a high proficiency level is required for this procedure.

Key words：distal clavicle fractures ; Dog Bone Button ; arthroscopic reconstruction

Introduction

Distal clavicle fractures account for 15％ of all clavicle fractures and indicate damage to the coracoclavicular（CC）ligament. The Craig classification is often used, and it has several types[1)]（Figure 1）. We encountered a few cases of Craig classification type 2b distal clavicle fractures in which the trapezoid ligament was intact, but the conoid ligament was torn[2)]（Figure 2）. Although

別刷請求先：藤原　圭　多根総合病院　整形外科
（〒550-0025　大阪市西区九条南1丁目12-21）

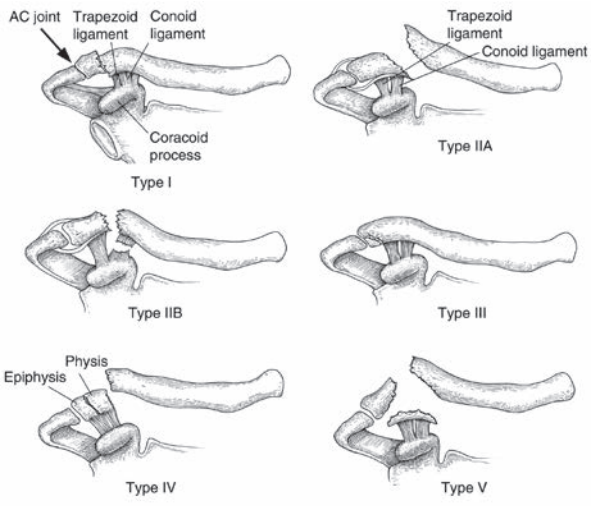


Figure 1 Craig classification cited from orthobullets.com

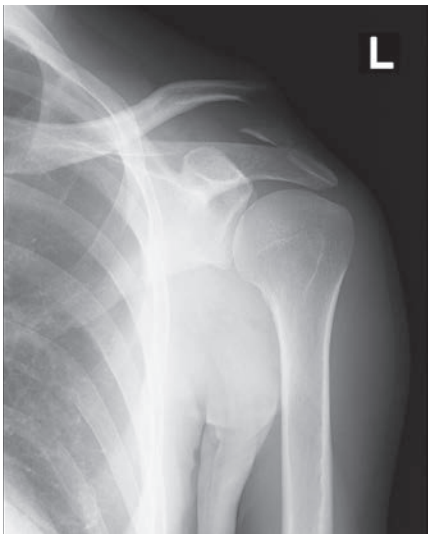


Figure 2 Craig Type 2b fracture

there are some established surgical procedures for the treatment of distal clavicle fractures, such as the use of hook plate or tension band wiring, we performed arthroscopic reconstruction of the CC ligament using FiberTape and the Dog Bone Button system for Craig type 2b fractures. This procedure is often performed for acromioclavicular (AC) joint dislocations.[4)]

Materials and Methods

Twenty-two patients who sustained falling injuries and complained of shoulder pain and difficulty in upper limb elevation were included in this study. We performed arthroscopic reconstruction for 22 shoulders of 22 patients, consisting of 5 females and 17 males, from February 2015 to September 2020 in our hospital. Patients for whom the follow-up period was less than 6 months were excluded. We followed up on an average of 10.8 months postoperatively.

We evaluated shoulder function using the Japanese Orthopedic Association (JOA) shoulder score and the clavicle position postoperatively. The reconstructed ligament's position and the bone tunnel changes in the clavicle and coracoid process were also investigated. The bone union was checked with computed tomography (CT) at the final follow-up and evaluated as poor or good.

Surgical procedure

We used the Dog Bone Button system (Arthrex, Naples, Florida) with the aiming device. Three portals (anterior, anterolateral, and posterior) were made, and the rotator interval was cleared with the shaving device to approach the base of the coracoid process. We performed fracture reduction with the temporary use of Kirschner wire from an acromion laterally using fluoroscopy. Then, an incision was made above the clavicle, where an aiming device was inserted to make bone holes on both the clavicle and coracoid process. We drilled both the clavicle and the coracoid process (2.4 mm), and FiberTape (Arthrex, Naples, Florida) was inserted into both bone holes. The Dog Bone Button was fixed on the undersurface of the coracoid process. We hooked and tied the other Dog Bone Button to the FiberTape on the clavicle and fixed the fracture.

We performed this single-bundle procedure in 15 cases (Figure 3) and performed a double-bundle procedure for seven cases in which another bone hole on the clavicle was made distally, and another FiberTape was inserted through the hole and fixed with another dog bone button (Figure 4).

The clavicle was divided into 3 parts in the sagittal view : anterior, middle, and posterior. The bone holes' width changes in the clavicle and coracoid process were compared between the day of surgery

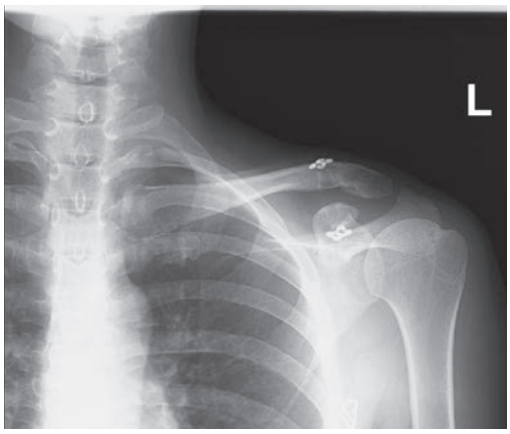


Figure 3　Single bundle procedure

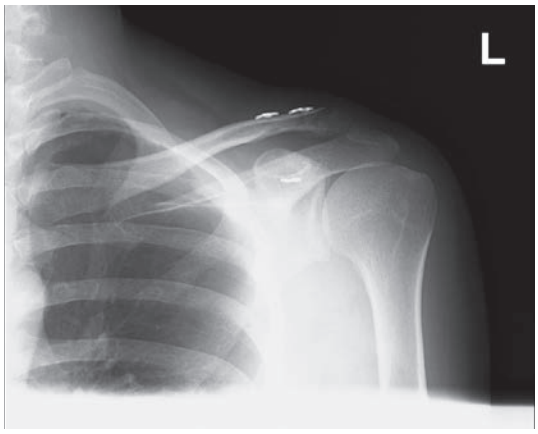
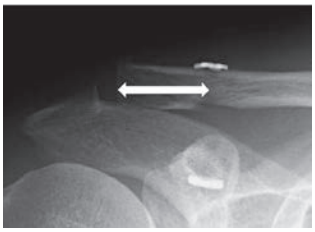
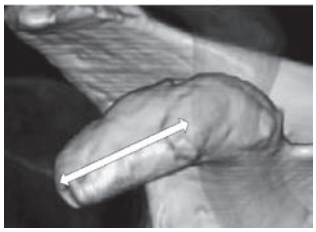


Figure 4　Double bundle procedure

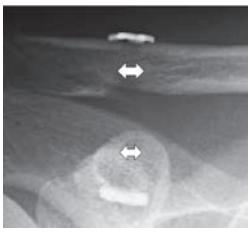


Distance between the bone hole and the distal edge of the clavicle (DiC)



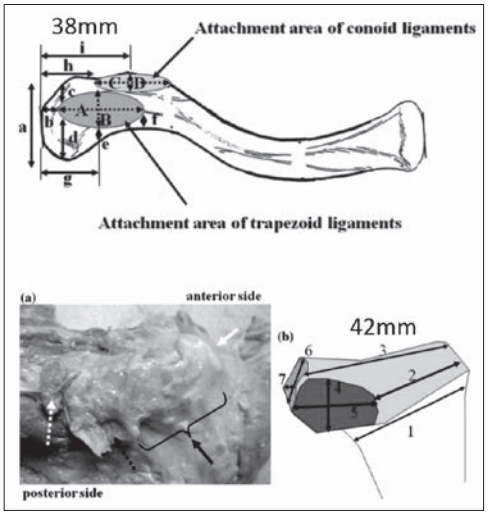
Distance between the bone hole and the distal edge of the coracoid process (DiCP)

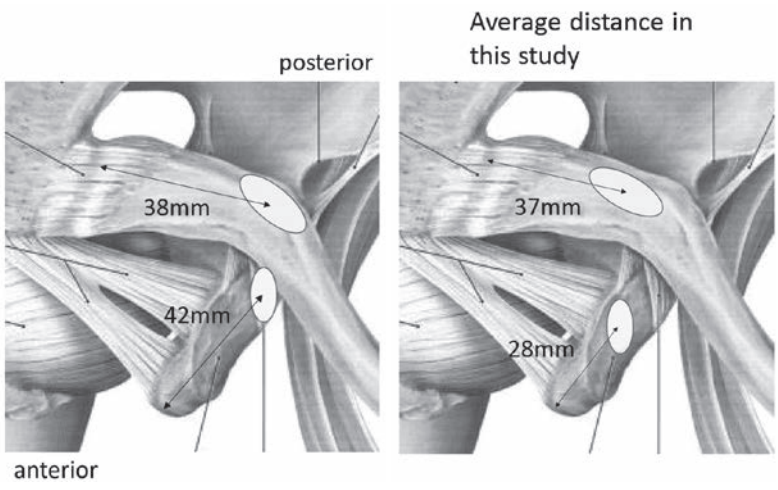
Divided the clavicle into 3 parts in sagittal view, anterior, middle and posterior (SvC)



Width changes of the bone holes in the clavicle and the coracoid process compared between the day of surgery and the time of final follow-up (BhC, BhCP)

Figure 5　How to evaluate





Takase, Surg Radiol Anato, 2010[5]

Figure 6　Anatomy of the CC ligament

and the time of the final follow-up (Figure 5).

Rehabilitation

The patients maintained a triangular bandage to rest the arm for 4 weeks postoperatively. Pendulum exercises and passive range of motion (ROM) of flexion and abduction up to 90 degrees, as tolerated, were started from 2 weeks post-op. Full

range and active ROM were started from 4 weeks postoperatively.

Results

Overall, 14 eligible patients [age：28-88 years] were evaluated for an average of 10.8 months (Table 1), and 8 were excluded from the study. In 9 cases out of the remaining 14, the single-bundle technique was used, and the other 5 cases were double-bundle procedures. Five cases scored 100 points out of 100 on the JOA shoulder score, 6 cases scored 95 points, and the other 3 cases scored 90 points. The average score was 95.7 points. The average size of the bone hole on the clavicle was 3.8 mm, and that on the coracoid process was an average of 3.7 mm at the time of final follow-up.

Table 1

Case	age	sex	follow-up period	dislocated position	JOA	DiC (mm)	DiCP (mm)	bone tunnel during op (mm)	BhC (mm)	BhCP (mm)	position of bone tunnel in clavicle	position of bone tunnel in coracoid process	Bone Union
A	35	m	8m	less than 50 %	95	29	28	2.4	3.5	3.5	middle in sagittal view	middle	Good
B	47	m	8m	less than 50 %	95	33	32	2.4	4	3.5	middle in sagittal view	medial	Good
C	74	f	14m	less than 50 %	100	34	24	2.4	3.1	3.7	middle in sagittal view	middle	Good
D	82	m	14m	less than 50 %	95	33	28	2.4	5.2	4	anterior in sagittal view	middle	Good
E	40	m	7m	less than 50 %	95	39	32	2.4	3.8	3.2	middle in sagittal view	medial	Good
F	33	f	11m	less than 50 %	100	34	24	2.4	4.7	4.5	posterior in sagittal view	middle	Good
G	42	m	7m	less than 50 %	100	36	28	2.4	4.5	3.8	middle in sagittal view	middle	Good
H	56	m	18m	less than 50 %	95	41, 23	30	2.4	3.4, 3.4	3.8	middle in sagittal view	middle	Good
I	80	f	18m	less than 50 %	95	26, 15	32	2.4	3.4, 3.6	4	middle in sagittal view	middle	Good
J	38	m	7m	less than 50 %	100	40, 23	28	2.4	3.0, 3.3	3.3	middle in sagittal view	middle	Good
K	28	f	12m	less than 50 %	100	39	28	2.4	3.9	3.6	middle in sagittal view	middle	Good
L	50	m	12m	less than 50 %	90	34	30	2.4	4.4	4	middle in sagittal view	medial	Good
M	80	m	9m	less than 50 %	90	36, 21	32	2.4	3.8, 3.6	3.8	posterior in sagittal view	middle	Good
N	78	f	7m	less than 50 %	90	34, 21	26	2.4	3.4, 3.4	3.5	posterior in sagittal view	lateral	Good
Average	54.5		10.8m		95.7	34.8	28.7	2.4	3.8	3.7			

The bone holes' position was an average of 34.8 mm from the distal edge of the clavicle and an average of 28 mm from the distal edge of the coracoid process at the final follow-up. The bone union was confirmed as good for all cases in which CT scans were performed.

Discussion

Recently, there have been several procedures for distal clavicle fractures, such as hook plate, tension band wiring, and arthroscopic reconstruction ; there are advantages and disadvantages to all procedures. These fractures need to be considered to determine whether damage to the CC ligament is presented. A Craig classification type 2b fracture in which the trapezoid ligament is intact and the conoid ligament is torn would be considered for the arthroscopic reconstruction of the CC ligament. This procedure's results were as satisfactory as a conventional open reduction and internal fixation using a plate in which an implant removal procedure would be needed, especially with a hook plate. This arthroscopic CC ligament reconstruction would not be considered as a second procedure to remove the implant. We need to know and consider the CC ligament's anatomical attachment for reconstruction. The results at the time of the final follow-up were satisfactory in this study ; however, we need to evaluate the size changes of the bone holes on both the clavicle and the coracoid process.

There were size changes of 1.4 mm wider on the clavicle's bone hole and 1.3 mm wider on the bone hole on the coracoid process on average in this study. We evaluated a few reasons for these results and considered that the tension and movement of the FiberTape could be different from that of the original CC ligament, and the positions of the bone holes also differed from the anatomical position of the CC ligament. In a previous paper, Takase et al. showed that the anatomical attachment of the conoid ligament on the clavicle's undersurface was approximately 38 mm proximal to the distal edge and that on the upper surface of the coracoid process was approximately 42 mm posterior from the anterior edge[5] (Figure 6). Our results of these distances were an average of 34.8 mm medially on the clavicle and 28.7 mm posterior on the coracoid process. The bone hole area on the clavicle was approximately 3 mm laterally from the anatomical attachment site, but the area on the coracoid process was approximately 13 mm anterior. From this issue, we could improve the result if a bone hole on the coracoid process was closer to the anatomical site. Robert M. Coale et al. showed that a transclavicular-transcoracoid approach could not restore the conoid and trapezoid ligaments' footprints. In addition, independent tunnel drilling and the graft's looping around the coracoid are recommended.[6]

There are a few limitations to this study. This study included only 14 cases with short follow-up periods. This study also included both single-bundle and double-bundle techniques, and we did not compare these procedures separately.

Conclusion

Arthroscopic reconstruction of the CC ligament using FiberTape and the Dog Bone Button system is recommended for distal clavicular fractures and AC joint dislocation. Consideration of the CC ligament's anatomical attachment is essential for the reconstruction procedure. More cases need to be assessed, and a high proficiency level is required for this procedure.

References

1）Cho CH, Jung JH, Kim BS : Coracoclavicular stabilization using a suture button device for Neer type IIB lateral clavicle fractures. J Shoulder Elbow Surg, 26(5) : 804-808, 2017
2）Neer CS 2nd : Fracture of the distal clavicle with detachment of the coracoclavicular ligaments in adults. J Trauma, 3 : 99-110, 1963
3）Robinson CM, Akhtar MA, Jenkins PJ, et al : Open reduction and endobutton fixation of displaced fractures of the lateral end of the clavicle in younger patients. J Bone Joint Surg Br, 92(6) : 811-816, 2010
4）Cohen G, Boyer P, Pujol N, et al : Endoscopically assisted reconstruction of acute acromioclavicular joint dislocation using a synthetic ligament : outcomes at 12 months.

Orthop Traumatol Surg Res, 97(2)：145-151, 2011
5）Takase K：The coracoclavicular ligaments：an anatomic study. Surg Radiol Anato, 32(7)：683-688, 2010
6）Coale RM, Hollister SJ, Dines JS, et al：Anatomic considerations of transclavicular-transcoracoid drilling for coracoclavicular ligament reconstruction. J Shoulder Elbow Surg, 22(1)：137-144, 2013

要　　旨

鎖骨遠位端骨折は鎖骨骨折全体の約15％ほどである．烏口鎖骨靭帯の損傷程度やCraig分類により鎖骨遠位端骨折を評価することが多い．われわれは烏口鎖骨靭帯のうち菱形靭帯は損傷なく円錐靭帯が損傷しているCraig分類Type 2bの鎖骨遠位端骨折を経験した．手術の方法としては，Hook plateやTension band wiringを利用しての観血的固定術もあるが，今回われわれは関節鏡を併用しFiberTape® とDog Bone Button® を使用した烏口鎖骨靭帯再建を行った．肩鎖関節脱臼に対して行われている方法である．本論文での目的は，肩関節機能，術後骨折整復位などを評価することである．対象は2015年2月から2020年9月までに転倒にて受傷し鎖骨遠位端骨折Craig 分類Type 2bと診断し手術を行った14症例である．平均経過観察期間は10.8か月で，最終観察時の肩関節機能はJOA scoreにて5例が100点，6例が95点，3例が90点であり，術後整復位は全症例で良好な結果を得た．烏口鎖骨靭帯再建は鎖骨遠位端骨折に対して良好な結果を得られたが，さらに症例を重ね烏口鎖骨靭帯の解剖学的位置を十分に理解することが重要と考える．

Editorial Comment

鎖骨遠位端骨折に対し関節鏡視下に手術を行った報告である．鎖骨遠位端骨折の治療は直視下手術が一般的である．手術方法はプレート固定，テンションバンド固定，靱帯移行術など様々な報告がある．遠位骨片が大きい場合プレート固定など骨接合術で良好な成績が報告されているが骨片が小さい場合，骨片に挿入されるスクリューの本数が限られ，後に転位をきたす可能性がある．鎖骨遠位端骨折は烏口鎖骨靭帯が断裂し鎖骨近位が上方に転位する．今回の術式は断裂した烏口鎖骨靭帯を関節鏡視下に再建することで鎖骨近位の上方転位を防ぎ骨癒合を得る方法である．骨癒合は全例に得られ，術後臨床結果も良好であったが，今後はより解剖学的再建を目指しさらなる成績の向上に期待したい．

宇治徳洲会病院　整形外科
久山陽一郎