Cлавикулярные переломы являются распространенной травмой, с общей частотой от 35% до 45% среди переломов плечевого пояса.1 Пятнадцать процентов до 25% вовлекают дистальную часть лопатки.2,3 Неер-типа II переломы лопатки происходят в области коракоилловых связок или с нарушением конойной связки (Рисунок 1). Эти переломы часто значительно смещены из-за супинации мускулов стерноцепеломастоида и трапеция по отношению к медиальному фрагменту и весу конечности на дистальном фрагменте.4 Судя по описанию, в настоящее время не было предложено специфического хирургического протокола для этих переломов. Хирургические техники включают открытую репозицию с внутренним фиксатором, крючковые пластины, коракоилловые винты, керклажные винты, раскрепованные и запертые предформированные пластины, а также реконструктивные техники коракоилловых связок с использованием различных материалов или тенонных синтезов. Кроме того, в 2008-2012 гг. в общем стационаре было проведено 17 оперативно-хирургическое вмешательство на Неер-типа IIB переломах для оценки результатов. Функциональные результаты были оценены с помощью шкалы боли, шкалы Handicap Arm, Shoulder, and Upper Extremity, шкалы Penn Shoulder и шкалы American Shoulder and Elbow Surgeons. Рентгенологическое соединение произошло у 14 пациентов. Арthroскопический метод репозиции с помощью подвесной костьной кнопки может привести к предсказуемому результату при низкой частоте осложнений. [Orthopedics. 201x; xx(x):xx-xx.]

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with or without excision of the distal fragment. Arthroscopically assisted fixation techniques have also recently been described. This article presents the short-term results of arthroscopically assisted fixation of type II distal clavicle fractures using the TightRope system (Arthrex, Naples, Florida). This minimally invasive technique accomplishes anatomic fracture alignment, fracture compression, and restoration of anteroposterior and superoinferior ligamentous stability.

**Materials and Methods**

**Patients**

Between 2008 and 2012, a total of 17 patients (5 men, 12 women) with a mean age of 41±19 years (range, 21-89 years) underwent surgical stabilization of a Neer type II clavicle fracture within 3 weeks of initial injury using the TightRope system. All 17 fractures were evaluated as displaced Neer type II clavicle fractures on radiograph (Figure 2). The left side was affected in 6 patients, and the right side was affected in 11 patients. Mechanisms of injury involved ground-level falls (n=7), a fall from a tree (n=1), bicycle accidents (n=5), a motor vehicle accident (n=1), a scooter accident (n=1), wrestling (n=1), and rugby (n=1). All patients were stabilized within 3 weeks of injury and had no concomitant injuries.

**Operative Technique**

The authors’ operative technique is a modification of the technique by Baumgarten. The patient is placed in either a lateral decubitus or a beach chair position. The osseous structures are identified. A diagnostic arthroscopy through a standard posterior portal is then performed to evaluate for intra-articular pathology. A standard rotator interval-working portal is established under direct visualization. The middle glenohumeral ligament is released, and the subcapsularis bursa is resected until the base of the coracoid process is visualized (Figure 3). A 3-cm incision is made along Langer’s lines to expose the distal clavicle and acromioclavicular joint. An anterior cruciate ligament guide is set to 90°, inserted anteriorly, with the foot of the guide centered on the undersurface of the base of the coracoid process (Figure 4). The drill guide is centered on the clavicle 15 mm medial to the fracture. A guide pin is then placed from the clavicle to the coracoid, and a cannulated drill is passed over the guide pin. A nitinol wire is passed through the drill and retrieved through the anterior portal. The TightRope system is shuttled using the nitinol wire (Figure 5). The fracture is reduced under direct visualization, and the TightRope system is tensioned in place. The sutures from the system are then tied over the clavicle and subsequently passed through the acromioclavicular joint capsule in a figure-of-eight fashion using a free needle. This restores anteroposterior stability while providing compression across the fracture (Figure 6). A layered closure is performed, and a ster-
ile dressing is applied. The arm is placed in a sling for 4 weeks, with pendulum exercises started in the first postoperative week. Weight-bearing activities are delayed until radiographic union occurs (Figure 7).

Outcome Measures

The authors evaluated function, union of the fracture site, and fracture-related complications. The pain score, the Disabilities of the Arm, Shoulder and Hand score, the Penn Shoulder Score, and the American Shoulder and Elbow Surgeons score were used to assess shoulder function. Radiographic union was evaluated using an anteroposterior view and a 45° cephalic tilt view of the clavicle or 4 standard views of the shoulder. Radiographic union was defined as evidence of bridging callus across the fracture or elimination of fracture lines. Shoulder function and union were assessed at most recent follow-up. Three patients were lost to follow-up: 2 could not be contacted and 1 had died. Those lost to follow-up had radiographs but not pain scores, Disabilities of the Arm, Shoulder and Hand scores, Penn Shoulder Scores, or American Shoulder and Elbow Surgeons scores.

RESULTS

Functional Outcome

The mean duration from surgery to most recent follow-up was 12 months. The mean pain score at follow-up was 0.9±1.1. The mean Disabilities of the Arm, Shoulder and Hand score was 10.9±11.1, the mean Penn Shoulder Score was 90.3±7.9, and the mean American Shoulder and Elbow Surgeons score was 90.1±10.1. No patients showed loss of motion compared with the contralateral shoulder at follow-up (Table).

Radiographic Outcome

No patients were lost to radiographic follow-up. There were no failures of fixation and no loss of reduction at follow-up. Union was achieved in 14 patients. Nonunion, with 1 being painful, occurred in 3 patients.

Complications

There were 3 complications in the cohort of patients. One patient had an early infection requiring an irrigation and débridement. The patient’s fracture achieved union. Frozen shoulder, which resolved with physical therapy, occurred in a patient who had a painless nonunion. One patient underwent additional surgery for removal of a prominent suture.

DISCUSSION

Although multiple surgical techniques have been developed to treat distal clavicle fractures, none has become the gold standard. Implant use for the treatment of distal third clavicle fractures can be problematic because of hardware migration, symptomatic hardware requiring removal, and hardware failure.9,22 Recently, arthroscopically assisted fixation techniques have been described. The main advantages of an arthroscopically assisted fixation technique include its minimally invasive nature, anatomic reduction of the fracture without violation of the acromioclavicular joint, and ability to identify and treat intra-articular pathology. Additionally, the current technique restores anteroposterior and superoinferior stability, allows for fracture compression, and uses low-profile hardware.

Pujo et al19 described a similar technique of arthroscopically assisted fixa-

tion of distal clavicle fractures. They noted osseous union and asymptomatic shoulders in 4 patients treated with their technique.19 Takase et al20 reported on similar fractures treated using an EnDoButton (Smith & Nephew, Andover, Massachusetts) tied to a screw and washer for fixation. They noted union in all 7 patients, with postoperative follow-up of 30 months.20 Checchia et al17 described a complex method of suture passing and retrieving to create a double coracoclavicular cerclage for fracture reduction using an all-arthroscopic technique. Union occurred in all 7 of their patients, with 2 postoperative complications. All 3 techniques lacked the additional anteroposterior stabilization of the fracture that the current technique provides.

Hohmann et al18 used the TightRope system in combination with a distal radius locking plate in 31 patients, with a 96% union rate. Although Hohmann et al18 and Takase et al20 did not comment on prominent hardware necessitating removal, this has been described for other screw and plate configurations in the clavicle. The current study achieved a union rate of 82.5%, an improvement over the 30% nonunion rate obtained with nonoperative treatment.

One strength of the current study is that it reports the largest number of Neer type II distal clavicle fractures treated solely with the TightRope system. Using this
approach, the authors observed no loss of fracture reduction or hardware failure.

This study had limitations. It was not a prospective, randomized trial with a control group. Also, it had a relatively short follow-up of 12 months. Longer follow-up is needed to verify that no other patient requires surgical removal of a knot stack. However, pain scores, Disabilities of the Arm, Shoulder and Hand scores, Penn Shoulder Scores, and American Shoulder and Elbow Surgeons scores showed that patients had minimal disability during the follow-up period.

**Conclusion**

The debate about which method of fixation should be used to treat Neer type II distal clavicle fractures continues. The authors have presented a technique that can be performed in a minimally invasive fashion using arthroscopic assistance to obtain fracture reduction, compression, and stability, thus achieving fracture union.

**References**

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