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CLINICS

Galeazzi Fractures and Dislocations

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The Galeazzi fracture was first described by Sir Astley Cooper in 1822 but was named after Italian surgeon Riccardo Galeazzi (1866–1952) [1,2], who reported 18 cases of this type of fracture in 1934.

The Galeazzi fracture is a fracture of the middle to distal third of the radius associated with dislocation and/or instability of the distal radioulnar joint (DRUJ) [3,4]. There are three other eponyms for this fracture pattern. It has been described as a fracture of necessity, which refers to the need of surgical treatment for optimal results. Another one has been described as the Piedmont fracture, because in 1957 Hughston [5] in the Piedmont Orthopaedic Society originally described the poor results from nonoperative management. And the third one has been described as the reverse Monteggia fracture.

Galeazzi fracture-dislocations often go unrecognized. This unstable lesion can be mistaken for a simple radius fracture. Dislocation of the distal radioulnar joint should be suspected at the time of injury, with a displaced fracture of the distal shaft of the radius (Fig. 1). Persistent instability of the distal radioulnar joint leads to an unfavorable result, with pain at the joint and restriction of forearm rotation. The goal of the treatment is an anatomic reduction and a rigid internal fixation of the radial fracture and also restoration of normal anatomy of the distal radioulnar joint. That is the reason for the high rate of unsatisfactory results of closed reduction and cast immobilization. For a long time, however, nonoperative treatment had been the predominant way to treat these fractures. Hughston [5] reported 92% unsatisfactory results in 38 patients treated without internal fixation; Wong [6] reported a successful result for only 9% of 34 patients treated with simple immobilization; and Mikic [3] found an 80% failure rate for conservative treatment.

Classification

There are several classification systems that have been used. According to Macule and colleagues [7], there are three types of lesion. In a type 1 lesion, the fracture of the radius occurs between 0 and 10 cm from the styloid process; in a type 2 lesion, the fracture occurs between 10 and 15 cm; and in a type 3 lesion, the fracture occurs at more than 15 cm from the styloid process.

There is also a new treatment-oriented classification scheme suggested by Rettig and Raskin [8]. In a type 1 fracture, the distance between the midarticular surface of the distal radius and the fracture is within 7.5 cm. In a type 2 fracture, the distance is more than 7.5 cm. According to the authors, in the type 1 fracture, the distal radioulnar joint was found to be significantly more unstable when it was tested intraoperatively after fixation of the radial fracture as compared with the type 2 fracture. In the type 2, only 6% of the patients required open fixation of the distal radioulnar joint.

The Galeazzi fracture-dislocation, according to Bruckner and colleagues [9], is also considered as simple or complex. When reduction is easy after

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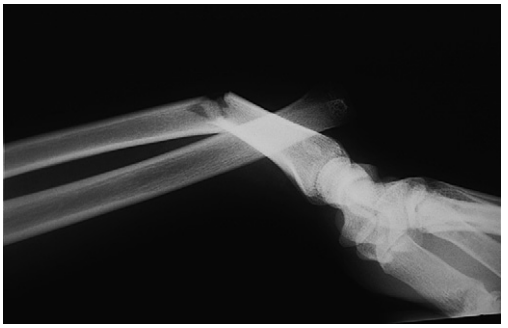

Fig. 1. Lateral radiograph of a Galeazzi fracture-dislocation. This characteristic radiograph demonstrates a fracture at the junction of the middle to distal third of the radius with dorsal angulation and a complete disruption of the DRUJ, with dorsal dislocation of the distal ulna.

fixation of the fracture, it is considered as simple. In a complex dislocation, it is impossible to reduce or to keep the reduction because of interposition of soft tissue.

Galeazzi equivalents

There are certain injuries that are considered as Galeazzi's equivalent lesions. A fracture of the radial shaft in children may be associated with separation of the distal ulnar epiphysis without a disruption of the DRUJ. On the other hand, in adults a fracture of the radial shaft may be associated with an additional fracture of the distal ulna. These injuries are considered as Galeazzi's equivalent lesions and they are treated the same way as a Galeazzi fracture in children or in adults, respectively [3,10–13].

Mechanism of injury

The mechanism of injury is somewhat controversial. Many authors believe that the injury occurs as a result of a fall on an outstretched and pronated hand [3]. Other authors believe that the injury requires considerable force with an axial load and extremes of wrist extension and pronation. Attempts to produce the injury by this mechanism under laboratory conditions have been unsuccessful [14]. Another cause has been reported to be a direct blow to the dorsoradial aspect of the forearm [5]. Commonly obtained histories leading to a Galeazzi fracture include motor vehicle accidents [8], athletic endeavors, and falls from a height. Fractures resulting from gunshot wounds carry a higher risk of neurovascular injury and more often have extensive soft tissue destruction.

The radius and the ulna are parallel and relatively tightly constrained proximally and distally. Any disturbance in length of one of the two bones must affect either the proximal or the distal radioulnar joint. An important soft-tissue stabilizer of the distal radioulnar joint is the triangular fibrocartilage complex (TFCC). A rupture of the TFCC is thought to be the first step to dislocation and occurs at the extreme of pronation and extension of the wrist [3,13–21]. Disruption of the TFCC is certain if the ulnar styloid is fractured and was noted in more than 30% of the cases as Mikic [22] reported in one study.

Studies in cadavers by Moore and colleagues [23] have shown that 5 mm of radial shortening is required before rupture of the TFCC occurs, and 10 mm of radial shortening is required before the interosseous membrane ruptures, thus producing the full-blown injury. They believe that isolated fractures of the distal third of the radius resulting from axial loading are more likely to be associated with distal radioulnar pathology and injury to the interosseous membrane. On the other hand, Sarmiento and Latta [24] believes that a similar fracture of the distal third of the radius resulting from a direct blow perpendicular to the bone, which displaces the radial fragment ulnarward, does not necessarily have associated distal radioulnar joint pathology or injury to the interosseous membrane.

Natural history

When the injury is left untreated or without a satisfactory reduction and stabilization, the pull from the different muscles that act on the fracture fragments leads to a deformity of the distal forearm. There is angulation and shortening of the radius with swelling, as well as tenderness and prominence of the ulnar head [14]. In chronic instability and dislocation of the distal radioulnar joint, the wrist appears narrowed due to the pronator quadratus muscle, which approximates the ulna to the radius [9,13].

Evaluation

Clinical

A patient who sustained a Galeazzi fracture-dislocation presents with swelling, deformity, and additional tenderness and pain to palpation of the

distal forearm and wrist. Usually, there is an obvious angular deformity on the shortened radial side of the forearm with a protrusion of the ulnar head, which is found to be more mobile than usual. A high index of suspicion should be maintained by the examiner and a meticulous evaluation for instability of the distal radioulnar joint must be conducted [8,9,13]. All of these signs and symptoms vary with the severity of injury and the degree of displacement. Subluxation or dislocation will be evident in the distal radioulnar joint, with prominence of the head of the ulna and severe tenderness over the joint. It should be remembered that injury to the distal radioulnar joint occurs in approximately 20% of Galeazzi fractures, so any fracture of the distal third of the radius should be regarded as a potential Galeazzi fracture and the distal radioulnar joint should be examined very carefully [25–27]. In open fractures, the wound is usually a small puncture wound from within where the distal end of the proximal fragment has protruded through the skin. Neurovascular damage is usually rare.

Imaging

It is essential to have very good radiographic evaluation. This consists of anteroposterior (AP) and lateral radiographs of both the entire forearm and the wrist. It is of great importance to identify a subluxation or a dislocation of the distal radioulnar joint (Figs. 2 and 3) [13,27]. Similar radiographs of the opposite wrist for comparison may be useful, because a subluxation of the distal radioulnar joint sometimes can be easily overlooked [28].

A patient who sustained a Galeazzi fracture-dislocation usually has the following radiographic findings. On the AP film the radius appears relatively shortened, with an increase in the space between the distal radius and ulna where they articulate (Figs. 4 and 5). In the lateral view, the fractured radius is usually angulated dorsally and the ulnar head is prominent dorsally (see Fig. 1).

Fig. 2. An AP radiograph of a Galeazzi fracture demonstrates a fracture of the distal third of the radius. It is to be noted that without a lateral radiograph, this Galeazzi type of lesion may be misdiagnosed.

Fig. 3. A true lateral radiograph of the same patient reveals the fracture of the distal radius and also a dorsal subluxation of the distal ulna.

The injury to the radioulnar joint may be purely ligamentous (Fig. 6), or the ligament may remain intact and the ulnar styloid may be avulsed [13,26,28]. Sometimes CT scanning may be helpful for the assessment of the dislocated distal radioulnar joint [29].

There are four radiographic signs that suggest rupture of the distal radioulnar joint: (1) fracture at the base of the ulnar styloid, (2) widening of the DRUJ (AP view), (3) dislocation of the radius

Fig. 4. An AP radiograph of a Galeazzi fracture-dislocation. The radius appears relatively shortened and the space between the distal radius and ulna where they articulate is obviously increased.

Fig. 5. An AP radiograph of a Galeazzi fracture-dislocation reveals fracture of the radius with severe angulation, complete disruption of the DRUJ, and dislocation of the distal ulna. Clinically, there was an obvious angular deformity on the shortened radial side of the forearm, with a protrusion of the ulnar head.

relative to the ulna (on a true lateral view), and (4) more than 5 mm of shortening of the radius relative to the ulna (''ulna plus,'' compared with the presumed normal ulnar variance in the opposite wrist) [13,30].

Meticulous evaluation of the TFCC can be performed by using MRI, arthrogram, arthroscopy, or a combination of these [3]. In treatment planning, it is important to identify an occult injury to the TFCC because its presence seems to indicate significantly more instability of the overall injury [18–22,31].

Treatment

Nonoperative

Treatment can be divided according to age. Conservative management of Galeazzi fracture has been found to be successful in children, although this type of injury is uncommon in children [3]. Good results can be achieved in children when the ulna is displaced dorsally (most common) with longitudinal traction, manipulation of the fracture, and immobilization in a long-arm cast with the forearm in supination for 4 to 6 weeks. Galeazzi advocated treating the fracture with strong traction through the thumb [1,2,4]. Volar or anterior ulnar displacement is less common [32]. The stability of this type of fracture, after reduction, in children is presumed to be due to the thick periosteum. According to the literature, even when distal radioulnar joint disruption is not recognized in children, as long as the fracture is immobilized in a long-arm cast in supination an excellent result ensues. Open reduction sometimes is necessary if there is difficulty maintaining the reduction; however, internal fixation is usually not required [13,26,33,34].

Fig. 6. An AP radiograph of a Galeazzi type of lesion, demonstrating a fracture of the distal third of the radius without a severe displacement. In this particular case, the injury to the DRUJ was purely ligamentous.

In adults, conservative treatment results in a high percentage of failure [5,17]. It has been shown that angulation and slipping of the radial fragments accompanied by subluxation or dislocation of the DRUJ can occur while the arm is in a cast, usually 7 to 10 days after the reduction. Hughston [5] mentioned four major deforming factors that cause loss of reduction: (1) Gravity acting through the weight of the hand, even in a cast, tends to cause subluxation of the DRUJ and dorsal angulation of the fractured radius; (2) the insertion of the pronator quadratus on the palmar surface of the distal fragment rotates it toward the ulna and pulls it in a proximal and palmar direction; (3) the brachioradialis tends to use the DRUJ as a pivot point on which to rotate the distal fragment of the radius and at the same time causes shortening; and (4) the abductors and the extensors of the thumb cause shortening and relaxation of the radial collateral ligament so that one is not able to keep the soft tissue bridge on stretch, even though the wrist is placed in ulnar deviation. Because of these factors, closed reduction and immobilization results in as high as 80% to 92% of failures (Fig. 7A, B) [5,17].

Surgical management

Campbell is said to have called this type of lesion ''the fracture of necessity,'' by which he meant that open reduction and internal fixation was necessary if a good result were to be obtained [14]. Hughston [5], in 1957, collected 41 cases from members of the Piedmont Orthopaedic Society

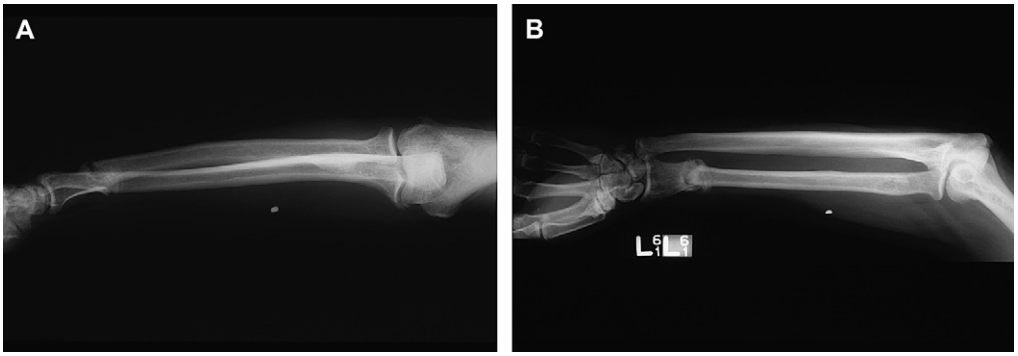

Fig. 7. (*A, B*) Radiographs of a Galeazzi fracture-dislocation treated conservatively, without satisfactory reduction and stabilization. There is shortening of the radius with angulation of the bone, prominence of the ulnar head, and persistent dislocation of the DRUJ, causing severe limitation of rotation of the forearm.

and called attention to the frequent mistakes in management of the Galeazzi fracture-dislocations. His criteria for a satisfactory result were very strict. They included union with perfect alignment, no loss of length, no subluxation of the distal radioulnar joint and full pronation and supination [5,17].

From the above discussion, it should be apparent that the results of closed treatment in adults are poor. The deforming forces are so great that even if the fracture is undisplaced initially or if good position is obtained by closed reduction, displacement in the cast is the rule rather than the exception. To obtain good pronation and supination and to avoid derangement and arthritic changes in the distal radioulnar joint, the fracture must unite in an anatomic position. For all these reasons, open reduction and internal fixation are almost always the preferred treatment [13,26,35,36].

In a Galeazzi fracture-dislocation, the difficulties in reduction are attributable to the instability of the distal radioulnar joint and the different muscles that act on the fragments of the radius. The anatomy of the radius and of the distal radioulnar joint must be restored to achieve normal function [35,36]. For these reasons, open reduction and internal fixation are recommended in adults. Both bone and soft tissue injuries should be addressed [35–38]. Osteosynthesis of the radius fracture by using plate and screws is most commonly used [5,38]. Alternative methods of fixation include K-wires, an obliquely placed transfixation screw, intramedullary pins, square nails, transfixation pins, Rush rods, external fixation, or a combination of external fixation and percutaneous pinning [5,13,36,37]. These methods in our experience and according to the literature have been less effective than plating, because they do not control rotation and they also allow shortening of the radius. Medullary nails do not provide very satisfactory fixation for these fractures. Usually, the medullary canal at the level of the fracture is large and continues to enlarge distally. The nail does not prevent medial offset of the distal fragment and shortening of the radius. Additionally, the medullary canal of the distal fragment is too large for the nail to control rotation. Small plates and screws also do not provide sufficient fixation to resist the deforming forces. The plates may bend or the screws may pull loose resulting in loss of reduction with malunion or nonunion [5,26,35–37]. Plate and screw fixation is by far the preferred method for treatment [5,38].

The radius fracture is approached through a volar ''Henry'' incision. Rigid internal fixation is imperative and provided by a 3.5-mm or 4.5-mm dynamic compression plate that should be of sufficient length and the screws must obtain good purchase in both cortices (Fig. 8A, B) [13,26,38].

Once anatomic reduction and rigid fixation have been accomplished, the adequacy and stability of reduction of the DRUJ are assessed intraoperatively. This is of high importance. The amount of relaxation of the joint varies in different individuals, so the opposite DRUJ should be used for comparison. If the ulnar head can be translated dorsally out of the sigmoid notch with the forearm in supination, instability of the DRUJ is confirmed. When marked instability of the joint is found, further treatment should be performed. Exploration of the joint with ligamentous repair or transfixation of ulna and radius with K-wires after reposition of the dislocation is necessary [37–40]. Reduction of the DRUJ may not be possible because of an interposed extensor carpi ulnaris,

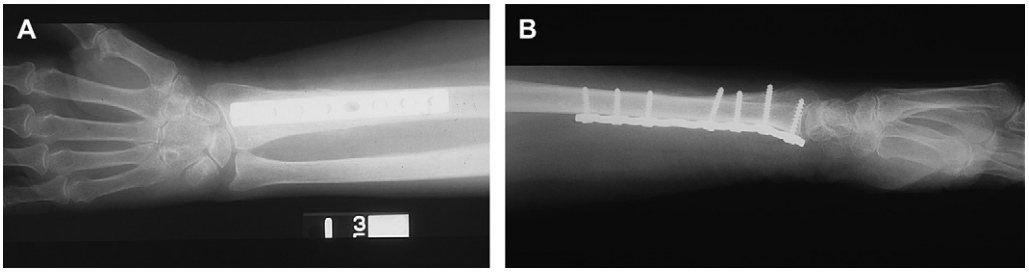

Fig. 8. (*A, B*) Postop AP and lateral radiographs of a Galeazzi fracture. An anatomic open reduction and internal fixation were performed. The plate is of sufficient length to secure rigid fixation and the DRUJ is well reduced. The arc of the radius, the relative length of one bone to the other, the apposition, and the stability of the DRUJ must be normal to restore normal function.

extensor digitorum communis, or extensor minimi tendon [41–46]. Other causes of irreducible fractures can be a metaphyseal fragment that is dislocated through a capsular buttonhole, periosteal tissue, or a bony fragment from an avulsion fracture of the fovea [47]. Further treatment depends on the stability and presence or absence of an ulnar styloid fracture. Such a fracture necessitates open reduction and internal fixation by using a screw or a K-wire with a tension-band technique [5,13].

After anatomic reduction of the radius has been performed, further treatment is defined by the stability of reduction of the DRUJ. The options are as follows:

Stable DRUJ. Reduction of the DRUJ should be maintained with the forearm in supination for 6 weeks to allow for healing of the volar and dorsal marginal ligaments of the joint.

Unstable DRUJ. Repair of the TFCC should be performed [21,22]. Sutures drilled through the ulna styloid or a suture anchor may be used. Following repair, the DRUJ must be pinned with a K-wire in neutral rotation to minimize loss of pronation. This repair is protected for 6 weeks.

Unstable DRUJ with ulna styloid fracture. The ulna styloid fracture is usually through the fovea. The TFCC is attached to this fragment, and stability is regained by open reduction and internal fixation of the styloid fragment, accomplished by tension band wiring or a lag screw technique.

Irreducible DRUJ. Inability to reduce the DRUJ may be due to soft tissue interposition. Open reduction in these cases can be accomplished and repair of the TFCC should be performed [5,40,48].

For postoperative management, a long-arm cast is generally used for 4 to 6 weeks according to the literature. Most authors suggest the forearm be immobilized in neutral position or 10 to 15 degrees of supination. Some others suggest full supination. It has also been said that the structures that stabilize the DRUJ approximate in supination for dorsal DRUJ dislocations and in pronation for volar dislocations (Table 1) [9,13,26,30,40]. It is of high importance to have postoperative radiographs to confirm that there is no subluxation of the DRUJ (see Fig. 8A, B).

Authors' preferred method of treatment

The most important step is to make the correct diagnosis, especially as it concerns the DRUJ.

Table 1
Algorithm for the treatment of Galeazzi fracture-dislocations

1. Stable DRUJ	2. Unstable DRUJ		
Long-arm cast 4–6 weeks	Radius reduction? Soft-tissue interposition?	A. Ulnar styloid fracture: ORIF TFCC repair?	B. Ulnar styloid intact: Reduce and K-wire DRUJ

A. ORIF radius fracture (adults)/closed reduction (children)
B. Reduce dislocation of distal ulna–DRUJ.
Abbreviations: DRUJ, distal radio-ulnar joint; ORIF, open reduction, internal fixation.

This requires a high index of suspicion in all apparent isolated distal radial fractures [48]. Good radiographic evaluation must be obtained, particularly with lateral views. In the clinical examination, it is very important, to assess the stability of the DRUJ and to compare it with the opposite side. In case this cannot be performed at the time of presentation of the patient, it is certainly possible after the reduction of the radial fracture.

Closed reduction is the preferred treatment method only for children. Preferably under general anesthesia, and with the child in the supine position, the radial fracture is reduced under fluoroscopic guidance. Perfect cortex-to-cortex alignment is not necessary in children, although rotation should be correct and shortening of the radius should be avoided, since it is likely to affect the DRUJ. The DRUJ should then be checked for stability and reduced in full supination. When an unusual volar subluxation has occurred, the position of immobilization is usually neutral or in pronation. Immobilization in full pronation should be avoided because this may lead to a loss of supination for which functional compensation is difficult. In this case, after the reduction of the joint, Kirschner wiring in neutral rotation should be considered. It is important to confirm that no subluxation of the DRUJ remains. If reduction is impossible, the DRUJ is approached through a dorsal incision and whatever is interposed in the joint is removed.

If a Galeazzi equivalent is present with an epiphyseal separation of the distal ulna, the reduction is secured by a longitudinal K-wire through the epiphysis into the metaphysis. Postoperatively, the arm is placed in a long-arm cast with the elbow in 90 degrees of flexion and the forearm in neutral or slightly supinated position.

In adolescents approaching maturity, who have significant displacement of the fracture site and/or an unstable DRUJ, consideration should be given to internal fixation, such as Kirschner wires or plating.

In adults, the treatment method of choice is surgical. With the patient in a supine position and the arm resting on a hand-table, the operation is performed under general anesthesia and tourniquet control. In case of an open fracture the existing wounds determine the approach that is chosen, volar or dorsal. The radius fracture is approached through a volar "Henry" incision. The palmar surface of the radius is flat and provides a better bed for the plate. A 5- to 6-inch longitudinal incision is made, centered over the fracture in the internervous plane, which lies between the flexor carpi radialis muscle, which is innervated by the median nerve, and the brachioradialis muscle, which is innervated by the radial nerve. The radial artery and veins are identified and retracted ulnarly and the brachioradialis with the superficial radial nerve are retracted radially. It is to be noted that the fracture is almost always located just above the proximal border of the pronator quadratus muscle. Its insertion is freed from the radius and reflected ulnarward. The palmar surface of the proximal fragment is then exposed for a distance long enough to allow placement of the plate.

After having exposed the fracture, anatomic reduction is performed, usually with the use of self-retaining, bone-holding Lane forceps. Internal fixation is achieved with an Arbeitsgemeinschaft für Osteosynthesefragen 3.5-mm or 4.5-mm dynamic compression plate that is at least six or four holes long, respectively. The length of the plate depends on the obliquity of the fracture and the degree of comminution. The appropriate plate is centered accurately, so that at least three 3.5-mm, or two 4.5-mm screws, can be placed in both proximal and distal fragments, with no screw closer than 1 cm to the fracture, even if this means leaving a hole in the plate empty. The plate is clamped to the proximal and distal fragments Once anatomic reduction has been achieved, the correct position of the plate is secured with a Lane forceps to prevent angulation and/or shortening when compression is applied. Then the screws are inserted into the distal fragment first. At this junction, radiographs are obtained in anteroposterior and lateral planes to assess if the relationship at the DRUJ is exactly right. If it is, the screws are inserted into the proximal fragment. Strong compression can usually be applied without disturbing the anatomic relationship of the DRUJ. Sometimes, however, the fracture may be so comminuted or oblique that shortening of the radius and disturbance of the DRUJ may occur when compression is applied. If there is significant comminution, some authors suggest the use of autogenous iliac bone graft. The pronator quadratus muscle is then allowed to fall back into position over the plate. The fascia should not be closed to prevent compartment syndrome. Finally, the subcutaneous tissue and the skin are routinely closed.

The next, very important, step is to assess the stability of the DRUJ. If it is stable, final radiographs are made to verify that the DRUJ is reduced anatomically. If it is reduced, a transfixation of the

ulna to the radius is made by using two K-wires with the forearm in a neutral or slightly supinated position. The K-wires should be placed proximal to the sigmoid notch of the radius. In case the DRUJ is unstable or not reduced, the joint is opened through a dorsal approach [49]. Through an open exposure, whatever is interposed in the joint is removed and then the TFCC and the ligaments are repaired. It is to be noted that some authors suggest an arthroscopic repair of the TFCC [50]. If there is an ulnar styloid fracture, an osteosynthesis by using K-wires, or in combination with a tension-band technique is performed. Once more, the position of the DRUJ is verified with radiographs.

Postoperative care

Even though a rigid fixation has been performed, the patient should be placed in a long-arm cast for 4 to 6 weeks to allow sufficient healing of the soft tissues. The sutures are removed after approximately 2 weeks. After cast removal, active and passive exercises of the elbow, wrist, and forearm are begun. Emphasis needs to be given, on regaining pronation and supination. The wrist can be protected in a removable splint for an additional 3 to 4 weeks.

Because the plate is well covered with soft tissue, it is seldom necessary to remove it. The plate needs to be removed in young athletes or in patients with symptoms from the forearm that could be related to the plate. In such cases, to prevent refracture and/or other complications, removal of the plate has to be done at least 18 months after primary surgery.

Prognosis

Prognosis of Galeazzi fracture-dislocations treated by anatomic open reduction and internal fixation is very good to excellent. The reduction of both the radial fracture and the DRUJ, must be anatomic, and the fixation must be rigid. According to the literature, only a moderate limitation of wrist and forearm motion (mainly supination-pronation), has been reported in a very small cohort of patients.

Complications

The complications of Galeazzi fracture-dislocations are those incident to all forearm fractures. These are nonunion, delayed union, malunion, nerve injuries, and infection. Some others complications are synovitis, reflex sympathetic dystrophy, reduced motion, and refractures after plate removal.

The most common complication is angulation at the fracture site and subluxation or dislocation of the DRUJ. In patients who present with an acute Galeazzi fracture-dislocation, these types of complications are largely avoided with anatomic reduction and rigid fixation.

Additionally, it is of high importance that one should be aware of the compression forces when applying a plate, as inaccurate use may lead to subluxation of the DRUJ, because the radius is a bone that is bowed in two different planes in its distal part [51].

Mikic [3] reported that a temporary radioulnar transfixation gave better results when compared with no transfixation. It is to be noted that the K-wire broke in one of his patients, and infection occurred in some patients, thus resulting in poor and fair results. Infection has also been reported by others, and especially in one report in such a high rate as 12% of the patients.

Another complication is the irreducible DRUJ due to an interposed soft tissue, as it has been mentioned. Cetti [34] described an unusual case of blocked reduction of Galeazzi lesion. He reported two cases in which the extensor carpi ulnaris tendon was caught in the DRUJ, preventing reduction. In the first case, exploration of the DRUJ was performed 5 months after the initial operation because of remaining radioulnar dislocation and persisting pain of the joint. The clinical examination revealed marked restriction of pronation and supination. At the second operation, the extensor carpi ulnaris tendon was found to be trapped between the radius and the ulna. In this particular case, the tendon was extracted and the distal end of the ulna was excised with a good result. In his second case, because of an unsuccessful closed reduction, the lower end of the ulna was exposed through a dorsal vertical incision, revealing that the distal ulna had erupted dorsally through the capsule of the joint. Additionally, a complete separation of the ulnar styloid process was found, which, with the TFCC, remained in its normal relationship to the distal radius. The tendon of the extensor carpi ulnaris was found trapped between the ulna and the capsule. To reduce the dislocation, the capsule of the DRUJ incised distally and the tendon displaced.

In patients with nonunion and malposition and late presentation for treatment (after 6 weeks), the

best option is to realign the radius and apply a bone graft to it [52]. A full-thickness iliac crest bone graft, can often be used to regain radial length, restore the DRUJ, and obtain good function. Even if the distal ulna must be resected, it is better to allow the nonunion to heal before doing so. Even though the distal relationship may not be satisfactory, the ulna relieves some of the deforming forces on the radius.

In some other patients with mild to moderate degrees of malunion of the radius, pronation and supination is limited and painful. In these cases, the distal ulna should be resected at the proximal border of the sigmoid notch–Darrach resection, but only after the radius is solidly united (Fig. 9A, B). An alternative to resecting the distal ulna might be a Sauve-Kapandji procedure.

Sometimes nerve injuries occur, such as injuries of the median and the ulnar nerve at the wrist, of the anterior interosseous nerve [53] and of the branches of the radial nerve. Release of the carpal tunnel with neurolysis of the median nerve and/or exploration of Guyon's canal with neurolysis of the ulnar nerve [54] may be necessary in some patients with unresolving symptoms.

Factors that affect the outcome

According to the literature and all studies, it clearly seems that anatomic reduction and rigid fixation of the radial fracture is the most important treatment, and if this is achieved, the DRUJ stability is good and leads to an excellent function. Even in a combination of Monteggia's and Galeazzi's lesions in the same patient, the dislocated heads of the radius and the ulna were reduced spontaneously after anatomic and rigid fixation of the forearm bones, and the final outcome was excellent [55]. Another excellent result for a child with the same combination of a Monteggia and a Galeazzi fracture-dislocation who was treated with closed reduction and a long-arm cast with the forearm in supination also has been reported [56].

The timing of the surgery in relation to time of the injury has been shown to be of high importance. If the treatment is delayed, nonunion, recurrent dislocation of the DRUJ, and infection are more common. In addition, resection of the ulnar head, in delayed treatment, is often performed, thus leading to a poor result [57]. A delay of more than 10 days before surgical treatment was found to have significant influence on the final range of motion.

Galeazzi fractures in children

The fracture is usually at the junction of the middle and distal third of the radius, although any fracture in the distal third of the radius may cause this lesion [58,59]. In children, the most common is a radius fracture in combination with a physeal fracture of the ulna [60]. The injury usually occurs from a fall onto an extended arm with the wrist in full pronation—the same mechanism as in adults.

Most Galeazzi fracture-dislocations in children can be treated by closed reduction. After the fracture is reduced, it has to be immobilized in a long-arm cast in full supination for 4 to 6 weeks, depending on the age of the child. Sometimes the extensors tendons may become entrapped and impede reduction, necessitating open reduction.

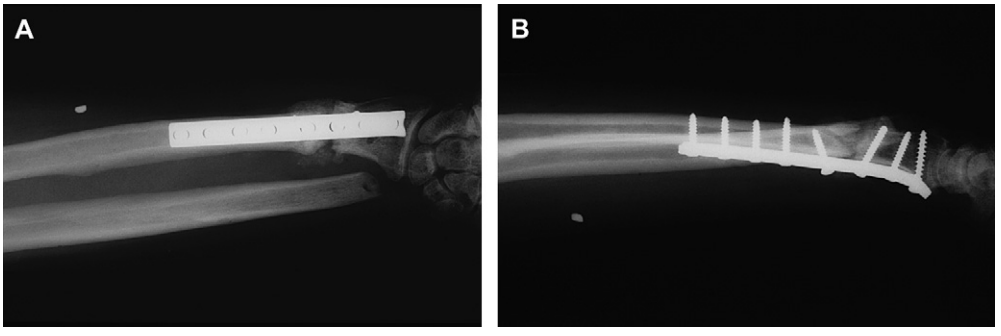

Fig. 9. (*A, B*) This patient presented with a malunited Galeazzi fracture-dislocation. The patient had experienced severe limitation of forearm rotation, secondary to malunion of the radius, instability of the DRUJ, and persistent pain. A Darrach procedure was performed to regain better function. The radius malunion was treated with an osteotomy and the distal ulna was used as the structural graft.

If the fracture of the radius is oblique, it can be unstable and requires open reduction and internal pin fixation to maintain reduction.

Complications following a Galeazzi fracture-dislocation in children are uncommon. Malunion of the radius can lead to instability and may require reconstruction.

Summary

In 1934, fractures of the middle and distal third of the radius associated with instability of the DRUJ were described by Galeazzi. This type of lesion is characterized by its unstable nature and the need for open reduction and internal fixation to achieve a satisfactory functional outcome. A high index of suspicion should be maintained by the surgeon, and a thorough examination for instability of the DRUJ must be conducted. The marked instability of this fracture-dislocation complex is further enhanced by the disruption of the TFCC, either with or without ulna styloid fracture. Treatment in adults is surgical, and both bone and soft tissue injuries should be addressed.

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