

# Complications of intramedullary Hagie pin fixation for acute midshaft clavicle fractures

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*The purpose of this report was to evaluate patient outcomes after treatment of acute midshaft clavicle fractures with an intramedullary Hagie pin, including clinical results and the incidence of postoperative complications. Between 1993 and 2003, 16 patients who underwent intramedullary Hagie pin fixation of a midshaft clavicle fracture were identified. The medical records of each patient were reviewed to ascertain the mechanism of injury, indication for surgical intervention, and treatment course. Clinical outcomes were evaluated with respect to time to fracture union, postoperative shoulder range of motion, and symptoms related to the fracture site and ipsilateral shoulder. The inpatient postoperative course and outpatient follow-up visits were assessed in an effort to document the incidence of postoperative complications. The most common mechanism of injury was participation in athletic activity. Operative indications included significant deformity, polytrauma, and neurovascular compromise. The mean time from injury to operative fracture stabilization was 15.8 days. No intraoperative complications occurred. All 16 patients (100%) were available for follow-up to fracture union, which occurred in all cases at a mean of 12.4 weeks. Of the 16 patients, 14 were available for further follow-up, and at a mean follow-up of 9 months, 85.7% had regained near-full to full range of shoulder motion and 93% had no symptoms related to the fracture site or ipsilateral shoulder. Postoperative complications occurred in 8 patients (50%), including 3 cases of skin breakdown*

*related to hardware prominence, 2 cases of hardware breakage, 2 cases of decreased sensation in the region of the surgical incision, and 1 case of persistent pain over the operative site. When indicated, the use of intramedullary devices for the stabilization of clavicle fractures offers theoretic advantages over traditional plate and screw fixation. In this case series, intramedullary Hagie pin fixation resulted in fracture union in 100% of cases, with a high percentage of patients regaining full range of shoulder motion and resolution of symptoms. However, there was a 50% incidence of postoperative complications associated with this treatment method. We believe that the complication rate associated with the use of the Hagie pin should preclude the use of this particular implant. (J Shoulder Elbow Surg 2007;16:280-284.)*

Clavicle fractures are common injuries affecting all age groups, most commonly occurring after a direct blow or a fall onto the shoulder.<sup>1,11,13</sup> Up to 80% of clavicle fractures occur in the middle third, because of its thin tubular structure and lack of muscular or ligamentous reinforcement<sup>4</sup> (Figure 1). Nonoperative management of these injuries typically results in a high rate of fracture union with little to no long-term sequelae.<sup>1,14</sup> Indications for operative treatment include open fractures, gross fracture fragment displacement, polytrauma, tenting of the overlying skin, neurovascular compromise, and inability of the patient to tolerate prolonged conservative treatment.<sup>15,16,18</sup>

When indicated, surgical options for management include plate and screw fixation, intramedullary pin fixation, and external fixation. The use of intramedullary devices for stabilization of clavicle fractures offers the advantages of fracture fixation through smaller incisions, avoidance of significant soft-tissue stripping about the fracture site with relative protection of the supraclavicular nerves, and the ability to remove the implant through a similarly small incision with the patient under local anesthesia<sup>4,12</sup> (Figure 2). Potential drawbacks to this technique include the incidence of hardware migration or failure, painful prominent hardware, and refracture after hard-

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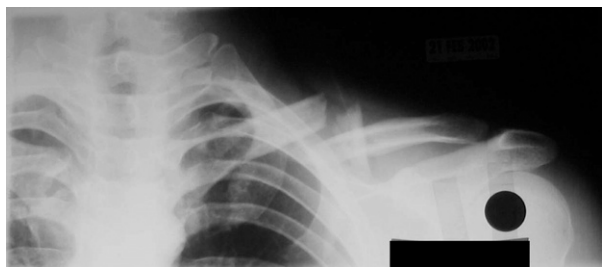
The clavicular intramedullary Hagie pin is manufactured by Smith & Nephew, Memphis, TN. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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**Figure 1** Anteroposterior view of left clavicle showing acute midshaft clavicle fracture with associated butterfly fragment.



**Figure 2** Anteroposterior view of left clavicle showing fracture stabilization with intramedullary Hagie pin.

were removal, as well as the development of non-union.<sup>2,4,19</sup>

A number of recent reports have described the clinical utility of intramedullary fixation techniques for stabilization of clavicle fractures by use of Hagie pins, Rockwood clavicle pins, Knowles pins, and Kirschner wires.<sup>3,9,10,19</sup> In addition to the high rate of union achieved by these methods (94%-100%), intramedullary fracture fixation has been associated with a variable rate of postoperative complications<sup>3,9,10,19</sup> (Table I). The purpose of this study is to report our experience with intramedullary Hagie pin fixation of acute midshaft clavicle fractures, focusing on clinical outcome and the incidence of postoperative complications.

## MATERIALS AND METHODS

In an institutional review board–approved retrospective analysis, 19 patients who underwent intramedullary Hagie pin fixation of a midshaft clavicle fracture between 1993 and 2003 were identified. Of the 19 total patients identified by Current Procedural Terminology coding, 3 in whom Hagie pin fixation was used for treatment of clavicular nonunion were excluded. The medical records of the remaining 16 patients were reviewed to ascertain the mechanism of injury, associated injuries, neurovascular status, hand dominance, and associated medical history. Radiographs for each patient were reviewed, and the fractures

were classified according to the Orthopaedic Trauma Association (OTA) system.<sup>5</sup> Each patient underwent fixation of the fracture with a clavicular intramedullary Hagie pin (Smith & Nephew, Memphis, TN) according to the manufacturer's suggested protocol.

The inpatient postoperative course and outpatient follow-up visits were assessed in an effort to document the incidence of postoperative complications and outcome measures, including postoperative range of motion and time to union. Fracture healing was evaluated both clinically and radiographically, with union defined as a lack of tenderness to palpation over the fracture site and evidence of bridging callus and cortical continuity for 3 of 4 cortices in the area of the fracture on 2 radiographic views.

## RESULTS

Clavicular intramedullary Hagie pins were used to treat 16 patients with 16 acute midshaft clavicle fractures. The patient cohort was composed of 9 men and 7 women with a mean age of 33 years (range, 21-48 years). Of the 16 patients, 14 were right hand–dominant. Right-sided clavicle fractures were present in 7 patients, with the remaining 9 having left-sided injuries. The mechanism of injury among these patients included an injury during athletic activity in 7 cases, a motor vehicle accident in 4 cases, and a fall from a height in 3 cases; in addition, in 1 case, a pedestrian was struck by a motor vehicle, and 1 patient was injured in an explosion. Of the fractures, 9 were simple midshaft clavicle fractures (OTA type 06A), 5 were diaphyseal wedge fractures (OTA type 06B), and 2 were complex multifragmentary fractures (OTA type 06C). Indications for operative intervention included significant deformity as a result of marked fracture fragment displacement in 9 cases (>100% displacement), polytrauma in 6, and neurovascular compromise in 1.

The mean time from injury to surgery was 15.8 days (range, 1-25 days). No intraoperative complications occurred during fracture stabilization with the intramedullary Hagie pin. Physical therapy, including pendulum exercises and passive shoulder range of motion with active range of motion of the elbow, wrist, and hand, was started on the first postoperative day in all patients. The intramedullary Hagie pins were removed in all patients at a mean of 9 weeks postoperatively (range, 5-15 weeks).

All 16 patients (100%) were available for follow-up to fracture union, which occurred in all cases at a mean of 12.4 weeks (range, 9-22 weeks). Of the 16 patients, 14 were available for further follow-up, and at a mean follow-up of 8.9 months, 85.7% had regained near-full to full range of shoulder motion, and 13 of 14 (92.9%) reported no residual pain in the shoulder or at the fracture site.

Postoperative complications after fracture stabilization with the intramedullary Hagie pin were ob-

**Table I** Complications associated with intramedullary fixation of midshaft clavicle fractures

Study	No. of patients	Complications reported
Grassi et al <sup>6</sup> (2001)	80 Patients: 40 managed nonoperatively and 40 treated with intramedullary fixation (2.5-mm threaded pin)	No complications were reported in those managed nonoperatively; superficial infection developed in 20% of the operatively treated patients, hardware breakage occurred in 5%, and refracture subsequent to pin removal occurred in 7.5%.
Johnson and Arrington <sup>7</sup> (2004)	37 Patients treated with intramedullary fixation (Hagie pin)	Intraoperative complications occurred in 16% of cases (pin breakage, anterior cortical penetration, drill bit breakage); skin irritation developed over prominent hardware in 43% of patients; 22% of patients had postoperative loss of reduction >5 mm; and in 5% of patients, superficial infection developed.
Thyagarajan <sup>17</sup> (2005)	51 Patients: 17 managed nonoperatively, 17 treated with plate and screw fixation, and 17 treated with intramedullary fixation (Rockwood pin)	No complications were reported in patients treated with Rockwood pins; of patients treated with plate fixation, 24% had scar-related pain and 18% had prominent hardware; of patients managed nonoperatively, 24% had nonunion and 29% had cosmetic complaints.

**Figure 3** Clinical picture of left shoulder showing skin breakdown over prominent distal end of Hagie pin.

served in 8 of 16 cases (50%). Skin breakdown developed posteriorly in the region of hardware prominence in 3 patients, with 1 case requiring a return to the operating room for surgical debridement (Figure 3). Hagie pin breakage occurred in 2 cases, with 1 patient requiring revision surgery (Figure 4). Two patients reported decreased sensation in the region of the surgical incision, and one reported significant pain over the fracture site with associated loss of shoulder motion postoperatively (Table II).

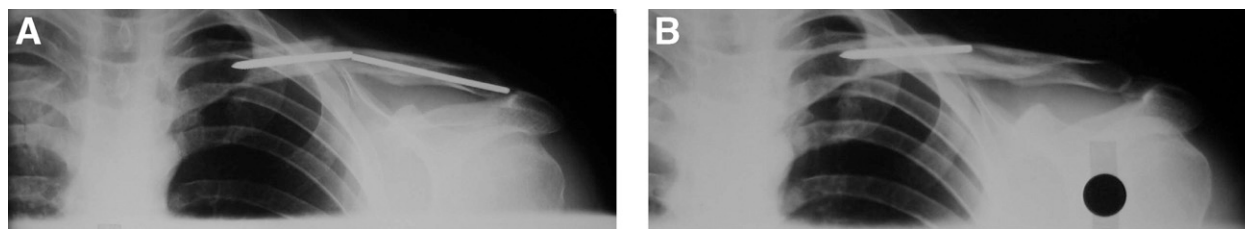
## DISCUSSION

The use of intramedullary fixation of midshaft clavicle fractures is recognized as a proven method of treatment.<sup>3,9,10,12,19</sup> Advantages of intramedullary fixation include smaller incisions, less required dissection and soft-tissue stripping, and relative protection of the supraclavicular nerves, as well as the load-sharing nature of the device and the ability to remove

the implant with the patient under local anesthesia.<sup>2,13</sup> Potential drawbacks to this technique include the possibility of hardware prominence, implant migration or breakage, or infection and the need for hardware removal.

Investigators have compared intramedullary fixation with nonoperative treatment for midshaft clavicle fractures with varying results.<sup>6-8,12,17</sup> Thyagarajan<sup>17</sup> evaluated the clinical outcomes of midshaft clavicle fractures treated nonoperatively, with plates and screws, and with an intramedullary Rockwood clavicle pin. The author showed that patients treated with intramedullary fracture fixation had shorter hospital stays, earlier mobilization, and no scar-related complaints compared with those in the other two treatment groups. On the basis of these findings, Thyagarajan concluded that for displaced midshaft clavicle fractures, intramedullary fracture fixation has advantages over other available treatment modalities. Grassi et al, in their comparison of conservative management versus intramedullary midshaft clavicle fracture fixation with a 2.5-mm threaded pin, came to a different conclusion.<sup>6</sup> They found that fracture stabilization with the intramedullary device was associated with a high incidence of complications. In their series, there were 8 superficial infections, 3 refractures, 2 delayed unions with pin breakage, and 2 nonunions in 40 treated patients. Mean Constant scores at 5 years of follow-up were similar between the 2 treatment groups; however, those managed nonoperatively had a significantly lower complication rate and were able to return to activity more rapidly.

In this study, we report our experience treating 16 acute midshaft clavicle fractures with intramedullary Hagie pin fixation. Although this treatment method resulted in 100% fracture union with greater than 85% of patients regaining nearly full postoperative shoulder range of motion, we found a high incidence



**Figure 4** **A**, Anteroposterior view of left clavicle showing broken intramedullary Hagie pin, which occurred 7 weeks postoperatively. **B**, Anteroposterior view of left clavicle 10 months postoperatively showing healing of midshaft clavicle fracture subsequent to hardware failure. The medial portion of the broken Hagie pin was retained, which had no impact on the ability of the fracture to heal in an adequate position.

**Table II** Postoperative complications associated with intramedullary Hagie pin fixation of acute midshaft clavicle fractures in 16 cases

Patient No.	Gender	Age (y)	Hand dominance	Side of injury	Mechanism of injury	Complication
1	F	39	R	L	Motor vehicle accident	
2	M	27	R	L	Athletic injury	Pin breakage
3	M	21	R	R	Athletic injury	
4	M	42	R	L	Pedestrian struck	Skin breakdown posteriorly
5	M	49	R	L	Motor vehicle accident	
6	F	39	R	L	Fall from height	
7	M	40	R	R	Athletic injury	Fracture site pain with associated decreased shoulder range of motion
8	F	29	R	R	Motor vehicle accident	Decreased sensation over site of incision
9	F	19	L	L	Explosion	
10	F	23	R	R	Fall from height	Pin breakage
11	M	21	R	R	Athletic injury	Skin breakdown posteriorly
12	F	30	R	R	Fall from height	Skin breakdown posteriorly requiring operative debridement
13	M	32	R	L	Athletic injury	
14	M	48	R	L	Athletic injury	
15	F	36	R	R	Motor vehicle accident	Decreased sensation over site of incision
16	M	26	L	L	Athletic injury	

of postoperative complications. Most of these were directly related to the implant, with breakage of the Hagie pin in 2 cases and skin breakdown as a result of pin prominence in 3. We did not notice any correlation between fracture type or body mass index and the incidence of postoperative complications. With regard to the 3 cases of skin breakdown reported, 1 patient was overweight, with a body mass index of 31 kg/m<sup>2</sup>, whereas the other 2 patients were thin, both with a body mass index of less than 30 kg/m<sup>2</sup>.

Similar outcomes and a similar rate of postoperative complications associated with intramedullary Hagie pin fixation of midshaft clavicle fractures were reported in a recent series by Johnson and Arrington.<sup>7</sup> They found a 100% rate of fracture union in their 37 cases, with healing occurring at a mean of 12 weeks. At a minimum follow-up of 12 months, all 37 patients had returned to their preinjury activity level without any restrictions. However, the authors described 6 intraoperative complications, including

anterior clavicular cortical penetration, drill bit and Hagie pin breakage, and fracture propagation. In the postoperative period, 26 complications occurred, including skin irritation in 16, loss of reduction greater than 5 mm in 8, and cellulitis in 2.

Intramedullary Hagie pins have also been used in the management of nonunions developing after midshaft clavicle fractures. Boehme et al<sup>2</sup> reported on 21 cases of midshaft clavicle nonunions treated with Hagie pin fixation and autogenous bone grafting. They achieved fracture union in 95% of cases at a mean of 22 weeks, with 14 patients having full active range of motion and no fracture site-related pain. In this series, breakage of the Hagie pin occurred in 3 cases, before fracture union in 1 and during implant removal in the other 2, resulting in retained hardware. In addition, during the treatment course, 17 of 21 patients (81%) reported pain in the region of the prominent distal end of the Hagie pin.

Our study is limited by its retrospective nature and relatively small patient population. In addition, 2

patients were lost to follow-up (12.5%), potentially altering our outcome results.

In summary, our experience with intramedullary Hagie pin fixation of 16 acute midshaft clavicle fractures showed fracture union in 100% of cases, with a high percentage of patients regaining full range of shoulder motion and resolution of symptoms. However, we had a high rate of postoperative complications associated with this treatment method. Intramedullary fixation of midshaft clavicle fractures remains a successful treatment option; however, on the basis of our data, we believe that the complication rate associated with the use of the Hagie pin should preclude the use of this particular implant.

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