

# A Study on Functional Outcomes after Plating of Middle Third Fractures of Clavicle

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## ABSTRACT

### BACKGROUND

Fracture clavicle is one of the most common conservatively treated fractures. Conservative management showed lesser rates of non-union and satisfactory results for fracture clavicle initially. Recent studies showed that the functional outcome following conservative management was not as optimal as it was thought to be. With changing injury patterns, increased incidence of high velocity trauma and increased functional demands of the modern patients which led to thorough evaluation of the functional outcomes following conservative management of fracture clavicle, the outcome was not optimal. Recent studies showed increased rate of non-union among conservatively managed cases compared to those which were fixed internally. Some found residual deficits among patients treated conservatively. We wanted to study the functional outcome and complications following internal fixation of clavicle fractures by using plating techniques.

### METHODS

This prospective study was done in Department of Orthopaedics, Andhra Medical College, Visakhapatnam. We studied functional outcome of 30 fractures of clavicle which were fixed using plating technique during the period October 2016 - October 2018. Thirty patients (n = 30) were treated with plating technique using precontoured locking plates and recon plates. The fractures in this study were middle third clavicle fractures which were divided into two types based on the classification of Robinson. Type 2 Robinson clavicle fracture implies that it is a middle third clavicular fracture, which is further divided based on fracture morphology. 2b1: Displaced simple or wedge comminuted fractures 2b2: Segmental comminuted fractures. In this study, superior plating was done. The implants used were precontoured LCP and recon plates. Functional outcome was assessed using Constant Murley scoring and Quick Dash score at 10 weeks. The follow up period was for 1 year - October 2016 to October 2018.

### RESULTS

The average time of union for the fractures treated with plating technique in our study was around 10.2 weeks. The mean Constant Murley score of our study was 91. Eighteen out of 30 patients had excellent outcomes. One patient had fair outcome due to stiffness of the shoulder. 10 patients had good result. The average DASH score of the patients was about 9.8.

### CONCLUSIONS

Treatment of fracture middle third of clavicle using plating technique provides good functional outcome and faster recovery with minimal complications.

### KEYWORDS

Clavicle A02.835.232.087.227, Wounds and Injuries C26, Postoperative Complications C23.550.767

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**BACKGROUND**

The incidence of clavicle fracture is 64 per 100,000 population. Fracture clavicle accounts for 2.6 percent of all the fractures. Fractures of the middle third of clavicle are more common which account for about 80 to 85 percent. Conservative management was the main treatment modality for these fractures and most of the studies conducted showed satisfactory results with conservative treatment previously. In recent times prolonged immobilization is not favored much. Hence, the need for evaluation of different modalities of surgical treatments and their functional outcomes.

**METHODS**

This prospective study was done in the Department of Orthopaedics, Andhra Medical College, Visakhapatnam. This study constitutes functional outcome of 30 fractures of clavicle which were fixed using plating technique, the period spanning from October 2016 to October 2018. Thirty patients with fracture clavicle (n = 30) were treated with plating technique using pre contoured locking plates and recon plates. Robinson classification was applied to classify these fractures.

Sl. No	Activities / Question	No Difficulty	Mild Difficulty	Moderate Difficulty	Severe Difficulty	Unable to Do
1	Opening a tight or new jar	1	2	3	4	5
2	Do heavy chores (washing walls, floor etc.)	1	2	3	4	5
3	Carrying a shopping bag or briefcase	1	2	3	4	5
4	Washing back of the body	1	2	3	4	5
5	Use a knife to cut food	1	2	3	4	5
6	Recreational activities like tennis, hammering	1	2	3	4	5
7	Interference of social activities because of shoulder pain	Not at all 1	Slightly 2	Moderately 3	Quite a bit 4	Extremely 5
8	Interference of normal activities of daily living because of hand or shoulder problem	Not at all 1	Slightly 2	Moderately 3	Quite a bit 4	Extremely 5
<b>Rate the Severity of the Symptoms in the Past Week</b>						
9	Arm or shoulder pain	None 1	Mild 2	Moderate 3	Severe 4	Extreme 5
10	Tingling in arm, shoulder or hand	None 1	Mild 2	Moderate 3	Severe 4	Extreme 5
11	Difficulty in sleeping because of pain in shoulder, arm or hand in the past week	No difficulty 1	Mild difficulty 2	Moderate difficulty 3	Severe difficulty 4	Could not sleep at all 5
<b>Quik Dash Score</b>						
Dash disability score: $\frac{((\text{Sum of n responses}) - 1)}{n} \times 25 / 10$ , n = number of completed responses, Quick dash score is invalid if more than one response is missing.						

Measured at 90 degrees lateral abduction 1 point per 0.5 kg, maximum 25 points. Quick dash score has eleven components and each response is graded on a scale 1 to 5 depending on the severity of pain and difficulty in performing the activities. Greater is the dash score, more severe is the compromise in the functional activity and disability of the patient on a scale of 0 to 100.

**Surgical Procedure**

All the patients were operated under general anaesthesia. Position was supine with a sandbag between the shoulder blades / scapulae and a 15 degree head up tilt of the operating table to minimize the blood loss. Head was turned to the opposite side of operative field and surgeon stands beside the neck on the side to be operated. Incision was given on the antero inferior subcutaneous border of the clavicle. This creates a flap of skin to be elevated along with platysma muscle exposing the fracture directly with its periosteum. Fracture was reduced directly and preliminarily fixed with k wires or if feasible with inter fragmentary screw. A pre contoured locking plate or 3.5 mm recon plate contoured on table to the shape of the clavicle was applied on the superior aspect of the clavicle rigidly fixing the fracture with locking cortical screws or 3.5 mm cortical screws. Haemostasis was achieved with the help of mono polar diathermy and the wound was closed in two layers one platysma the other skin meticulously. Sterile padded bandage plaster was applied and the limb was supported in an arm pouch. Pendulum exercises were allowed from postoperative day 3. After 2 weeks, sling was discontinued and the patient was allowed unrestricted range of motion of exercises. Sports and lifting heavy weights were not allowed till 12 weeks.

**Inclusion Criteria**

1. Age more than 18 years and less than 60 years.
2. Middle third clavicle fractures of Robinson type 2 variety.
3. Segmental fractures clavicle.
4. Associated with neurological injury.
5. Displacement more than 2 cm.
6. Shortening more than 2 cm.
7. Patients motivated for faster return to work.
8. Cases fixed with plating, middle third fractures.

**Exclusion Criteria**

1. Age less than 18 years and more than 60 years.
  2. Un-displaced fractures.
- Medical co morbidities which precluded surgical treatment.

**RESULTS**

Thirty patients were treated with plating technique using pre contoured locking plates and recon plates (n = 30). There

were three females and twenty-seven were males, 10 % and 90 % respectively. In the present study the age group of patients ranged between 18 years and 60 years. Out of 30 patients, 16 patients sustained fracture clavicle on right side, rest of the patients had clavicle fracture on left side. There were no cases of bilateral involvement. Twenty-five patients sustained fracture clavicle due to road traffic accident and 5 patients had fracture clavicle due to accidental fall. There were 18 cases of type 2b1 fractures and there were two cases of type 2b2 fractures. In this study, superior plating was done. The implants used were pre contoured LCP (Locking Compression Plates) and recon plate. 18 cases were treated with pre contoured LCP and 12 cases were treated with recon plate. The average time of union for the fractures treated with plating technique in our study was around 10.2 weeks, with 4 fractures uniting in less than 8 weeks and 16 fractures uniting between 9 to 10 weeks and 8 fractures healing within 11 to 12 weeks and two fractures healing after 12 weeks. All the patients returned to their day to day activities like eating, grooming themselves and activities of personal hygiene by 2 to 3 weeks. Most of the patients returned to their work by 8 to 10 weeks. Seven patients who work as manual laborers resumed their work between 13 to 14 weeks. Three patients who were engaged in heavy work resumed their work between 15 to 16 weeks. One patient who was non-compliant to physiotherapy had stiff shoulder and took more than 16 weeks to return to work. The mean Constant Murley score of present study was 91. The Constant Murley score was calculated for 29 patients as one patient had brachial plexus injury for which the functional score could not be calculated as there was no abduction and forward flexion of the shoulder. This was taken as poor result. Eighteen out of 30 patients had excellent outcomes. One patient had fair outcome due to stiffness of the shoulder. 10 patients had good result (Table 1).

Outcome based on Constant Murley Score	Number of Patients	Percentage
Excellent	18	60 %
Good	10	33.33 %
Fair	1	3.33 %
poor	1	3.33 %

**Table 1. Constant Murley Score in the Present Study**

The average Quick dash score of the patients was about 9.8. The patient with brachial plexus injury was excluded while calculating the Quick dash score. Eighteen out of 30 patients had excellent outcomes. One patient had fair outcome due to stiffness of the shoulder. 10 patients had good result.

**Complications**

Complications in the present study were 2 cases of hardware irritation (6.7 %) which was treated with implant removal at a later date after the fracture union. One case of superficial infection was treated with antibiotics (3.33 %). Another case was of delayed union. There were 2 cases of shoulder stiffness (6.7 %). They were instructed to do pendulum

exercises and their scores were poor compared to other people at the end of the study. Two cases had hypertrophied scar with the present study (6.7 %). Two cases had incisional numbness (6.7 %) in the present study. There was one case of brachial plexus injury which did not recover. The patient was referred to higher centres for further management. Delayed union was seen in 3.3 percent of cases. There were no cases of non-union in the present study. There were no cases of implant failure and 6.7 percent of cases had hypertrophied scar. Two cases had incisional numbness (6.7 %) in the present study (Table 2).

Complications	Number of Cases	Percentage of Total Cases Operated
Hardware Irritation	2	6.66 percent
Infection	1	3.33 percent
Non Union	0	
Malunion	0	
Delayed Union	1	3.33 percent
Hardware Failure	0	
Stiffness of Shoulder	2	6.66 percent
Paraesthesia	2	6.7 percent
Hypertrophied Scar	2	6.7 percent

**Table 2. Incidence of Complications**

**DISCUSSION**

The study by Zlowodzki et al, which is one of the largest meta-analysis comparing on operative treatment, plating and intra medullary fixation of displaced fractures of clavicle from 1975 to 2005 showed that the internal fixation of clavicle produced lesser rates of non-union compared to conservative treatment.<sup>1</sup> Another meta-analysis of six RCTS by Mc Kee and Whelan et al showed better results with internal fixation compared to conservative management. There was reduction of non-union rates from 23 % in non-operative group to 1.4 % in the operative group.<sup>2</sup>

In the present study there is increased incidence of fracture clavicle among males compared to that in females with 27 males and 3 females respectively. Present study results were consistent with the results of Eldirissi Mohammed et al where the number of males were 32 and number of females were two.<sup>3</sup> However it differs with the studies of Akshay Bharadwaj et al which showed female preponderance in clavicle fractures with 21 males and 48 females.<sup>4</sup>

The most common mode of injury which led to fracture clavicle was road traffic accidents followed by falls. This was in consistence with the studies of Soninder et al and Eldirissi Mohammed et al.<sup>5,3</sup> In the present study, the most common age group which sustained fracture clavicle was that in the age group of 35 to 40 years followed by the age group of 31 to 35 years. The mean age of the patients in the present study is 37.5 years. The results of the present study were in consistence with that of B.M. Naveen et al, where the mean age was 35.2 years.<sup>6</sup>

The fracture pattern in the present study was Robinson type 2a and 2b, former being more common than the later. We have chosen only middle third fractures of clavicle to have consistency in our study with respect to union rates. There was increased rate of delayed and non-union in case of lateral end of clavicle fractures.<sup>7</sup> So to prevent the error

in the result, only middle third shaft fractures were considered in the study. All the patients in the present study were operated within two to four days. This was in consistence with the study done by Ethiraj et al, where most of the cases were operated within first two days.<sup>8</sup> This was also consistent with that of K.B. Ravi et al where 60 percent of the patients were operated within two days and with average duration between trauma and the surgery was 4 days.<sup>9</sup>

The average time for the fracture to heal in the present study was 10.2 weeks. The average union time in the study by Akshay Bharadwaj et al was 15.6 weeks in the group treated with plating (pre contoured LCP) while in that of conservatively treated group the average union time was 22.8 weeks.<sup>4</sup> In the study by Ethiraj et al, where the patients were treated with pre contoured LCP showed average union time of 12 to 14 weeks.<sup>8</sup> In study by K.B. Ravi et al, there was some variation. Most of the patients had their fracture united by 12 weeks (more than 60 % of fractures) and 30 % of fractures united within 24 weeks.<sup>9</sup> However, in the study by Saidapur SK et al the average union time was about 12 weeks.<sup>10</sup> Study by Dilip kumar Naidu et al also showed that most of the fractures united by 11 to 12 weeks. Second highest union time for the fractures in their study was 9 to 10 weeks.<sup>11</sup> In the study by Eldrissi Mohammed et al the fracture united over 14 weeks on an average.<sup>3</sup> The results of the present study were superior to the above-mentioned studies.

The average Constant Murley score in our study was 91. The overall functional outcome of the study was excellent based on the Constant Murley score. In the study by Robinson et al, operative group showed better results compared to conservatively treated group with their mean Constant Murley score of 92 in the operated group, consistent with the results of our study. However, the Constant Murley score in conservatively treated group was 87.8.<sup>12</sup> The Constant Murley score of the operated group of patients in the study done by Akshay Bharadwaj et al was 89.42 and 76.24 in group treated conservatively.<sup>4</sup> Study by B.M. Naveen showed Constant Murley score to be 94 in surgically treated group compared to 89.6 in non-operatively treated group.<sup>6</sup> The results of Ethiraj et al were superior to our study, which showed 76 percent excellent results and 17 percent good results. 5 percent fair and 2 percent poor results.<sup>8</sup> In the study by K.B. Ravi et al, 77 percent showed excellent results, followed by 13 percent good results and 7 percent fair results and 3 percent poor result.<sup>9</sup> Study by Saidapur et al showed excellent to good results in 92 percent of their cases with fair and poor results in 5 percent and 3 percent of their patients respectively.<sup>10</sup> The results were in consistence with the results of the present study. In a study by Soninder Kumar Sharma et al, the functional outcome was excellent in 68 percent of the patients.<sup>5</sup> Another study by Olivier Verborgt et al in which, semi-professional athletes were treated with plating for clavicle fractures had its constant Murley score of 88.<sup>13</sup> The average Constant Murley score was 95.33 in the study done by Eldrissi Mohammed et al.<sup>3</sup> (Table 3).

Syed Ibrahim et al showed average Quick dash score of 7.1 and Robinson et al had quick dash score of 3.2 in

operatively treated fracture clavicles.<sup>14,12</sup> The results according to Quick dash score were better in these studies compared to the present study where the average Quick dash score was 9.8. (Tables 4)

Name of the Study	Constant Murley Score
Robinson et al	92
Akshay Bharadwaj et al	89.42
B.M. Naveen et al	94
Olivier Verborgt et al	88
Eldrissi Mohammed et al	95.3
Present Study	91

**Table 3. Comparison of Constant Murley Score from Other Studies**

Name of the Study	Quick Dash Score
Syed Ibrahim et al	7.1
Robinson et al	3.2
Present study	9.8

**Table 4. Quick Dash Score Compared with Other Studies**

The Constant Murley score is an assessment tool which also includes the components of physical examination. Whereas the quick dash scores are based more on the subjective questionnaire which may be variable depending on the activity of the patients and variable pain tolerance among the population. Since most of the patients in the present study were laborers by profession, their quick dash scores were less compared to that of Robinson et al and Syed Ibrahim et al.

### Complications

The study by Olivier Verborgt et al had 18 percent of cases complicated by infection. 5 percent had re fracture and 5 percent had non-union and 7 percent had paraesthesias.<sup>13</sup> The study by Soninder kumar Sharma et al had hardware prominence in 4 percent of cases, 3.1 percent of cases had infection, 3.1 percent of cases had delayed union and 3.1 percent had hypertrophic scar.<sup>5</sup> In a study by Saidapur et al the non-union with implant failure rate was 1.7 percent and rate of delayed union was 5 percent with two patients complaining of incisional numbness and 5 cases with pain and decreased range of shoulder movement. 18 percent of cases had hardware prominence for which implant removal was done.<sup>10</sup> In the study done by Robinson et al, the non-union rate in operated group was 1.1 percent (1 out of 86 cases) while it was about 14 percent in non-operative group (13 among 92 cases). Eleven percent of cases had to be operated again for implant removal in this study. Four percent of cases had implant failure and re fracture in this study.<sup>12</sup> The results of the study by Kulkshetra et al showed no cases of non-union and one case of hardware prominence. There were no major complications in the study.<sup>15</sup> The study of Eldrissi Mohammed et al had no complications like infection, hardware failure. Only 4 patients had hardware prominence and they got their implant later on. There was only one case of non-union in their study.<sup>3</sup> In the study done by K.B. Ravi et al, ten patients had complications out of 30 cases. 1 case had infection, 1 case had non-union with implant failure and two cases had implant failure: 3 cases had hardware prominence and 3

cases had decreased shoulder range of movements.<sup>9</sup> In study by Ethiraj et al, there were no complications other than one patient who had implant failure due to premature load bearing.<sup>8</sup>

### Non-Union

There were no cases of non-union in the present study. In study by Akshay Bharadwaj, there were two cases of non-union.<sup>4</sup> In the study by K.B. Ravi, there was one case of non-union.<sup>6</sup> Study by Eldirissi Mohammed had one case of non-union.<sup>3</sup> The meta-analysis of Zlovodski et al showed non-union rate of 2.2 percent and the study by Robinson et al showed a non-union rate of 1.1 percent.<sup>1,12</sup> The results of the present study where there was no case of non-union were superior compared to other studies. The results were comparable with that of Ethiraj et al, kulkshetra et al and B.M. Naveen et al where there are no cases of nonunion.<sup>8,15,6</sup>

### Hardware Problems

Hardware prominence and hardware failure were the major implant related problems. Most of the studies had occurrence of hardware prominence as a major complication which lead to increased reoperation rates. In the present study there were two cases with hardware prominence. The results of the present study were comparable with that of Akshay bharadwaj et al and B.M Naveen et al. Kulkshetra et al, had lesser cases of implant prominence.<sup>4,6,15</sup> The results of present study were better than that of Eldirissi Mohammed where there were 4 cases of hardware prominence<sup>3</sup> However studies by Saidapur et al had 18 percent rate of hardware prominence for which removal was done.<sup>10</sup> Study by Robinson et al also had 11 percent rate of implant related complications.<sup>12</sup> Usage of low profile implants with preferably better soft tissue coverage over the implant leads to decreased prominence of the implants.

### Hypertrophic Scar

The study by Soninder kumar Sharma et al and B.M. Naveen et al had cases of hypertrophied scar.<sup>5,6</sup> The present study also has two cases of hypertrophied scar. The present study had two cases of shoulder stiffness or decreased range of shoulder movements. B.M. Naveen et al had 9 cases complicated by stiffness of shoulder followed by Saidapur et al, where 5 patients had decreased range of shoulder movements.<sup>6,10</sup> The results of the present study were comparable to that of K.B Ravi which had 3 cases of decreased shoulder range of movements and superior to that of B.M. Naveen et al and Saidapur et al.<sup>9,10</sup>

### Infection

There was only one case of superficial infection in the present study (3.33 %). However, study of Vorborgt was complicated by high infection rate of 18 percent.<sup>13</sup> The studies of Zlovodski and Soninder et al also showed infection rates of 4.6 percent and 3.1 percent respectively.<sup>1,5</sup> The

results of the present study were superior to that of other results except that of Soninder et al with only one case of superficial infection (3.1 percent). It was treated by administering antibiotics.<sup>5</sup> Two cases had incisional numbness (6.7 %) in the present study. The results of the present study were consistent with those of Saidapur et al and Vorborgt et al studies with 5 percent and 7 percent reported incidence of incisional paraesthesias.<sup>10,13</sup> In the present study, superior plating was done. Biomechanically, superior plating was considered to be more superior to antero inferior plating. A study by Toogood et al showed that superior plating to be stiffer in axial compression and torsional loading.<sup>16</sup> However, with superior plating chances of injuring the neurovascular structures are more. Chances of injury to neurovascular structures and implant exposure are minimized in antero inferior plating. Studies by Glide et al showed excellent results with antero inferior plating of clavicle with 2.5 mm DCP (Dynamic Compression Plates) and lesser rates of implant removal. They opined that the chances of hardware prominence were lesser in antero inferior plating. The vas scores and symptoms were also better in antero inferior plating.<sup>17</sup>

## CONCLUSIONS

Treatment of fracture middle third of clavicle using plating technique provides good functional outcome and faster recovery with minimal complications. Early initiation of pendulum exercises, decreasing the time of immobilization leads to better shoulder range of movements. Superior plating is biomechanically stiffer than anterior plating. The latter is associated with less implant prominence.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

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## REFERENCES

- [1] Zlowodzki M, Zelle BA, Cole PA, et al. Treatment of acute midshaft clavicle fractures: systematic review of 2144 fractures: on behalf of the Evidence-Based Orthopaedic Trauma Working Group. *J Orthop Trauma* 2005;19(7):504-507.
- [2] McKee RC, Whelan DB, Schemitsch EH, et al. Operative versus non-operative care of displaced midshaft clavicular fractures: a meta-analysis of randomized clinical trials. *J Bone Joint Surg Am* 2012;94(8):675-684.
- [3] Mohammed E, Mahadane H, Mechchat A, et al. Functional outcome of midclavicular fracture fixation utilising a reconstruction plate. *Malays Orthop J* 2013;7(3):6-9.
- [4] Bhardwaj A, Sharma G, Patil A, et al. Comparison of plate osteosynthesis versus non-operative management

- for mid-shaft clavicle fractures - a prospective study. *Injury* 2018;49(6):1104-1107.
- [5] Sharma SK, Yadav SS, Gupta S, et al. Evaluation of functional outcome after plate fixation of midshaft fracture of clavicle. *International Journal of Orthopaedics Sciences* 2018;4(3):373-376.
- [6] Naveen BM, Joshi GR, Hari Krishnan B. Management of mid-shaft clavicular fractures: comparison between non-operative treatment and plate fixation in 60 patients. *Strategies Trauma Limb Reconstr* 2017;12(1):11-18.
- [7] Robinson CM, Cairns DA. Primary non-operative treatment of displaced lateral fractures of the clavicle. *J Bone Joint Surg Am* 2004;86-A(4):778-782.
- [8] Ethiraj P, Prathap P, Arun HS et al. Functional outcome in surgical management of midshaft clavicle fractures fixed with precontoured plate in adults. *International Journal of Orthopaedics Sciences* 2016;2(4):458-462.
- [9] Ravi KB, Ravishankar J, Shetty P, et al. Operative management of clavicle fractures by LCP. *International Journal of Orthopaedics Sciences* 2017;3(3):519-530.
- [10] Saidapur SK, Khadabadi NA. Locking plate fixation of mid-shaft clavicle fractures: analysis of complications, reoperation rates and functional outcome. *International Journal of Orthopaedics Sciences* 2017;3(3):1071-1073.
- [11] Naidu DK, Anand AV. A clinical study of displaced clavicle fractures treated with precontoured locking compression plate. *International Journal of Research in Orthopaedics* 2017;3(6):1122-1126.
- [12] Robinson CM, Court-Brown CM, McQueen MM, et al. Estimating the risk of non-union following non-operative treatment of a clavicle fracture. *J Bone Joint Surg Am* 2004;86-A(7):1359-1365.
- [13] Olivier V, Kathleen P, Van Glabbeek F, et al. Plate fixation of middle-third fractures of the clavicle in the semi-professional athlete. *Acta Orthop Belg* 2005;71(1):17-21.
- [14] Syed I, Jimmy JM. Retrospective study of superior anterior plate as a treatment for unstable (Neer type 2) distal clavicle fractures. *Rev Bras Ortop* 2017;53(3):306-313.
- [15] Kulshrestha V. Primary plating of displaced mid-shaft clavicular fractures. *Med J Armed Forces India* 2008;64(3):208-211.
- [16] Toogood P, Coughlin D, Rodriguez D, et al. A biomechanical comparison of superior and anterior positioning of precontoured plates for midshaft clavicle fractures. *Am J Orthop (Belle Mead NJ)* 2014;43(10):E226-E231.
- [17] Gilde AK, Jones CB, Sietsema DL, et al. Does plate type influence the clinical outcomes and implant removal in midclavicular fractures fixed with 2.7-mm anteroinferior plates? A retrospective cohort study. *Journal of Orthopaedic Surgery and Research* 2014;9:55. <https://doi.org/10.1186/s13018-014-0055-x>.