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Is bioabsorbable screw an alternative choice for displaced medial epicondylar fractures in adolescents

A comparative study of metallic cannulated lag screw versus bioabsorbable screw

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Abstract

In adolescent patients, cannulated lag screw (CLS) is a widely accepted choice for fixation of the medial epicondylar fracture of the humerus (MEFH). Absorbable implants, including rod, screw, and mini-plate, have been reported in children. However, to the best of our understanding, this study is the first head-to-head comparative study of CLS versus bioabsorbable screw (BS) in the treatment of MEFH.

Patients of MEFH operated at our institute, from January 2010 to January 2016, were reviewed retrospectively. The patients were divided into 2 groups, the CLS group and the BS group, as per the type of implant the patient received. The CLS group consisted of 35 patients, whereas the BS group consisted of 30 patients. Demographic data, including sex, age at the time of surgery, operated side, and implant material, were collected from the hospital database. Elbow range of motion (ROM), radiographic manifestation was recorded during the out-patient visit. The elbow joint function was evaluated according to the Broberg and Morrey elbow scale and Mayo elbow performance index score.

Thirty patients, including 18 males and 12 females, were included in the CLS group, whereas 35 patients, including 21 males and 14 females, were included in the BS group. At 6-month follow-up, elbow range of motion, Broberg and Morrey elbow scale and Mayo elbow performance index scale showed no significant difference between the 2 groups. The carrying angle was within the normal range in both groups. There was no nonunion or malunion in either group. The rate of hypoplasia or hyperplasia was low in both groups, 3.3% in CLS and 2.9% in BS. The rate of implant prominence was significantly higher in the CLS group (33.3%) than BS (0%).

Both CLS and BS are safe and effective choices for displaced MEFH in adolescents. The BS can produce a satisfactory clinical outcome and is comparable to the CLS. Besides, the BS has the advantage of not needing second surgery for implant removal.

Abbreviations: BS = bioabsorbable screw, CLS = cannulated lag screw, KW = Kirschner wire, MEFH = medial epicondylar fracture of the humerus, ORIF = open reduction and internal fixation, ROM = range of motion.

Keywords: adolescent, bioabsorbable screw, cannulated lag screw, medial epicondyle

1. Introduction

Medial epicondylar fracture of the humerus (MEFH) is a relatively common injury in children and adolescents.[1] Nonsurgical treatment of MEFH shows good to excellent clinical outcomes, regardless of the presence of bony union.[2] However, open reduction and internal fixation (ORIF) is gaining favors among orthopedic surgeons due to the functional demands of adolescent patients and evolving knowledge of the role of medial

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epicondyle.[3,4] Besides, ORIF offers a significantly higher union rate than nonsurgical methods.[5–7] Therefore, ORIF was adopted at our institute for significantly displaced or incarcerated MEFH.

In adolescent patients, cannulated lag screw (CLS) is a widely accepted choice for fixation.[8–10] Absorbable implants, including rod, screw, and mini-plate, have been reported in children.[11,12] However, to the best of our understanding, this study is the first head-to-head comparative study of CLS versus bioabsorbable screw (BS) in the treatment of MEFH.

2. Methods

All the patients with MEFH operated at our institute, from January 2010 to January 2016, were reviewed retrospectively.

Inclusion criteria were:

1) Patients managed with ORIF with either the use of CLS or BS within 2 weeks after the trauma,
2) availability of both the clinical and radiological data, and
3) the follow-up period of 24 months or more.

The exclusion criteria were:

1) Patients with incomplete clinical data or radiographs,
2) open or pathological fracture,
3) previous elbow fracture or instrumentation.

The patient's legal guardians were thoroughly explained about the risks and benefits of the implant designs and let them choose the implant material accordingly.

The patients were divided into 2 groups, the CLS group and the BS group. The CLS group consisted of 35 patients, whereas the BS group consisted of 30 patients. Demographic data, including sex, age at the time of surgery, operated side, and implant material, were collected from the hospital database. Preoperative radiographs were reviewed and classified according to Wilkins.[13] The elbow range of motion (ROM) and radiographic evaluation was performed and recorded during the out-patient visit. The elbow function was evaluated according to the Broberg and Morrey elbow scale[14] and Mayo elbow performance index score.[15] Complications, including infection, malunion, nonunion, cubitus valgus deformity, stiffness of the elbow joint, failure of fixation, and implant prominence, were also recorded.

This study was approved by the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology on June 1, 2016 (IORG0003571). Written consent was obtained from the patient's legal guardians.

2.1. Biodegradable screw

The BS is made up of a blend of L-lactide, D, L-lactide, and trimethylene carbonate (TMC). It has a diameter of 3.5, 4.5, and 5.5 mm, and a length of 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, and 6.5 cm.

2.2. ORIF in the CLS group (Fig. 1)

A longitudinal medial incision, centered on medial epicondyle, was made to expose the fragment and ulnar nerve, and the fracture fragment was reduced and fixated by 1 or 2 CLS (diameter, 3.5–4.5 mm).

2.3. ORIF in the BS group

A similar approach was chosen as in the CLS group, and the fracture fragment was routinely fixated by 1 or 2 BSs (Fig. 2).

2.4. Postoperative care and follow-up

The operated arm was immobilized in the long-arm posterior slab for 2 to 3 weeks. After removal of the slab, active ROM exercise was encouraged. Patients were followed-up every month for the first 3 months, then every 3 months until 1 year, and then annually. At our institute, CLS was routinely removed at about 6 to 12 months after primary surgery.

2.5. Statistical analysis

SPSS statistical package program (SPSS 19.0 version; SPSS Inc., Chicago, IL) was used for statistical analysis. The categorical data were analyzed using the Chi-squared (χ^2) test, and the continuous data were analyzed using Student *t* test. Fisher exact test was used under those circumstances with fewer subjects in groups of interest. Data were presented as mean ± SD (range), median (range), or n (%). A *P*-value of $<.05$ was considered a statistically significant difference.

3. Result

As shown in Table 1, there was no significant difference between the 2 groups concerning sex and age. Thirty patients, including 18 males and 12 females, were included in the CLS group, whereas 35 patients, including 21 males and 14 females, were included in the BS group. The average age of patients in the CLS group was 11.3 years, and that of BS was 11.6 years ($P = .409$). Patients in both groups were followed-up for at least 24 months. The fracture classification and duration form injury to surgery showed no significant difference between both groups.

As shown in Table 2, at 6-month follow-up, elbow ROM, Broberg and Morrey elbow scale, and Mayo elbow performance index scale showed no significant difference between the 2 groups. The carrying angle was within the normal range in both groups.

As shown in Table 3, there was no nonunion or malunion in either group. The rate of hypoplasia or hyperplasia was low in both groups, 3.3% in CLS and 2.9% in BS. Besides, the infection rate was similar and low in both the groups (3.3% in CLS and 5.7% in BS). The rate of implant prominence was higher in the CLS group (33.3%) than BS (0%).

In this study, the average duration of CLS removal was 11.5 ± 2.9 months after primary surgery, whereas implant removal was not required in the BS group.

4. Discussion

Both CLS and BS are safe and effective choices for displaced MEFH in adolescents. The BS can produce a satisfactory clinical outcome and is comparable to the CLS. Besides, the BS has the advantage of not needing second surgery for implant removal.

Treatment of MEFH depends on the displacement of the fragment and the stability of the elbow joint.[6] Operative indications include open injuries, incarcerated fractures associated with the elbow dislocation, and fractures with more than 5 mm of displacement.[16–18]

Figure 1. Thirteen-year-old girl of left medial epicondyle fracture treated with metallic screw. A. AP view of the elbow before surgery. B. AP view of the elbow after surgery. C. AP view of the elbow at 3-mo follow-up. D. Lateral view of the elbow at 3-mo follow-up. E. AP view of the elbow after hardware removal. F. Lateral view of the elbow after hardware removal.

Irrespective of a relatively low rate of bony union, the nonsurgical treatment provides good to excellent functional results.[19–22] However, the nonsurgical treatment with cast application and immobilization of fractured elbow is increasingly being replaced by surgical fixation.[16,19] The primary purpose of surgical fixation is to achieve an anatomic reduction and early mobilization. Kamath et al found a significantly higher union rate in operative fixation (92.5%) than nonoperative management (49.2%).[7] Similarly, Lee et al found excellent outcomes in 96.2% of operated patients.[23] Therefore, ORIF is the preferred choice for Wilkins type III and IV MEFH at our institute.

Fixation choices include metallic CLS, Kirschner wire (KW), and biodegradable osteosynthesis. Szymanska et al found the metallic screw to be the better choice than KW,[24] but Lee et al concluded similar and satisfactory outcomes for both CLS and KW.[23] Several other authors favored the use of CLS in adolescents and KW in younger children.[9,25] In adolescents, CLS was our preferred choice before the BS was available at our

Figure 2. Eleven-year-old girl of right medial epicondyle fracture treated with bioabsorbable screws. A. AP view of elbow before surgery. B. AP view of elbow after surgery. C. AP view of elbow at 2nd month surgery. D. Lateral view of elbow at 2nd mo surgery. E. AP view of elbow at 6th month follow-up. F. Lateral view of elbow at 6th month follow-up.

Table 1

Demographics of the patients.

Parameters	CLS (n = 30)	BS (n = 35)	*P* value
Age (yr)	11.3 ± 1.7	11.6 ± 1.8	.409
Sex (male/female)	18/12	21/14	>.999
Side (left/right)	15/15	18/17	.921
From injury to surgery (d)	3.2 ± 1.0	3.4 ± 1.1	.610
Wilkins Classification			
III	18 (60.0%)	21 (60.0%)	>.999
IV	12 (40.0%)	14 (40.0%)	

BS = biodegradable screw, CLS = cannulated lag screw.

Table 2

Clinical outcome of the patients at 6th month follow-up.

Clinical outcomes	CLS (n = 30)	BS (n = 35)	*P* value
Carrying angle (degree)	5.3 ± 3.2	4.6 ± 3.1	.386
Extension (degree)	–4.4 ± 3.3	–4.2 ± 3.0	.801
Flexion (degree)	130.7 ± 5.0	130.7 ± 7.0	.960
MEPI score	93.6 ± 2.7	93.7 ± 2.6	.939
Elbow scale			
Excellent	22	25	.650
Good	7	9	
Fair	1	1	
Poor	0	0	

BS = biodegradable screw, CLS = cannulated lag screw, elbow scale = Broberg and Morrey elbow scale, MEPI = Mayo Elbow Performance Index.

Table 3

Complications of the patients until last follow-up.

Complications	CLS (n = 30)	BS (n = 35)	*P* value
Nonunion	0	0	>.999
Malunion	0	0	>.999
Hypoplasia	1 (3.3%)	1 (2.9%)	.885
Hyperplasia	1 (3.3%)	1 (2.9%)	.885
Exposure of implant	0	0	>.999
Revision after infection	0	0	>.999
Unresolved stiffness	0	0	>.999
Implant prominence	10 (33.3%)	0	.002*
Superficial infection	1 (3.3%)	2 (5.7%)	.636

* < .05.

BS = biodegradable screw, CLS = cannulated lag screw.

institute. The washer is not routinely used in our hospital, and all metallic screws are offered to be removed at our institute.

As shown in results, patients in both groups displayed good and excellent clinical outcomes at 6-month follow-up, consistent with previous studies on operative management.[7,16,19,23] There was no nonunion and malunion in either group, and the rate of hypoplasia or hyperplasia was low (2.9%–3.3%) in both groups without noticeable symptoms. There was no patient of elbow instability in both groups. The incidence of implant prominence was higher in the CLS group, partly because we did not overdrive the screw into the bony surface in case of over-compression. However, the inter-fragmentary force of BS is limited, and the screw was driven into the bony surface to reduce the risk of hardware prominence.

The BSs were more expensive (500–600 US dollars for each screw) than metallic CLS (100–150 US dollars), and it was not covered by the basic medical insurance in our province. In contrast, the patients receiving metallic CLS require second surgery; however, the cost of hardware removal was covered by the medical insurance in our province. Still, the financial burden of the patients remains to be investigated.

We undertook a retrospective investigation; therefore, our findings should be interpreted with caution. The allocation process of patients to either the CLS group or BS group partly depended on the preference of the surgeon in charge, and this strategy may cause allocation bias. The follow-up was not long enough, and the long-term impact upon growth remains unclear.

5. Conclusion

Both CLS and BS are safe and effective choices for displaced MEFH in adolescents. The BS can produce a satisfactory clinical outcome and is comparable to the CLS. Besides, the BS has the advantage of not needing second surgery for implant removal.

Author contributions

Conceptualization: Pan Hong.
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