Clinical outcomes of scaphoid nonunions treated with 1,2 intercompartmental supraretinacular artery pedicled vascularized bone graft and compression screw

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Abstract
Scaphoid fractures are the most common fracture of the carpal bones and account for 60% of all carpal fractures and 11% of all hand fractures [1]. Scaphoid nonunion occurs in 5% to 12% of all scaphoid fractures [2,3]. The primary risk factor for nonunion of the scaphoid is displacement/instability, but delayed or missed diagnosis, inadequate treatment, fracture location, and blood supply are also risk factors [4]. Nonunion of scaphoid fractures can cause scaphoid nonunion advanced collapse (SNAC), which can lead degenerative osteoarthritic changes of the wrist [5].

There are different treatment options for scaphoid nonunion, including percutaneous fixation, open reduction and internal fixation with vascularized or nonvascularized bone grafts. The 1,2-intercompartmental supraretinacular artery (1,2-IC-SRA) vascularized bone grafting was described by Zaidemberg et al in 1991 [6]. They reported 100% union rate. Other authors reported union rates range from 27% to 100% [6-10]. In this article, we aimed to report our clinical results in scaphoid fractures treated with 1,2-IC-SRA vascularized bone graft between 2009 and 2012.

Materials and Methods
A retrospective search was performed on all medical records of patients with diagnosis of scaphoid nonunion and treated with 1,2-IC-SRA vascularized bone graft in our clinic. Between January 2009 and March 2012. Consent forms had been taken preoperatively in all cases. All patients informed about vascularized graft would be taken from distal radius. 19 patients (18 males, 1 female) of scaphoid nonunion treated with a 1,2-IC-SRA vascularized graft. One patient was excluded because of lost to follow up. The mean age of patients was 31.2 (range 12-47) years. Mechanism of injury was sport injury in 17 patients, traffic accident in one patient. Dominant hand was affected in ten patients. Nine patients had right scaphoid fracture and nine had left scaphoid fracture. All patients presented with wrist pain to our outpatient clinic and had no prior surgery. All patients had scaphoid fractures more than six months. The diagnosis of scaphoid nonunion was made on plain radiographic assessment. We didn’t especially investigated for avascular necrosis (AVN) preoperatively. The delay between initial trauma and operation was 40.8 months (range 8 months to 20 years).

The operation was performed by same experienced hand surgeon. We used surgical technique described by Zaidemberg et al [6]. We used a curvilinear dorsal-radial approach, centered the space between first and second extensor tunnels. Dorsal sensory branches of radial nerve identified and protected. The extensor retinaculum

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divided. Extensor pollicis brevis and abductor pollicis longus are retracted palmarly and extensor carpi radialis brevis and longus tendons retracted ulnarily. The 1,2 IC-SRA is identified overlying distal radius. Then, scaphoid fracture site is visualized and sclerotic bone ends are freshened with a burr drill until healthy bleeding bone seen(Fig. 1b). The required bone graft was harvested with a thin chisel. The pedicle dissected to its origin and with rotation of pedicle the graft is transferred into recipient site(Fig. 1a-1c). Fixation was achieved with a cannulated headless compression screw(standard Acutrak® screw)(Fig. 1d).

Postoperatively, all patients were placed into thumb free short arm splint for 6 weeks. Radiological examinations were performed at 4,8,12 and at the latest follow up. Outcome scoring was performed at the end of follow up period by Mayo Wrist Score[11].

Results

Fracture union was achieved in all patients in a mean 9.4 (range 8-12) weeks. The criteria for fracture union was bridging trabeculae crossing the fracture side on plain radiographs or on computed tomography(CT)if plain radiograph was suspicious for union. The mean Mayo Wrist Score was 76.6(25-100). All patients returned their previous occupations. No wound complication(e.g. infection) was seen.

Discussion

The ideal treatment for scaphoid nonunion is still unsolved and controversial. Despite optimal treatment in scaphoid fractures, nonunion and malunion may occur [2,3]. Despite,
we did not see any SNAC in our series even patient with 20 years history. scaphoid nonunion could cause radiocarpal arthrosis [5], so early diagnosis and treatment is essential. Since described by Zaidemberg in 1991, the vascularized bone graft based on 1,2-IC-SRA was used for scaphoid nonunion by many authors and union rates range from 27% to 100% (Table 1). In our series, we had 100% union at 18 patients.

Table 1. Results of 1,2-IC-SRA for treatment of scaphoid nonunion

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of patients</th>
<th>Union Rate(%)</th>
<th>Time to Union (weeks)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zaidemberg et al.</td>
<td>11</td>
<td>100</td>
<td>6,2 weeks</td>
<td>1991</td>
</tr>
<tr>
<td>Boyer et al.</td>
<td>10</td>
<td>60</td>
<td>18,4 weeks</td>
<td>1998</td>
</tr>
<tr>
<td>Uerpairojkit et al.</td>
<td>10</td>
<td>100</td>
<td>6,5 weeks</td>
<td>2000</td>
</tr>
<tr>
<td>Malizos et al.</td>
<td>22</td>
<td>100</td>
<td>6-12 weeks</td>
<td>2001</td>
</tr>
<tr>
<td>Steinmann et al.</td>
<td>14</td>
<td>100</td>
<td>11,1 weeks</td>
<td>2002</td>
</tr>
<tr>
<td>Tsai et al.</td>
<td>5</td>
<td>100</td>
<td>&lt;18 weeks</td>
<td>2002</td>
</tr>
<tr>
<td>Straw et al.</td>
<td>22</td>
<td>27</td>
<td></td>
<td>2002</td>
</tr>
<tr>
<td>Chang et al.</td>
<td>48</td>
<td>70,8</td>
<td>15,6 weeks</td>
<td>2006</td>
</tr>
<tr>
<td>Waitayawinyu et al.</td>
<td>30</td>
<td>93</td>
<td>5,1 months</td>
<td>2009</td>
</tr>
<tr>
<td>Ong et al.</td>
<td>13</td>
<td>77</td>
<td>152 days</td>
<td>2011</td>
</tr>
<tr>
<td>Our series</td>
<td>19</td>
<td>100</td>
<td>9,4 weeks</td>
<td></td>
</tr>
</tbody>
</table>

Other authors reported good results with other vascularized bone bone grafts [19-25]. In these series union rates were between 80% and 100%. In some of these studies, surgical time is longer than technique we chose due necessity of arterial anastomosis of free vascularized grafts [25,28]. Nonvascularized bone grafts have been also used for treatment of scaphoid nonunions [26-28]. Union rate was 80% to 90%. Braga-Silva et al. compared vascularized and nonvascularized bone graft treatment for scaphoid nonunion and found similar results functionally [29]. Union rate was 100% in non vascularized group, they had 3 nonunions in vascularized group. They had associated these nonunions with technical difficulties.

In treatment of scaphoid nonunions, different types of fixation were used (e.g; K-wires or screws or both). Type of fixation did not show difference in union rate in series of Straw et al [8]. In their series, they had 927 union rate, this could be explained by their removal of K-wire regardless of union at 8 weeks. In a cadaveric study, Panchal et al. found better results in terms of strenght of stability and stiffness in screw fixation group than K-wire group [30]. Screws also had advantage of achieving interfragmentary compression. Compression in fracture site has been shown to enhance healing [31]. In an other biomechanical study, Dodds et al. reported no statically significant difference in stability between screw fixation and both screw and K-wire fixation [32].

There is some limitations in our study. First; our study is a retrospective study with limited sample size. Second; we did not classify type of fracture.

In conclusion; we think the vascularized bone graft based on 1,2-IC-SRA for treatment of scaphoid nonunion is a good option and have excellent results. We recommend this procedure for good selected patients with scaphoid nonunion.

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References


