Comparison of the Results of Treatment for Scaphoid Nonunion with a Minimally Invasive Surgical Technique and that with Traditional Open Procedure

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INTRODUCTION:

Scaphoid nonunion has high treatment failure rates due to its unique anatomy, including shear stress at the fracture site and a tenuous blood supply. Therefore, surgeons are challenged to explore new treatment methods. The optimal treatment strategy for scaphoid nonunion remains controversial. Various surgical techniques are available, such as open reduction and internal fixation with vascularized or non-vascularized bone grafting, and arthroscopic-assisted procedures. Recently, we have been using a minimally invasive technique that employs a bone marrow biopsy needle for non-vascularized bone grafting before internal screw fixation. However, there is a lack of prospective data to show the usefulness of this minimally invasive procedure. The purpose of this study is to compare the treatment outcomes for scaphoid nonunion using the minimally invasive procedure versus those using the traditional open incision method for non-vascularized bone grafting.

METHODS:

We prospectively analyzed 26 cases of scaphoid nonunion that underwent surgical treatment and were followed for 12 months. There were no cases with bone necrosis. This study comprised 18 males and 8 females, with an age range of 9 to 84 years and a mean age of 36.2 years. We compared two groups: a minimally invasive surgery group (MIS group, n=14) and an open surgery group (OPEN group, n=12). In the MIS procedure, the guidewire is inserted from the distal aspect and advanced along the long axis after a 0.5 mm skin incision at the entry point. The entry point is confirmed by several views under fluoroscopy. After removing the guidewire, drilling is performed in multiple directions up to the nonunion site to freshen the nonunion from the entry point. Secondly, a 1 cm skin incision is made lateral to the anterior superior iliac spine for bone graft harvesting. Cancellous bone is harvested by inserting and twisting a bone marrow biopsy needle after creating a small bone window by removing the cortical wall (Figure 1). The needle with the cancellous bone is then withdrawn. The distal end of the needle is positioned in the nonunion site through the drill hole. The core of the bone graft in the needle is inserted into the bone defect by pushing the distal end of a blunt obturator (Figure 2). These procedures are repeated until the void is firmly packed with the bone graft. Finally, the guidewire is reinserted, and a headless compression screw is used for fixation (Figure 3). In the open surgery, the nonunion was treated with bone grafting and the same compression screw under direct vision. According to the Slade classification (MIS group/OPEN group), the distribution was as follows: Group III: 2/0 cases, Group IV: 9/0 cases, Group V: 2/5 cases, and Group VI: 1/7 case. We evaluated the time to bone union and duration of postoperative external fixation. Additionally, subjective and objective evaluations, including arc of motion (palmar and dorsiflexion), grip strength, and DASH score were performed at one year postoperatively for both groups. The results were shown with the mean values and 95% confidence intervals. Student's t-tests were used to compare data between groups. $P<0.05$ was considered statistically significant.

RESULTS:

In the MIS group, bone union was achieved in all cases, whereas in the OPEN group, bone union was achieved in all except for one case. The duration of postoperative external fixation was 6.8 (4.0 to 9.6) weeks for the MIS group and 8.8 (6.8 to 20.8) weeks for the OPEN group. The time to bone union was 12.5 (9.0 to 17.7) weeks for the MIS group and 26.0 (13.6 to 39.5) weeks for the OPEN group. The arc of motion (palmar and dorsiflexion) postoperatively was 159.6° (149.0 to 170.1) in the MIS group and 132.4° (116.3 to 148.5) in the OPEN group. The average postoperative grip strength ratio to the contralateral side was 93.5 % (89.6 to 97.4) for the MIS group and 83.4 % (68.3 to 98.5) for the OPEN group. The DASH scores postoperatively were 4.4 (1.1 to 7.8) for the MIS group and 13.1 (3.3 to 23.0) for the OPEN group. There were significant differences in the time to bone union and postoperative arc of motion between the MIS and OPEN groups ($P=0.04$ and $P=0.01$, respectively). On the other hand, no significant differences were found in postoperative grip strength and DASH score.

DISCUSSION AND CONCLUSION:

In the treatment of scaphoid nonunion, achieving reliable bone union and reducing the time to union are crucial. Additionally, it is important to minimize postoperative functional loss. In this study, the MIS group achieved early bone union. Due to the minimally invasive nature of the procedure, early functional outcomes in the MIS group were favorable. Additionally, donor site pain at the iliac crest is also less because of minimal invasion. However, complete correction of flexion deformity was not achieved in the MIS group. These findings suggest that MIS can be a valuable treatment option. However, it should be carefully considered in cases with severe deformity because percutaneous methods are insufficient for deformity correction. For these cases, traditional open surgical techniques are more appropriate.

Figure 2

Figure 1

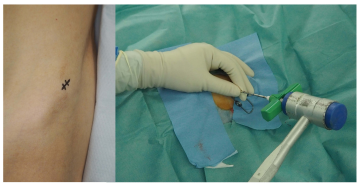

Figure 3