The Outcomes of Open Reduction and Internal Fixation of Malleolar Fractures

Abstract
Background & Objective: Malleolar fractures account for 10% of all lower limb fractures. However, the therapeutic results of fractures of this joint are of paramount importance due to the significant role of this joint in walking and weight bearing. The study aimed to investigate the outcomes of ankle fractures treated by open reduction and internal fixation.

Methods: This cross-sectional study was conducted on 169 patients with malleolar fractures, who underwent open reduction and internal fixation. Patients were evaluated and allocated scores by the clinical rating system for the ankle and hindfoot. In addition, the subjects were divided into three groups of A, B, and C.

Results: In total, 53 females and 116 males were enrolled in the research. According to the results, bimalleolar was the most common type of fractures, and most patients suffered from daily dysfunction and pain. Furthermore, the gait pattern of the subjects was changed. According to Danis-Weber classification system, fracture type B had the highest incidence rate (45%). The mean score of clinical rating system for the ankle and hindfoot was 51 (95% CI 49-53) with a lower mean score of 47 in the B groups, compared to groups A and C.

Conclusion: According to the results of the study, the outcomes of surgical treatment of malleolar fractures are still not favorable (especially in the Danis-Weber type B), and further investigations are required to find more appropriate interventional methods in order to obtain the desired results. To achieve optimal surgical outcomes, it is recommended that the injury-to-surgery interval does not exceed four days.

Keywords: Ankle Fractures, Fracture Fixation, Internal, Open Fracture Reduction, Outcome

Received: 5 months before printing; Accepted: 3 months before printing

*Ali Maavaeian, MD; *Farsad Biglari, MD; *Siamak Shabani, MD; **Hamid Mahdavi Mohtasham, MSc; *Seyyed Morteza Kazemi, MD

Introduction

Ankle fractures are common fractures of the lower limb, accounting for 10% of the total fractures reported in the emergency units. However, the rate of these fractures seems to be on the rise. In these conditions, one or several bones of the ankle joint are fractured, which may be associated with damage to the ligaments. In these injuries, the greater the trauma to the bones or the damage to the ligaments, the more instability of the fractures. The conventional method to treat malleolar fractures is open reduction and internal fixation (ORIF). However, the stable ankle fractures are treated today with conservative techniques.

In a research by Shah et al. (2007), the functional results of 69 patients (43 females and 26 males) with the mean age of 50 years were evaluated for five years. According to the results, 63% of the subjects had complaints about ankle joint stiffness after the interval. Other complaints included swollen feet (45%) and pain (50%), and 38% had not yet returned to their preoperative activity level. It could be concluded that many of the patients who underwent operative treatment still had functional limitations even after five years.

In 2008, Porter et al. followed up the condition of 27 male athletes (mean age=18 years) 12 months to 3.7 years after surgery.
In that research, fractures were caused by 13 different sports with the highest incidence rate observed in soccer. According to their results, bimalleolar fractures were the most common type of injury among the participants, followed by the isolated fractures of the lateral malleolus, damage to syndesmosis, Salter-Harris, medial malleolus, and pilon fractures. Evaluation of the subjects revealed that those with isolated fractures of the lateral malleolus returned to the competitions faster (6.8 weeks), compared to individuals with other types of fracture. Meanwhile, patients with medial malleolus fractures returned to the competitions last (17 weeks). Moreover, athletes undergoing open surgeries started weight training exercises sooner and were able to return to their normal state with only slight pain within two-four months.

In a research by Egol et al., 347 patients with unstable ankle fractures were evaluated clinically and radiographically at month 3, 6 and 12 to assess their level of function. In addition, 79 patients with stable syndesmosis were recognized and compared to 268 patients with unsustained fractures. In the mentioned research, while both groups were homogeneous in terms of age, the number of male participants was higher in the syndesmosis group. Patients with type C fractures more often required syndesmosis stabilization, whereas there was less need for syndesmosis stabilization in patients with type B fractures. After 6-12 months of assessment, the patients receiving syndesmosis stabilization had a low functional score and weaker basic function, compared to the other group.

In a study by Van der Weert (2011), 82 patients received conservative methods and 103 individuals underwent surgery to treat fractures. According to the results, the selected treatment based on joint stability and judgment of the surgeon led to a favorable clinical outcome in both groups. In addition, it was concluded that reducing the immobilization period improved the outcome. In 2014, a study was carried out by Segal et al. to assess the difference between the gait patterns of patients with medial and lateral, as well as bimalleolar and trimalleolar fractures. The results indicated that the gait pattern of patients with medial and lateral malleolus fractures was better, compared to those with other mentioned fractures. To date, no study has been conducted on the incidence of malleolar fractures and the operative treatment outcomes in this regard in Iran. Therefore, the present study aimed to evaluate the outcomes of operative treatment of operative open treatment of malleolar fractures.

**Methods**

This cross-sectional research was conducted on 169 randomly selected patients, who were hospitalized during 2015-2017 due to malleolar fractures, and underwent operative treatment and three Anatomical reduction. Exclusion criteria were a previous or pilon fracture, smoking, underlying diseases, and use of certain medications that increase the risk of nonunion. At first, a written informed consent was obtained from the subjects, who were ensured of confidentiality terms regarding their personal information. After that, the researcher completed the questionnaires via in-person interviews, followed by clinical and radiographic assessments performed by an orthopedic surgeon. The participants were divided into three groups of type A, B, and C based on radiographic before the operative treatment. Subjects were followed up for six months and each patient was examined for 30 minutes. In this research, the “clinical rating system for the ankle and hindfoot” (CRSAHF) was applied to collect data. This clinical rating system for the ankle and hindfoot determined the scores of the ankle, subtalar, talonavicular and calcaneocuboid joints.
This system can be also, this system can be applied for dislocation of the ankle joint, arthrodesis of the ankle, unstable ankle injuries, talonavicular arthrodesis, calcaneocuboid arthrodesis, calcaneal osteotomy, calcaneal fractures, as well as talus and malleolar fractures.

In addition to pain, the range of motion, alignment and gait pattern of patients were evaluated by an orthopedic surgeon, who scored the subjects in this regard. Each measure is comprised of nine questions and cover three categories: pain (40 points), function (50 points) and alignment (10 points). These are all scored together for a total of 100 points (90). Data analysis was performed in SPSS version 22 using descriptive statistics (frequency, mean and standard deviation) to evaluate the prevalence of the condition and its complications. In addition, P-value of less than 0.05 was considered statistically significant.

**Results**

In total, 169 patients were enrolled in the research, including 53 females (31%) and 116 males (68%). Mean clinical score of ankle and hindfoot was 51 (95% CI 53-49). In addition, approximately half of the cases had bimalleolar fractures. They were classified based on Weber categorization in type A (14%), type B (45%), and type C (41%). Most of the patients complained about limitations in daily functioning (72%) and moderate pain (66%). Moreover, the majority of patients had difficulty walking on uneven ground (95%), and gait pattern of the subjects was somewhat changed (95%) (Table 1).

Three Danis-Weber scoring types were, as follows:
1. In type A, the mean score of the patients was about 54.
2. In type B, the mean score of the patients was about 47.
3. In type C, the mean score of the patients was about 52.

According to the results, a significant difference was observed between group B and groups of A and C (P<0.05).

**Discussion**

The present research aimed to evaluate the treatment results in ankle fractures with open surgery. According to the results, mean score of treatment outcomes was 51, meaning that half of the patients suffered from pain and impaired ankle function which was also reported in other studies (7-17).
Despite the common belief that open surgical treatment of ankle fractures yields good results [17-21], such results have not been observed in long-term [11]. In the current research, patients with lateral malleolus at syndesmosis level (Danis-Weber type B) had less efficient functional outcomes, compared to those with lateral malleolus at below or above the syndesmosis level (Danis-Weber types A and C). The reason for this can be attributed to the lack of proper decision on the need to stabilize syndesmosis or not.

According to the results of the present study, bimalleolar fracture accounted for half of the fractures, which is consistent with the results obtained by Nilsson et al. and Day [11,22]. Bimalleolar fracture occurs due to falling from the stairs, severe ankle rotation, or falling on the ground. In addition, the incidence rate of this condition is higher in the disabled individuals and the elderly [2]. In the current research, no significant difference was observed between the male and female subjects regarding the type of malleolar fractures, which is in line with the results obtained by Gregory [11]. It is notable that a greater number of male individuals experienced ankle fractures in the past, compared to females [2]. However, Bengner et al. marked that this has reversed in the current time, meaning that a higher number of female individual’s experience malleolar fractures, compared to men. These researchers reported that in 1950-1952, this type of fractures

<table>
<thead>
<tr>
<th>Complaints</th>
<th>Male (N=116)</th>
<th>Female (N=53)</th>
<th>Total (N=169)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain in the first four weeks</td>
<td>Slight</td>
<td>23</td>
<td>15.1</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>64</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>13</td>
<td>15.1</td>
</tr>
<tr>
<td>Limitations in daily functions</td>
<td>No limitations</td>
<td>22</td>
<td>15.1</td>
</tr>
<tr>
<td></td>
<td>Low limitations</td>
<td>72</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>High limitations</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Maximum walking distance (blocks)</td>
<td>Four-six blocks</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>One-three blocks</td>
<td>68</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>less than one block</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Walking on uneven surfaces</td>
<td>slightly difficult</td>
<td>96</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>very difficult</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Disturbance in gait pattern</td>
<td>Noticeable</td>
<td>95</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Flexion plus extension</td>
<td>Moderate 15-29</td>
<td>97</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Marked less than 15</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hindfoot motion</td>
<td>Moderate 25-74</td>
<td>97</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Marked less than 25</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Alignment</td>
<td>Fair</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ankle-hindfoot stability</td>
<td>Stable</td>
<td>87.1</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Unstable</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Medial Maleoal</td>
<td>25</td>
<td>15.1</td>
<td>22</td>
</tr>
<tr>
<td>Lateral Maleoal</td>
<td>24</td>
<td>32.1</td>
<td>26</td>
</tr>
<tr>
<td>Bi Maleoal</td>
<td>50</td>
<td>52</td>
<td>50</td>
</tr>
<tr>
<td>Post Maleoal</td>
<td>12</td>
<td>16</td>
<td>14</td>
</tr>
</tbody>
</table>
occurred more in men (especially old ones), compared to women. Nevertheless, the statistics in this regard has changed since 1980, meaning that more young men and older women present with an ankle fracture, compared to the other society members. In the current research, most of the patients (72%) had impaired daily functions, which is in congruence with the results of other studies. In a research that followed up patients with malleolar fractures for two years, it was reported that 37% of the cases were fully recovered, whereas 40% had a problem with the occupational and 60% with sport and recreational activities. According to the results of the current present, no significant difference was observed between male and female participants regarding function impairment, which is in accordance with the results of Nicolas. Patients in the research by Egol et al. had poor functional outcomes one year after the surgery. In a 10-year follow up by Gregory et al. and a study by Bauer et al., 36% and 33% of the subjects respectively had poor functional performance. Mont et al. believed that the poor functional outcomes might be due to delay in surgical treatment after the incident. These researchers stated that delay more than seven days could be the cause of these complaints. While Gregory et al. agreed with the belief of Mont et al., they reported the delay time to be four days.

According to the results of the present study, the majority of the patients had impaired gait pattern, which is in line with the results obtained by Jansen et al., but is inconsistent with the results of Becker et al. and Gregory et al. On the other hand, Michelson et al. demonstrated that the process of clinical decision making about ankle fractures had a significant impact on the gait pattern of patients, which, if not implemented properly, can lead to arthritis of patients in the future. These researchers claimed that the main determinant of clinical outcomes of ankle movement was the swing phase. If movement is abnormal and not on the right alignment in this phase, the ankle might be vulnerable to injury.

Our findings showed that the range of motion was complete in movements of dorsiflexion, plantar flexion, supination and pronation, which is in accordance with the results obtained by Gregory et al., who reported the slightly drop from 5 to 14 degrees in the dorsiflexion motion of a few patients and complete range of motion in others. In the present study, 66% of the patients had moderate pain, which was observed in the majority of studies. In addition, more than half of the patients reported pain, stiffness, and foot swelling. Egol et al. found that patients with unstable fracture would continue to have pain over one year. According to the results obtained by Gregory and Mont and et al., time of surgery is significantly important. Therefore, it is recommended that for a favourable result and faster recovery, the surgery should not be delayed more than 4 days.

One of the major drawbacks of the current research was lack of attention to the time interval between the accident and surgical fixation. Another limitation was lack of assessment of the quality of life of the participants. It is recommended that in future studies, these two parameters be carefully documented and evaluated.

**Conclusion**

According to the results of the present study, stable stable bimalleolar fractures were common. The functional score, even with the anatomical surgical reduction, in particular in Danis-Weber type B, is low. Despite the good range of motion, many patients have painful ankles, gait pattern abnormality, and difficulty in uneven surface walking results. With regard to the results of the current research and other studies, the surgical outcomes of malleolar fractures are still unfavorable, and further research is required to find more suitable intervention.
Acknowledgments

Hereby, we extend our gratitude to the participants and the hospital staff for their cooperation with the research.

References