Choice of surgical treatment for patients with arthrosis of the ankle joint

by Kirill S. Mikhaylov¹, Vladimir G. Emelyanov², Alexandr Yu Kochish³, Aleksandr A. Bulatov⁴

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The purpose of this study was to justify the algorithm of rational choice of surgical treatment in patients with arthrosis of the ankle joint, based on a comparative analysis of risk factors for poor results after surgery involving ankle fusion and ankle arthroplasty. We evaluated the efficiency of ankle fusion (63 patients) and ankle joint replacement (71 patients). All patients were divided into 2 groups – prospective (6, 12 and 24 months) and retrospective (3, 5, 7 and 10 years). The results were evaluated with the help of a visual analogue scale (VAS) and the 100-point AOFAS scale; we also performed X-ray examinations. The longest follow-up period was 10 years. We found that the desirable angles of ankle fusion ranging from 90° – 95° could reduce the chance of the rapid progression of arthritis in the joints of the middle part of the foot. For ankle joint replacement we identified a significant risk factor for the most frequent complication, which was aseptic instability of the implant components. From the results of our analysis we suggest an algorithm of surgical treatment in patients with terminal stage arthrosis of the ankle joint.

Keywords: ankle joint, arthrosis of the ankle joint, ankle arthroplasty, ankle fusion, risk factors of poor treatment outcomes

The improvement of methods of surgical treatment for patients with late stages of deforming arthrosis of the ankle joint is one of the priority goals of modern traumatology and orthopaedics [1,2]. Currently, patients with the specified pathology undergo two main types of surgery: the first is ankle joint arthrodesis which has been used since the beginning of surgical orthopedics and the second is total ankle replacement (TAR) which has been used in clinical practice since the 1970s [3,4] and quickly became an accepted method. According to the literature both specified methods of surgical treatment have advantages and disadvantages and also show different results in the present day compared with the past. Therefore the choice of one of these methods presents certain difficulties. Indications and contraindications for performing either of these surgeries are discussed in the following articles [5-9]. Surgeries of each type are quite often followed by complications and pathological states that substantially worsen the result of treatment in both the short and long term. In particular, after ankle joint fusion patients often develop degenerate and dystrophic changes in joints of the middle part of the

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foot and in addition, compensatory loads of the overlying large joints of the lower extremity lead to increased development of a pain syndrome [7]. Operations involving TAR increase the risk of future development of a number of pathological states such as destruction of the established prosthesis designs, aseptic instability of their components and a deep periprosthetic infection [10-12]. Therefore, introduction of TAR surgeries has been approached cautiously in clinical practice around the world. Indeed, according to the German register of operations, arthrodesis of the ankle joint is carried out approximately 3 times more often than its endoprosthetic replacement; the number of annually established endoprostheses of the ankle joint is about 1300 [13].

On the other hand, the relevant literature also has suggestions from some orthopaedists to greatly expand the indications for arthroplasty of the ankle joint [14,15]. In particular, there are publications describing operations with the angles of varus or valgus deformities in this joint over 20° [16-18], at the site of tumoral damage of the tibia or talus [19], at defects of a talus [20] and also at the fracture of an earlier arthrodesis of the ankle joint [21-23].

The analysis of literature on this subject has convinced us that the comparative efficiency of operations of an ankle fusion and TAR, especially regarding long-term performance, and also risk factors of the development of a number of pathological states, are insufficiently studied and need to be further investigated. Here, we have discussed the choice of a method of surgical treatment for patients with late stages of deforming arthrosis of the ankle joint based on the analysis of significant risk factors of unsatisfactory outcomes. The investigation of the practical importance of the above unresolved questions was one of the purposes of this study.

In addition, we attempted to justify an algorithm for the choice of a surgical treatment of patients with late stages of deforming ankle joint arthrosis, on the basis of a comparative analysis of risk factors for unsatisfactory outcomes after ankle fusion and TAR.

### Materials and Methods

We performed an analysis of the most common noninfectious complications and unsatisfactory outcomes of treatment after these 2 surgeries to detect significant risk factors in 2 clinical groups of patients during the period from 2003 to 2014. The first of these groups (63 patients) underwent biarticulated arthrodesis of the talocrural and subtalar joints using the interlocked intramedullary nail. The second group (71 patients) underwent TAR using 3 implants of the third generation: Mobility (DePuy) 27, Hintegra (NewDeal) 37, and STAR (Waldemar Link) 7. Gender and age characteristics of patients of the 2 specified clinical groups are provided in Tables 1 for comparison.

<table>
<thead>
<tr>
<th>Group</th>
<th>Ave age (years)</th>
<th>Sex</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53.8±5.8</td>
<td>M 30 (67%)</td>
<td>F 33 (53.4%)</td>
</tr>
<tr>
<td>2</td>
<td>48.1±4.2</td>
<td>M 29 (41%)</td>
<td>F 42 (59.1%)</td>
</tr>
</tbody>
</table>

Table 1 Age and sex of patients of the first clinical group.

Radiological examination was used to diagnose the deforming arthrosis of the talocrural and subtalar joints for all 63 patients of the first clinical group and was based on the classification of Kellgren et al [24]. At the same time we established that 7 (11.1%) patients had stage II with expressed pain syndrome, 31 (49.2%) patients had stage III and 25 (39.7%) patients had stage IV. Among patients of the second group, 15 (21.1%) patients had stage II, 41 (57.8%) patients had stage III and 15 (21.1%) patients had stage IV of arthrosis of the ankle joint.

Of note, the reasons for the deforming ankle joint arthrosis in patients of both clinical groups, including injuries and disease were similar, both in etiology, and in share ratios; therefore correct comparisons could be made.

Taking into account how the results of the surgeries were assessed and the availability of information for unsatisfactory outcomes, patients of the first and second groups were allocated to 2 prospective (49 and 31 patients) and 2 retrospective (14 and 40 patients) subgroups. The corresponding examinations of
patients in the prospective subgroups were conducted at 6, 12 and 24 months, and in the retrospective subgroups after 3, 5, 7 and 10 years after treatment. For all patients, we carried out an objective and radiological inspection of the feet including an X-ray analysis with the necessary projections and patients also completed scores for VAS and AOFAS. Of note, all patients included in the research underwent surgery in the clinic by one team of surgeons in order to avoid differences in the result of treatment due to different operational techniques and equipment.

**Results**

In the prospective subgroup of the first clinical group 2 years after surgery for a biarticular arthrodesis of the ankle joint and subtalar joints, also AOFAS (less than 50 points) was recorded 9 (18.4%) the unsatisfactory results of the carried out treatment on scales VAS (more than 6 points). At the same time, for 3 patients unsatisfactory results were caused in the 12 months after treatment by an unsuccessful arthrodesis in the talocrural and subtalar joints that necessitated carrying out repeated arthrodesis. Also, 6 other patients with poor clinical and functional outcomes of treatment have been associated with a 2-year period of postoperative osteoarthritis in the joints of the middle part of the foot, accompanied by severe pain syndrome and dysfunction of the feet which had undergone surgery.

Additionally, the analysis of the angles of ankylosis of the ankle joint in the sagittal plane showed that 4 of these 6 patients had a pathological condition; this angle ranged from 101° to 105°, which is confirmed by the radiographs in Figure 1. The other 2 patients with this pathology showed that the corners angles of ankylosis of the ankle joint ranged from 96°–100° and had angles of 90°–95°; these unsatisfactory outcomes were not noted until 2 years after surgical treatment (Table 2).

![Image](https://via.placeholder.com/150)

**Figure 1** The ankylosis of an ankle joint at an angle of 101°; arthrosis of joints of the middle part of the foot in an 82-year-old patient with pain syndrome (7 points on a scale VAS), 2 years after surgery.

<table>
<thead>
<tr>
<th>The studied parameters</th>
<th>Fusion angle</th>
<th>The average for the group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90–95</td>
<td>96–100</td>
</tr>
<tr>
<td>VAS</td>
<td>2.5±0.4</td>
<td>2.6±0.3</td>
</tr>
<tr>
<td>AOFAS</td>
<td>77±3.5</td>
<td>75±3.6</td>
</tr>
<tr>
<td>Numbers of patients</td>
<td>7 (15.2%)</td>
<td>28 (60.9%)</td>
</tr>
</tbody>
</table>

**Table 2** Outcomes in patients of the first clinical group 2 years after surgery, indicating the fusion angle.

In the analysis of the end result of treatment in the retrospective subgroup of the first clinical group, we found that 5 years after surgery of a biarticular arthrodesis the average scores for VAS and AOFAS were worse (R <0.05) for patients with the angle of an ankylosis of 101°–105°, in comparison with patients for whom this corner ranged from 90°–95°. The analysis of treatment outcomes showed that in all circumstances the best clinical functional results for patients of the first clinical group were achieved with ankle joint ankylosis corners in the sagittal plane from 90°–95°, and the corresponding corners with values within 101°–105° were in fact significant risk factors for unsatisfactory treatment outcomes (Table 3).
Table 3 Qualitative index for 2-year treatment results using the AOFAS and VAS scales depending on the angle of fusion.

<table>
<thead>
<tr>
<th>Angle</th>
<th>VAS</th>
<th>AOFAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bad 7–10</td>
<td>Satisfactory 5–6</td>
</tr>
<tr>
<td>90–95</td>
<td>–</td>
<td>6 (13%)</td>
</tr>
<tr>
<td>96–100</td>
<td>2 (4.3%)</td>
<td>24 (52.2%)</td>
</tr>
<tr>
<td>101–105</td>
<td>2 (4.3%)</td>
<td>7 (15.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>4 (8.7%)</td>
<td>37 (80.4%)</td>
</tr>
</tbody>
</table>

For patients of the second clinical group, the most frequent reason for unsatisfactory treatment results from 6 months until 10 years post-surgery was an aseptic instability of components of the installed ankle joint endoprosthesis. Therefore, special attention was paid in our work to the detection of significant risk factors of this emerging pathological state. We found that in the prospective subgroup of patients radiological signs of instability of the established designs were observed 2 years after the surgery in 6 (19.4%) of 31 patients under clinical supervision. However, the presence of a severe pain syndrome and essential decrease in functionality which necessitated carrying out a repeat operation (fusion) was reported only by one (3.2%) patient of the prospective subgroup.

Figure 2 The result 5 years after total ankle replacement (left side) in a 42-year-old patient with use of a Hintera implant (NewDeal): a) radiological signs of instability of an endoprosthesis: the slight shift backwards of a tibial component and a sagging of a talus component due to decreased height of a talus; b) satisfactory functional result: 3 points on a VAS and 69 points on the AOFAS.
In the retrospective subgroup from 3 to 10 years after treatment radiological signs of instability of components of ankle joint endoprostheses of were recorded for 16 (40%) of 40 observed patients. In addition, using scores of VAS and AOFAS, patients with this complication had worse average values of these indicators (R <0.01), than other patients of the subgroup. However, the revised procedures including removal of unstable implants with the subsequent biarticulate fusion of the ankle and subtalar joints were only carried out by interlocking intramedullary nails in 7 (43.8%) of 16 patients, as the other 9 patients preferred to keep the established endoprostheses. It should be particularly noted that these 9 patients had only radiological signs of instability of the endoprosthetic components without their essential migration regarding bone bed, and they had a satisfactory functional result of treatment.

An example of a satisfactory functional result can be observed (Figure 2) 5 years after TAR with the presence of radiological signs of instability of the established construction. However, it is necessary to note that the patient did not demand a high functional load from the operated ankle joint.

Special attention in our research was paid to the detection of risk factors for developing aseptic instability of endoprostheses of the ankle joint. A search was carried out concerning 2 groups of the factors noted in the relevant literature [4,15,17,22,25,26,27,28]. The first group of risk factors included various deformations of the bones forming the ankle joint. The second group included the age of patients, the related physical activity, and also functional loads of the operated joints as significant factors. It should be noted that such analyses were carried out separately in the prospective subgroup (31 patients) and in the retrospective subgroup (40 patients). The results are presented in Tables 4 and 5.

<table>
<thead>
<tr>
<th>Anamnesis</th>
<th>Age of patients, years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20–39</td>
<td>40–54</td>
</tr>
<tr>
<td>Change of a distal metaphysis of tibia</td>
<td>–</td>
<td>3 (50%)</td>
</tr>
<tr>
<td>Fracture of ankle bones</td>
<td>–</td>
<td>1 (16,7%)</td>
</tr>
<tr>
<td>Fracture of a collision bone</td>
<td>1 (16,7%)</td>
<td>–</td>
</tr>
<tr>
<td>Deforming ankle joint arthrosis</td>
<td>–</td>
<td>1 (16,7%)</td>
</tr>
<tr>
<td>Total</td>
<td>1 (16,7%)</td>
<td>5 (83,3%)</td>
</tr>
</tbody>
</table>

**Table 4** The anamnesis and age of patients who had aseptic instability of ankle joint endoprostheses 2 years after surgery.

<table>
<thead>
<tr>
<th>Anamnesis</th>
<th>Age of patients, years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20–39</td>
<td>40–54</td>
</tr>
<tr>
<td>Change of a distal metaphysis of tibia</td>
<td>–</td>
<td>3 (18,8%)</td>
</tr>
<tr>
<td>Fracture of ankle bones</td>
<td>2 (12,5%)</td>
<td>2 (12,5%)</td>
</tr>
<tr>
<td>Fracture of a collision bone</td>
<td>–</td>
<td>6 (37,5%)</td>
</tr>
<tr>
<td>Deforming ankle joint arthrosis</td>
<td>1 (6,3%)</td>
<td>1 (6,3%)</td>
</tr>
<tr>
<td>Total</td>
<td>3 (18,8%)</td>
<td>12 (75%)</td>
</tr>
</tbody>
</table>

**Table 5** The anamnesis and age of patients who had aseptic instability of ankle joint endoprostheses from 3 to 7 years after surgery.

The analysis showed that the risk of aseptic instability of endoprosthesis components of the ankle joint during all periods of observation was clearly associated with previous fractures of the bones forming the joint. As can be seen from Tables 3 and 4, such fractures occurred in 5 of 6 patients with this pathological condition in the prospective sub-group and in 13 of 16 patients in the retrospective subgroup. In addition, we observed that the vast majority of
these states (21 of 22 or 95.5%) occurred in patients under the age of 55 years. The proportion of patients with aseptic instability of the implant in the subgroup of patients younger than 55 years was 34.4% (21 of 61) and in the subgroup of 55 years and older only 10% (1 of 10). It should also be noted that in 19 (86.4%) of the 22 cases of aseptic instability of endoprosthesis components, these patients performed activities involving high functional loads on the ankle joint in the postoperative period.

Analysis of the models installed as ankle joint implants in patients diagnosed with aseptic instability of the implant did not reveal any significant advantages for any 1 of the 3 used structures. Studied implants of the third generation have a similar clinical effectiveness with respect to the development of the discussed pathological conditions.

The analysis revealed the following significant risk factors of aseptic instability of endoprosthesis components of the ankle joint: previous fractures of bones forming the joint, an age of up to 55 years, and a high functional load on the operated joints in the postoperative period.

The results of our study and related data of specialized scientific publications helped to substantiate and propose the algorithm for choosing a rational method of surgical treatment of patients with terminal stages of deforming arthrosis of the ankle joint. The algorithm involves the separation of diagnostic procedures in 2 stages and in sequence, as shown in the diagram (Figure 3).

**Figure 3** The algorithm for choosing the method of surgical treatment of patients with terminal stages of deforming arthrosis of the ankle joint.

At the beginning of the patient examination, we performed an assessment of the current stage of deforming arthrosis of the ankle joint. These data, along with the severity of pain, are crucial to the choice between conservative or surgical treatment of such patients. Particular attention should be given to the severity of the deformity. It is known that gross deformation of bones forming the ankle joint, in particular varus or valgus angles greater than 10°, practically excludes the possibility of adequately installing the endoprosthesis components and does not predict a long and successful outcome. Therefore, patients with these gross deformities of the ankle joint should be encouraged to undergo fusion of the affected joints.

Other patients with no such deformations can be considered as candidates for surgery involving endoprostheses of the ankle joint. However, it is advisable to assess the presence of risk factors for the development of pathological conditions that cause poor outcomes of surgical treatment such as aseptic instability of the endoprosthesis components. These
factors, according to the proposed algorithm (Figure 3), should be evaluated at the second stage of selecting a rational method of surgical treatment. Among the risk factors for this pathology the age of the patients is very important. Therefore, it is recommended initially to divide all patients into 2 age groups: under 55 years and older (Figure 3).

When evaluating the older age group, patient history of bone fractures of the ankle joint should be specifically assessed. The surgery for replacement of the ankle joint is only recommended for patients without an identified history of fractures, and if there is such a history it is expedient to look for arthrosis of the affected joints. In the group aged under 55 years, the selection method for surgery should be generally performed in accordance with the same principles as that of the older patient group. However, the assessment of risk factors for the development of instability of installed implants needs to be performed more fully and carefully.

Therefore, within the presented algorithm (Figure 3), we propose initially to allocate the patients under the age of 55 years into 2 subgroups depending on the presence or absence of a history of fractures of the ankle joint. In the presence of such fractures, it is advisable to offer the patients arthrosis ankle joint. In their absence it is also important to rate their level of anticipated physical activity and consequently, possible future functional load on the operated joints. High physical load on the joints was defined in our studies as one of the important risk factors of aseptic instability of the endoprosthesis components of the ankle joint. Therefore, patients with high demands for future functional loads on the affected joints should be made aware that fusion of the ankle joint has a more reliable positive long-term outcome. In cases of expected moderate physical activity of the treated joints, arthroplasty of the ankle joint can be recommended even at a young age.

Discussion

We have analysed unsatisfactory results of surgical treatment of patients with terminal stages of deforming arthrosis of the ankle joint, and found a number of risk factors for their development. These factors were different and specific for each of the 2 main types of surgery. In our view, these factors can and should be considered primarily at the stage of diagnosis and while determining the severity of pathological changes in the affected ankle joint. This is important both for preoperative planning and during surgery involving fusion or TAR.

The most clinically significant pathology observed a year or more after arthroplasty of the ankle joint is aseptic instability of components of the installed implants. According to authors from other countries, the proportion of patients with this pathological condition varies from 3% to 13.7% in the first 5 years after surgery and from 16% to 32% in the period from 5 to 10 years after the treatment [26,29,30]. In our observations, the proportion of patients with radiographic signs of instability of the endoprosthesis components was 19.4% after 2 years and 40% after 3 to 10 years. However, severe clinical symptoms arising from this condition and requiring repeat surgery were observed much less frequently: 3.2% after 2 years and 17.5% in the later periods of observation. It should be noted that the proportion of patients with aseptic instability of the implants in our study were slightly higher because patients purposely went to a clinic, where endoprosthesis treatment for the ankle joint was undertaken. In addition, patients without this pathology did not always agree to be tested over a long-term period after surgical treatment. In a retrospective sub-group of patients (40 observations) analysis of cases of aseptic instability of the endoprosthesis components of the ankle joint showed that the greatest number of them (and accordingly the highest percentage of the number of patients) was recorded 3 years (5 cases or 17.2%) and 5 years (10 cases or 43.5%) after the operations were performed. After 7 years of observations, these figures decreased (about 1 case of 8 or 12.5%) and when 3 patients were examined after 10 years, signs of this pathological condition were absent.

Among the risk factors for the development of the aseptic instability and, consequently, unsatisfactory outcomes for ankle joint replacement, the proposed algorithm first took into account the severity of
deformities in the affected ankle joint. In the literature a direct link between the development of aseptic instability of endoprostheses of the ankle joint and deformations of the articular surfaces of the tibia and talus, and also varus or valgus deviations of more than 10° have been reported [8,15,18,27,28]. In addition, many orthopaedists have reported a higher incidence of this pathology among people of a young age [4,22,25] and also in patients with increased functional load on the previously operated ankle joint, related to high physical activity [26,29]. These findings of other authors were fully confirmed in our study, in particular as illustrated by the data given in Tables 3 and 4. Therefore, all of these risk factors were considered significant and included in the algorithm.

In addition, our study identified opportunities to prevent some of the complications and pathological conditions that lead to poor results of surgical treatment, because of certain requirements during the 2 types of operations. In particular, we found that during surgery for ankle joint arthrodesis the aim should be to form an ankylosis with an angle in the sagittal plane of 90°–95°. If this is achieved, it is possible to prevent the rapid development of deforming arthrosis in the joints of the middle part of the foot, which often leads to decreased function and severe pain in the late postoperative period.

The algorithm presented in the present article is based on results of our own research and data from relevant literature. We have considered significant risk factors of the most frequent pathological states arising after surgeries of fusion and TAR and resulting in poor outcomes. At the same time we have shown that the desirable angles of an ankylosis of the ankle joint in the sagittal plane varying from 90°–95° can reduce the probability of rapid progression of arthrosis in joints of the middle part of the foot. For TAR surgery significant risk factors of development of the most frequent reason of unsatisfactory results of treatment (aseptic instability of the components of the installed designs) were revealed. If these are present, the algorithm assumes refusal of Total Ankle Replacement in favour of the more reliable surgery of ankle joint fusion. However, TAR can be indicated for patients aged 55 years and older and without anamnesis of fractures of the bones forming the ankle joint, and also for younger patients corresponding to these criteria but not expecting high loads on the operated joints.

We hope that practical use of the presented algorithm for selection of a method of surgical treatment will promote the prevention of a number of the pathological states predetermining the poor results of surgeries of both discussed types and will help to improve the outcomes of expeditious treatment.

References

9. Jiang JJ, Schipper ON, Whyte N, Koh JL, Tooan BC. Comparison of perioperative complications and hospitalization outcomes after ankle arthrodesis versus...


