The Postoperative COFAS End-Stage Ankle Arthritis Classification System : Interobserver and Intraobserver Reliability

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⟨ Clinical Research ⟩

The Postoperative COFAS End-Stage Ankle Arthritis Classification System

Interobserver and Intraobserver Reliability

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Abstract: *End-stage ankle arthritis is operatively treated with numerous designs of total ankle replacement and different techniques for ankle fusion. For superior comparison of these procedures, outcome research requires a classification system to stratify patients appropriately. A postoperative 4-type classification system was designed by 6 fellowship-trained foot and ankle surgeons. Four surgeons reviewed blinded patient profiles and radiographs on 2 occasions to determine the interobserver and intraobserver reliability of the classification. Excellent interobserver reliability (κ = .89) and intraobserver reproducibility (κ = .87) were demonstrated for the postoperative classification system. In conclusion, the postoperative Canadian Orthopaedic Foot and Ankle Society (COFAS) end-stage ankle arthritis classification system appears to be a valid tool to evaluate the outcome of patients operated for end-stage ankle arthritis.*

Keywords: ankle; arthritis; classification system; reliability

Ankle arthrodeses (AAs) and total ankle replacements (TARs) as surgical solutions for end-stage ankle arthritis are performed frequently, but substantial lack of objective, prospective, and controlled data on intermediate to long-term outcome of AA and TAR was exposed in a recent review of the literature.[1] Controlled trials comparing arthrodesis and arthroplasty are required to clarify appropriate indications for each procedure.[2,3]

Moreover, end-stage ankle arthritis rarely occurs in isolation and thus additional intra-articular and extra-articular pathologies affecting the outcome must be considered prior to surgery.[4] Additional pathologies were found to result in extended operations, longer operating time, and elevated complication rates.[5,6] For instance, the ipsilateral arthritis of the adjacent talonavicular joint increases the chance of nonunion if arthrodesis needs to be performed and creates a more rigid and stiff hindfoot.[7] However, if the adjacent joints are not addressed then the patient's pain may not completely resolve. Whether corrected or not, these additional pathologies likely impair the patient's outcome of both TAR and AA.[8,9]

"For a precise evaluation of various TAR [total ankle replacement] designs, AA [ankle arthrodesis] techniques, and TAR against AA, the patients' ankle arthritis must be classified as subsets of arthritis with increasing complexity."

For a precise evaluation of various TAR designs, AA techniques, and TAR against AA, the patients' ankle arthritis must be classified as subsets of arthritis with increasing complexity.

Consequently, a preoperative COFAS end-stage ankle arthritis classification was

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Table 1.

The COFAS Preoperative and Postoperative Classification System for End-Stage Ankle Arthritis

	Type 1	Type 2	Type 3	Type 4
Preoperative classification	Isolated ankle arthritis	Ankle arthritis with intra-articular varus or valgus deformity, ankle instability and/or a tight heel cord	Ankle arthritis with hindfoot deformity, tibial malunion, midfoot ab- or adductus, supinated midfoot, plantar-flexed first ray, etc	Types 1-3 plus subtalar, calcaneocuboid, or talonavicular arthritis
Postoperative classification	AA or TAR with no procedure requiring a second incision except syndesmosis fusion	AA or TAR with a soft-tissue procedure requiring a separate incision	AA or TAR with an additional osteotomy including midfoot arthrodesis	AA or TAR with an additional hindfoot arthrodesis
Concurrent procedures	None, hardware removal	Deltoid ligament release, ligament reconstruction, tendo Achilles lengthening, gastrocnemius recession, tendon transfer, capsule release, forefoot reconstruction, metatarsal osteotomy, dissection of neurovascular structures, plantar fascia release, syndesmosis reconstruction	Fibular osteotomy, calcaneal osteotomy, tibial osteotomy, midtarsal arthrodesis	Arthrodesis: triple, subtalar, talonavicular, calcaneocuboid

Abbreviations: AA, ankle arthrodesis; TAR, total ankle replacement.

recently established.[6] Since the treatment of end-stage ankle arthritis will likely change in time with research but the conditions will not, a postoperative end-stage ankle arthritis classification was added. As opposed to the preoperative classification, it considers what was eventually done during the operation, not what was intended to be done. Although the primary purposes of preoperative classification are teaching, decision making, and guidelines for surgery planning, those of postoperative classification are to help surgeons understand the treatment of end-stage ankle arthritis and superior comparability of outcome.

The objective of this study was to introduce a postoperative end-stage ankle arthritis classification system for end-stage ankle arthritis, compare it with the preoperative classification, and to present its interobserver and intraobserver reliability prior to widespread adoption and use. In the future a more detailed and pathology-specific stratification employed with this system might provide superior utility.

Methods

Derivation of the Classification System

Next to numerous conversations, 6 practicing fellowship-trained foot and ankle orthopaedic surgeons performing both TAR and AA met on 2 occasions exclusively to derive the classification system. At the same time of the derivation of the preoperative COFAS end-stage ankle arthritis classification, the need for an additional postoperative classification system was identified during the review of outcomes of end-stage ankle arthritis by the authors.

The criteria for the classification system were outlined as follows: a simple and reliable tool to be used for arthritis stratification and outcome comparison in research, representation of the local anatomic conditions that may affect outcome and surgical decisions, no appliance to patients who are not eligible for a joint replacement (such as sepsis or Charcot arthropathy).

While systemic factors (smoking, diabetes, etc) have significant effects on the outcome of end-stage ankle arthritis, these are not considered in this classification, and we assume that the surgeon has taken this into account before operating. Furthermore, systemic factors affect the outcome of all surgery and should not be limited to end-stage ankle arthritis. The classification system focuses therefore on the local anatomy and treatment that is unique to end-stage ankle arthritis.

End-stage ankle arthritis is defined as ankle arthritis that is no longer salvageable with preservation of the joint surface and is symptomatic enough to require alternative means of surgical intervention such as TAR and AA.

Classification System

The postoperative COFAS end-stage ankle arthritis classification includes 4 types, with each type reflecting the (normally) required operative procedure for each matching preoperative type 1 to 4. The preoperative end-stage ankle arthritis classification is outlined in Table 1.[6] Type

Figure 1.

Anteroposterior and lateral plain films (A) of a 62-year-old male patient with preoperative type 3 end-stage ankle arthritis (preoperative and postoperative) due to a hindfoot varus (long-standing idiopathic cavovarus deformity). Note the varus tilt of the talus and the hindfoot varus alignment. Postoperative anteroposterior and lateral and axial calcaneus plain films (B) of the same patient, who was treated with a total ankle replacement (Hintegra; Newdeal SA, Lyon, France) and a lateralizing calcaneal osteotomy.

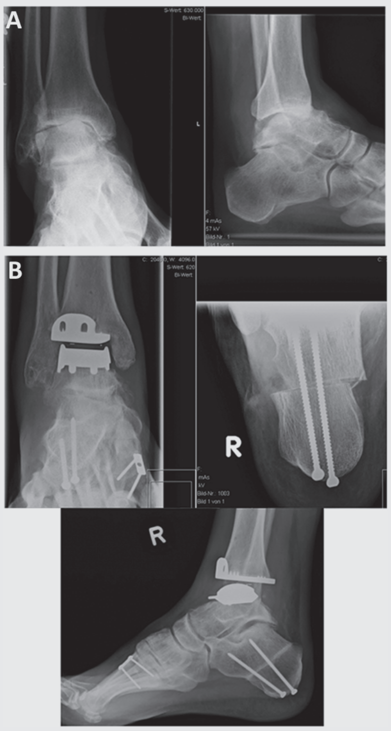
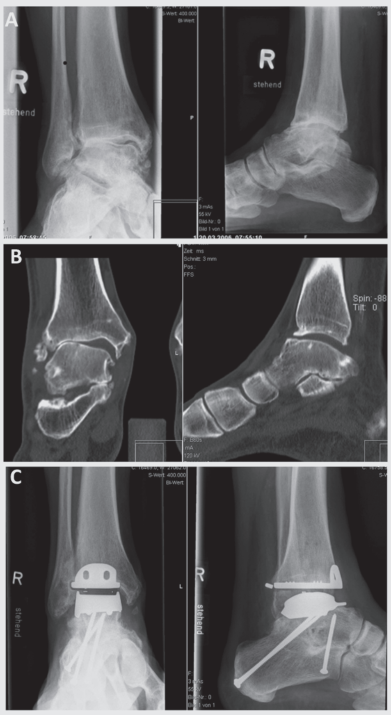


Figure 2.

Preoperative anteroposterior and lateral plain films (A) and computed tomography scans (B) of a 58-year-old male patient with type 4 end-stage ankle arthritis (preoperative and postoperative) due to severe flatfoot deformity. Note the valgus tilt of the talus and the advanced subtalar arthritis. Postoperative anteroposterior and lateral plain films (C) of the same patient, who was treated with a total ankle replacement (Hintegra; Newdeal SA, Lyon, France) and an additional subtalar arthrodesis.



1 patients undergo isolated AA or isolated TAR. Type 2 includes AA or TAR with an additional soft-tissue procedure. Type 3 is AA or TAR with an additional hindfoot or tibial osteotomy and/or midfoot arthrodesis (Figure 1). Type 4 consists of types 1 to 3 with an additional hindfoot arthrodesis (Figure 2).

The inclusion/exclusion criteria for the classification are summarized in Table 2. Patients with contraindications to TAR are excluded. For example, Charcot arthropathy or infection excludes patients from undergoing TAR. Patient factors such as diabetes, weight, smoking status, compliance, and other factors that may also affect the outcome of AA and TAR are not considered in the classification system.

Reliability Study

Institutional review board approval and informed patient consent of every patient were obtained.

All patients participating in this study failed nonoperative treatments for end-stage ankle arthritis and had a thorough clinical assessment including history, physical examination, operation report, and radiographs (preoperative and postoperative weight-bearing anteroposterior and lateral radiographs of the ankle and the foot).

Patients underwent either AA or TAR with or without additional procedures from May 2003 to December 2007 at our institution. Sixty patients were chosen randomly from our database. For correct statistical calculation with appropriate power of .8, a sample size of 60 cases for 4 raters was required to achieve an above-average intraobserver reliability of $\kappa > .7$ and interobserver reliability of $\kappa > .6$, as per literature (see discussion). Of these 60 patients 39 were male and 21 female with a mean age of 60.4 years (range = 34-86; standard deviation = 7.8). Twenty-three of these patients had end-stage ankle arthritis of the right and 37 of the left side.

The observers consisted of 1 foot and ankle fellow and 3 fellowship-trained foot and ankle surgeons. The first author (FGK) recorded the observer's ratings and assessed reliability and reproducibility and did not serve as an observer to avoid bias. The blinded cases were classified on 2 separate occasions at least 8 weeks apart. The order of cases was randomly scattered for the second rating to decrease the chance of observers recalling their choices from the first rating. Data pertaining to the patient or the treating surgeon were blinded. The observers were asked not to discuss the cases between reviews, and they were not informed of the results after the first observations were completed.

Statistical Analysis

For the interobserver reliability the results of each examiner were compared among all possible combinations of the different examiners, and for the intraobserver reproducibility the results of the 2 separate ratings of each single examiner were compared.

The interobserver reliability and intraobserver reproducibility were assessed with computer-generated κ statistics (SAS software; SAS Institute Inc, Cary, NC). The κ value measures the amount of agreement while correcting for a proportion of agreement that may have occurred by chance alone.[10] A κ value

Table 2.

Inclusion/Exclusion Criteria

Inclusion
End-stage ankle arthritis
Patients in whom a total ankle replacement or fusion would be a reasonable alternative
Exclusion
Diabetic Charcot arthropathy
Take down ankle fusion or revision ankle fusion
Revision ankle replacement
Septic arthritis

of .00 represents agreement by chance alone, whereas a κ value of 1.00 represents perfect agreement. Kappa values were interpreted using the guidelines proposed by Landis and Koch.[11] To give some credit to partial agreement of the observers, being a difference between observers of 1 classification group instead of 2 or 3 (eg, type 1 to 2 vs type 1 to 3 or 4), κ values of the ranked types were calculated "weighted." Values of less than .00 indicate poor agreement, .00 to .20 slight agreement, .21 to .40 fair agreement, .41 to .60 moderate agreement, .61 to .80 substantial agreement, and .81 to 1.00 excellent agreement. Kappa values were calculated of each possible pair of nominal parameter.

The ratings for the evaluation of the postoperative classification system in this study were correlated to the corresponding ratings of the preoperative classification in the former study.[6] On each occasion the data for preoperative and postoperative classifications on the same patient were given sequentially at least 1 week apart.

Differences of agreement among observers and agreement of preoperative ratings to intraoperative procedures between the first and second ratings were calculated using the paired Student *t* test. A *P* value less than .05 was considered statistically significant.

Results

The prevalence (base rate) refers to the number of times a given type is selected. For type 1 prevalence was calculated 51.7% (31 of 60 cases), 11.7% (7/60) for type 2, 8.3% (5/60) for type 3, and 28.3% (17/60) for type 4.

For the postoperative classification system an excellent interobserver reliability (κ = .89) and an excellent intraobserver reproducibility (κ = .87) were calculated.

For the postoperative end-stage ankle arthritis classification the agreement among observers (4 of 4 observers assigning the same type) yielded 78.3% (47/60) at the first rating and 86.7% (52/60) at the second rating. The difference between the first and second observations was not significant.

The agreement of preoperative ratings on 2 occasions to intraoperative procedures was recorded as 55% (264/480 equal ratings), 53.8% (129/240) in the first rating and 56.3% (135/240) in the second rating. Differences between the first and second ratings were not significant. The foot and ankle fellow did not score worse than the foot and ankle surgeons.

Discussion

Classification systems are valuable adjuncts not only for research purposes but also for the clinical routine of orthopaedic surgeons. For the patient's management, they support the surgeon to define a problem, prevent oversight of additional pathologies, and offer guidance in determining the optimal treatment method for a particular condition. Communication among surgeons and students is facilitated. The classification tool should not only suggest a method of treatment, it should also provide the surgeon and the patient with a predictable outcome of that treatment. Classification systems play an essential role in the reporting of clinical and epidemiologic data for research purposes, allowing uniform comparison and documentation of conditions.

A useful classification system is supposed to be reliable and valid.[2] The prevalence, agreement among observers, and κ values should be clearly stated in any report on classification reliability.[2] When interpreting the κ value, the impact of prevalence must be considered. The prevalence (base rate) refers to the number of times a given type is selected. In general, as the proportion of cases in 1 type approaches 0, or 100%, the κ value will decrease for any given observed agreement.

This study's results demonstrated an appropriate prevalence (base rate >5%), and therefore should not have an impact on the κ values of the interobserver reliability and the intraobserver reproducibility.[12]

The agreement among observers (unanimity) represents the percentage of times that different observers classified their observations the same. It was slightly better (not significant) for the second rating (78.3% vs 87%, not significant), which is likely due to the observer's learning curve during the 2 ratings. While the interobserver reliability and the intraobserver reproducibility were found to be excellent, the agreement of preoperative ratings on 2 occasions to the intraoperative procedures was recorded as only 55%. The poor agreement may be caused by the retrospective design of the study and further substratification of the classification system would likely improve the accuracy in this regard.

Other than expected the intraobserver κ value of the postoperative end-stage ankle arthritis classification that was predominantly based on the operation reports was not 1.0 but only .89. The only reasonable explanation is the learning curve of the observers. The poor agreement of preoperative ratings on 2 occasions to the intraoperative procedures was likely due to changes from preoperative type 3 or 2 to postoperative type 1 in 15% (9/60) of cases when realigning AA were performed that did not require ligament reconstructions or hindfoot osteotomies. There were also changes from preoperative type 4 to postoperative type 1 in 13% (8/60) of cases when either the adjacent joint arthritis was overrated or it was the surgeons preference to avoid hindfoot arthrodeses. There were changes from preoperative type 1 to postoperative type 2 in 5% (3/60) of cases when a tight gastrocnemius muscle including a positive Silverskjoeld test was not documented in the patient's chart while a gastrocnemius recession was performed during surgery.

The postoperative classification was primarily added to help surgeons better understand the treatment of end-stage ankle arthritis and for superior comparability of studies' outcome. In addition, it matches the procedures to the preoperative classification to assist in teaching and also to determine whether the preoperative classification was resulting in the correct surgery. To an extent this is a validation of the preoperative classification. A future prospective validity study could use the preoperative and postoperative classification as a tool with residents to see if they can better understand the treatment of ankle arthritis and have them assess what the problem is and what the treatment should be. Also, the poor agreement of preoperative ratings on 2 occasions to the intraoperative procedures being 55% only could be assessed in the recommended prospective study.

Several studies have evaluated the reliability and reproducibility of orthopaedic classification systems. Particularly for widely used fracture classification systems, the studies have demonstrated poor results.[11,13,14] The interobserver and intraobserver κ coefficients ranged from .30 to .61 for fracture classifications[4,9,12,15-20] and from .46 to .81 for staging classifications.[21-23] Compared with other classification system's reliability, the interobserver and intraobserver κ values presented in this study are above average.

Additional pathologies whether addressed or not likely impair the patient's outcome of both TAR and AA.[8,24] There is clinical evidence that coexisting malalignment and/or arthritis of the adjacent joints needs to be treated in patient with ankle arthritis. A significantly increased failure rate of TAR was reported in ankles with a persistent uncorrected preoperative varus or valgus deformity of >10°.[25] Aseptic loosening and edge-loading due to persistent deformity are likely the most important modes of failure.[26] To prevent early TAR failure in these conditions, realigning hindfoot arthrodesis and supramalleolar osteotomy prior to or during TAR were recommended.[8,24,27] Ligament imbalance of the ankle should be corrected at the time of the arthroplasty, particularly when there is a history of long-standing varus or valgus deformities at the ankle and/or subtalar joints.[24] If the ankle is not capable of 5° dorsiflexion, Achilles tendon lengthening was suggested, and failure to appropriately assess gastrocnemius-soleus tightness preoperatively was seen to lead to significant complications after TAR.[8,24]

There is clinical evidence that it is important to recognize coexisting malalignment and/or arthritis when planning surgical treatment for a patient with ankle arthritis. In the future better imaging and measurement may prevent these pathologies from being missed.

It appears to be reasonable that the outcome of AA is less than TAR affected by ligamentous imbalance or hindfoot deformities, which are addressed by the realigning ankle or hindfoot arthrodesis per se. However, the need to fuse the ankle's adjacent joints for arthritis is likely impairing the outcome of AA too. Johnson and Boseker[28] studied 140 AA and found worse results in patients who had fusions of both the ankle and the subtalar and transversal tarsal joints. This was explained by the more extensive fusions, as motion in the triple joint complex was found to be necessary for a patient to compensate for a fused ankle.[28]

These TAR and AA studies' results highlight the need of a classification system for end-stage ankle arthritis. Studies for TAR or AA outcome that include isolated ankle arthritis in the majority of cases will likely end up with better results than a study with predominantly complex cases.

Offering only 4 types each, both classification systems were intentionally kept simple at this time to facilitate communication and daily use. Subtypes were extensively discussed, and the authors are aware that it is questionable whether the pathologies grouped together are all reasonably similar and that the results of the classification and outcome interpretation could be misleading. Contrariwise, it has to be taken into account that more subtypes necessitate a substantially higher number of treated patients for appropriate statistical evaluation and comparison. We therefore advise to mention systemic factors (smoking, diabetes, etc) elsewhere in the study. However, once the systems had been in widespread use for a while, more pathology-specific subtypes may be considered if required.

Potential modifications are the following: preoperative type 3 subgroups include flat foot (A), cavovarus foot (B), and tibial deformities (C); preoperative type 4 subgroups include subtalar arthritis (A), talonavicular arthritis (B), combined (subtalar and talonavicular) arthritis (C), and arthritis A to C with deformity (D); the corresponding postoperative type 3 subgroups include flatfoot reconstruction (A), cavovarus reconstruction (B), tibial osteotomy (C); and the corresponding postoperative type 4 subgroups include subtalar fusion (A), talonavicular fusion (B), triple fusion (C), and triple fusion plus deformity correction (D).

The fact that most of the observers in our study were originators of the classification system and all observers were of one institution is a limitation of this study. Generalizability of interobserver and intraobserver κ values achieved in this study may be questioned, but even without this bias independent observer's reliability and reproducibility of the classification system would be expected to be above average as compared with other classification systems. The higher percentage of men refers to the nature of the sample and likely is not a selection bias.

The substantial differences of the preoperative and postoperative end-stage ankle arthritis classification systems are that, as opposed to the preoperative classification, the postoperative considers what was eventually done during the operation, not what was intended to be done. While the primary purposes of the postoperative end-stage ankle arthritis classification are to help surgeons understand the treatment of and to provide superior comparability of outcomes among studies, those of the preoperative classification are teaching, decision making, and guidelines for surgery planning. Also, since the treatment of end-stage ankle arthritis will likely change in time with research but the conditions will not, the postoperative classification was added.

In conclusion, the postoperative (COFAS) end-stage ankle arthritis classification system is a valuable adjunct for the foot and ankle surgeon. It does not take into account systemic comorbidities but instead focuses on the local anatomy. It has demonstrated excellent reliable and reproducible results prior to widespread adoption and use. The postoperative end-stage ankle arthritis classification system may play an essential role in the reporting of clinical and epidemiologic data for research purposes, allowing uniform comparison and documentation of conditions and will help the surgeon understand the treatment of end-stage ankle arthritis. FAS

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