Clinical and radiographic evaluation of total ankle arthroplasty with custom image measurement software

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Disclosure

NO CONFLICT TO DISCLOSE

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Our disclosures are in the Final AOFAS Mobile App. We have no potential conflicts with this presentation.
Introduction

- Ceramic 2-component total ankle prosthesis, TNK-Ankle, has been used clinically as standard prosthesis in severe ankle osteoarthritis or rheumatoid arthritis for long years in Japan.
- Two-component prosthesis would require more precise replacing because of more constraint than mobile prosthesis.
- We would report the outcomes of total ankle arthroplasty (TAA) with TNK-Ankle investigated radiographically using the custom image measurement software and compared with clinical scores.

TNK-Ankle (Kyocera, Japan) : Ceramic 2-component total ankle prosthesis
Materials and Methods

- Twenty four cases of total ankle arthroplasty with TNK-Ankle for osteoarthritis in stage 3b and 4 operated by an expert surgeon from 2009 to 2013
- Investigated on X-rays of preoperative unaffected and postoperative affected ankles. Clinical outcomes by JSSF score based on AOFAS score and SAFE-Q, patient-based questionnaire, were compared with radiographic measurements.
- Radiographic measurements performed with a custom software programmed for this study. This could match translucent X-ray images, an unaffected lateral ankle image and an implanted lateral ankle image with TNK-Ankle, and measure differences in geometry of ankle joint between two images with components 3D-shape matched to its silhouette using 2D/3D registration technique.
Overview of the custom software design

It works on Windows OS, 32 bit, 64 bit, developed by Visual Studio 2013, with OpenCV (3.0) and OpenGL (freeglut 2.8.1) libraries.

3D model file (STL format)
- Talus model
- Tibia model
- Tibia & Spacer model

Polyonize, lighting, orthogonal projection, etc.

X-ray image files (PNG format, etc.)
- Pre-op unaffected ankle
- Post-op implanted ankle

Resize, transparent, coloring, overlay, etc.

3D model display by OpenGL

Image copy, edge detection by Canny, transparent, overlay, etc.

Main display by OpenCV

Zoom display by OpenCV
Measurement flowchart with the custom software

Contralateral X-ray

For bilateral Post-op X-ray

Image Matching for translucent X-rays

On Talus

On Tibia

Image Matching for each Component Silhouette and 3D shape

Arc top of contralateral ankle joint
Arc top of component surface

Investigation of Component position on Contralateral X-ray
Clinical Results
at mean 46 months follow-up

Excellent and Fine (:=Group F) : 17 Cases
Loosening or Sinking (:=Group L) : 7 Cases
Revision : 3/7 Cases

- JSSF Scale (Japanese Society for Surgery of the foot, standard rating system) For 23 Cases
  Pre-op mean 57 Points (/100P) → Post-op mean 90 Points (/100P)

- SAFE-Q (Self-Administered Foot Evaluation Questionnaire)
  For 23 Cases
  Post-op mean
  Pain and Pain-related : 79.9 Points (/100P)
  Physical Functioning and Daily Living : 70.9 Points (/100P)
  Social Functioning : 77.5 Points (/100P)
  Shoe-Related : 69.4 Points (/100P)
  General Health and Well-Being : 76.7 Points (/100P)

Loosening of Talar Component
## Radiographic Results

### Tibial and Talar Anteversion

<table>
<thead>
<tr>
<th>Anatomy</th>
<th>Group F [deg.]</th>
<th>Group L [deg.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibia</td>
<td>11.7</td>
<td>12.3</td>
</tr>
<tr>
<td>Talus</td>
<td>1.5</td>
<td>2.2</td>
</tr>
</tbody>
</table>

### Tibial and Talar Curvature Radius

<table>
<thead>
<tr>
<th>Anatomy</th>
<th>Group F [mm]</th>
<th>Group L [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibia</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Talus</td>
<td>20</td>
<td>21</td>
</tr>
</tbody>
</table>

### ROM

<table>
<thead>
<tr>
<th></th>
<th>Group F [deg.]</th>
<th>Group L [deg.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td>18.4</td>
<td>21.8</td>
</tr>
</tbody>
</table>

NS
Geometry of Arc Tops of the replaced Components for contralateral Ankle joint

Group F  
Group L

(  Revision)

* P<0.05

Talar Arc Top
of Component for Contra-lateral

Tibial Arc Top
of Component for Contra-lateral

For 15 cases exclude bilateral diseased ankle
Discussion

- In this study it was indicated that a few cases may have loosening and revision after TAA even if it was performed on correct indication by an expert surgeon, they may be concerned in geometry of implanted ankle that the rotation centers of tibial component are more anterior than of contralateral tibial plafond.

- Precise replacing of total ankle prostheses by means of navigation and image-guided surgery may produce better results. Data accumulation by more radiographic measurements with digital tools must become useful for future navigation system. The development of custom-made software suitable to research demand like this study would be more efficient.
limitation

- The Validity and Reliability of this custom image measurement software have not been verified.

- Sample size is not enough.

- Though TAA components are matched with 3D shapes, bone shapes aren’t matched and measured with some 3D image but 2D X-ray. But this may be advantage to be used with only general-use X-rays.
References


