Preliminary report of a novel technique combining placement of PROPHECY INBONE tibia & INFINITY talus without an intraoperative guide for total ankle arthroplasty (TAA)

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Statement of Purpose

Total ankle arthroplasty (TAA) systems have standardized instrumentation to achieve accurate implant placement. Our adaptation of the standard PROPHECY INBONE technique for TAA is performed without an intraoperative guide (i.e. leg holder or external bracket) for placement of the intramedullary tibial component with fluoroscopic guidance by mini c-arm. Rather than the standard INBONE talus, we utilize the minimal resection chamfer cut talar component (INFINITY). The purpose of this study was to radiographically report the accuracy of tibial stem placement using our modified technique.

Literature Review

Seven primary and two revision ankle replacement systems are currently available for implantation in the US.[1] Mid-term outcomes with the INBONE implant have shown high survivorship rates with few tibial stem complications compared to the higher possibility of talar component subsidence.[2] Alternatively, the INFINITY talar component has mechanically stabilizing chamfer cuts and removes less bone from the talus than the INBONE talus. However, concerns regarding early tibial component loosening with the INFINITY have been raised.[3]

The INFINITY system design allows the tibial component to be combined with the INBONE talar component.[4] However, to our knowledge, there has been no prior report combining the INBONE tibia and INFINITY talus components for TAA despite similar compatibility. With the advent of patient-specific guides via the PROPHECY system, studies have shown that accurate placement of the tibial stem can be within 2-5° of the intended implant position.[5,6] We propose that accurate placement can be achieved with our modified TAA technique without the use of intraoperative guides for placement of the INBONE tibial stem.

Methods & Procedures

After obtaining Institutional Review Board approval, the first ten patients undergoing this technique with at least six months of postoperative follow up were identified. All procedures were performed by the senior author, PB.

Methods & Procedures continued

TECHNIQUE: (as it differs from standard technique INBONE technique; *note: fluoroscopic images obtained with mini c-arm)

1. **Tibial alignment guide & bone resection:**
   a) PROPHECY INBONE tibial alignment guide
   b) Tibial cut guide with 6 pins
   c) Perform tibial cuts

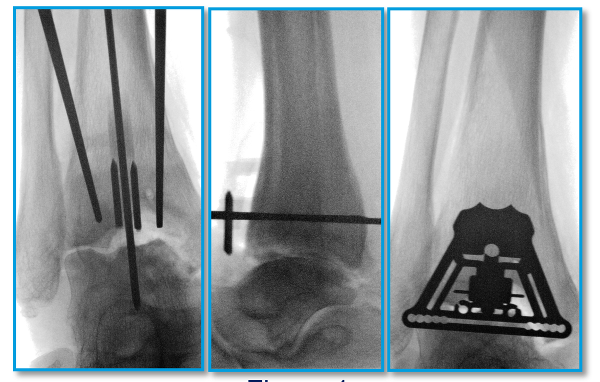

Figure 1

2. **Soft tissue balancing & talar bone cut**
   a) Flat-top cut to remove 3mm wafer
   b) Maintain alignment with hand on heel & foot at 90°

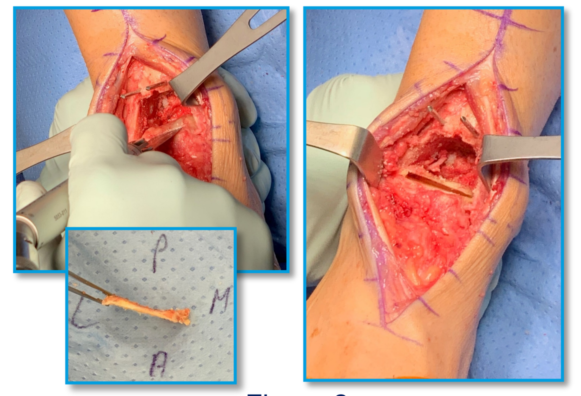

Figure 2

3. **Guidewire placement (no foot holder or C-bracket)**
   a) Insert pin slightly anterior to plantar fat pad & slightly lateral to midline
   b) Upon entering the tibia, check coronal and sagittal alignment with mini c-arm

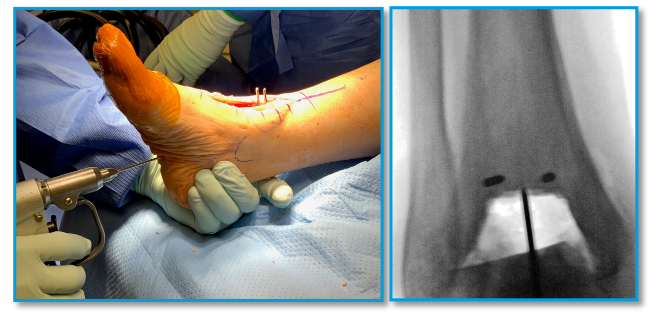

Figure 3

4. **Drilling & reaming tibia**
   a) Start small & work way up

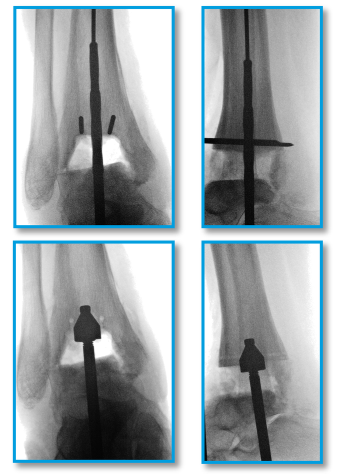

Figure 4

5. **Stem placement, tibial tray, & poly trial**
   a) Standard INBONE technique

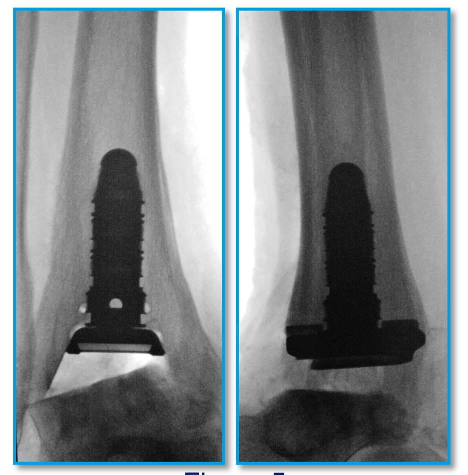

Figure 5

6. **Talar component placement**
   a) Complete chamfer cut
   b) Standard INFINITY technique

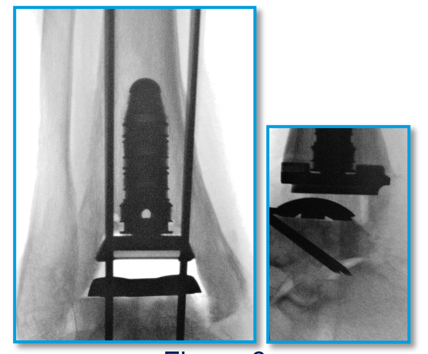

Figure 6

Methods & Procedures continued

RADIOGRAPHIC ANALYSIS:

First postoperative weightbearing ankle anteroposterior (AP) and lateral (lat) radiographs for each of the 10 subjects were assessed by three blinded evaluators (PB, SM, JC). The anatomical axis was determined using previously described methods.[5,6] A line through the center of the tibial stem component was then made. The angle between the two lines was measured to determine the implant's deviation from the anatomical axis in both the coronal (AP view, Figure 7) and sagittal (lat view, Figure 8) planes. Based on prior studies, acceptable deviation of the tibial stem from the anatomical axis was determined to be less than 5°.[5,6]

Figure 7

Figure 8

STATISTICAL ANALYSIS:

Mean ± standard deviation (SD) was determined for each subject. Inter-rater reliability was calculated. Unpaired t test was utilized to determine statistical significance (defined as $p < 0.5$).

Results

Table 1: Patient demographic data

Patient	Gender	Age	BMI	Comorbidities	Etiology	Deformity	Concomitant procedures	Complications
1	M	76	34.6	Hypothyroidism, ulcerative colitis	Osteoarthritis	11° incongruent valgus	OGR, HWR, deltoid plication	Superficial wound dehiscence
2	M	65	34.0	A. fib, HTN, HLD	Posttraumatic	9° incongruent varus	OGR, modified Brostrom	Intraoperative medial malleolar fracture
3	F	84	27.5	GERD, hypothyroidism, depression	Posttraumatic	17° incongruent valgus	OGR, modified Brostrom, deltoid plication, ORIF of medial malleolar fracture	--
4	M	66	25.0	COPD	Osteoarthritis	30° incongruent varus	OGR, modified Brostrom, deltoid plication	--
5	M	76	25.5	A. fib, T2DM, CKD, HTN, HLD, CAD	Posttraumatic	5° incongruent varus	OGR, modified Brostrom, deltoid plication	--
6	F	55	30.1	HTN	Posttraumatic	--	OGR, modified Brostrom, deltoid plication	Superficial wound dehiscence
7	F	72	30.8	Anxiety, depression, HTN, HLD	Posttraumatic	2° incongruent varus	OGR, modified Brostrom, deltoid plication, HWR	--
8	F	43	38.1	HTN, obesity	Posttraumatic	Congruent varus	OGR, modified Brostrom, deltoid plication	--
9	M	40	27.9	--	Posttraumatic	Congruent varus	OGR	--
10	F	48	32.8	HTN, gestational diabetes	Posttraumatic	--	OGR	--

A.Fib = atrial fibrillation, HTN = hypertension, HLD = hyperlipidemia, GERD = gastroesophageal reflux disease, COPD = chronic obstructive pulmonary disease, T2DM = Type 2 diabetes mellitus, CKD = chronic kidney disease, CAD = coronary artery disease, OGR = open gastrocnemius recession, HWR = hardware removal

Ten patients (50% male, average age 62.5 years, average BMI 27.6) underwent this modified technique for TAA (Table 1). First weightbearing ankle radiographs were evaluated for postoperative tibial implant alignment.

Table 2: Mean Deviation of Tibial Component from Anatomical Axis

Patient	Coronal (°)	Sagittal (°)
1	1.0	0.0
2	1.3	1.7
3	0.7	6.3
4	1.0	4.0
5	0.0	8.7
6	1.0	0.7
7	1.3	1.3
8	0.3	1.3
9	1.7	0.3
10	1.3	0.0

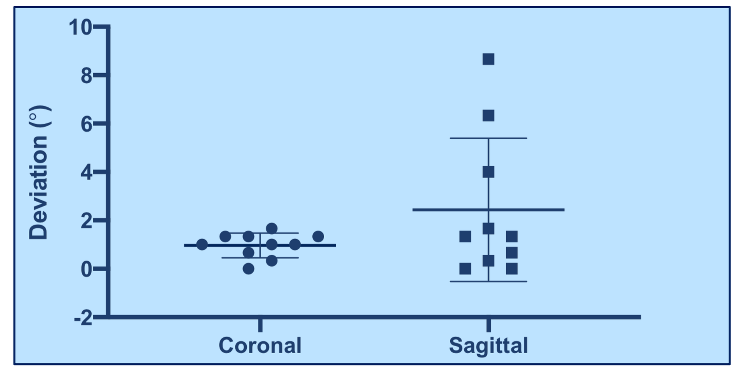

Figure 9: Deviation of Tibial Component from Anatomical Axis

Results continued

The mean of the three evaluator measurements for each patient were calculated (Table 2). Only two values, both in the sagittal plane, fell outside the acceptable deviation for accuracy. The overall mean ± SD deviation of the tibial implant in the coronal plane was 1.0° ± 0.5°, compared to 2.4° ± 2.8° in the sagittal plane. The difference between the coronal and sagittal measurements did not reach statistical significance with unpaired t test ($p = 0.14$). Inter-rater reliability was found to be 51.6%. Complications included one stable intraoperative medial malleolar fracture and superficial wound dehiscence in two patients. No implant-related complications were encountered.

Discussion

To our knowledge, we are the first to report on this modified technique for TAA. We believe this provides optimal tibial stability and reduces the risk of talar component subsidence, which may lead to improved TAA survivorship. Overall average deviation of the tibial component in both the coronal and sagittal planes were better or within the previously defined parameters for accuracy of implant placement.

Our preliminary results demonstrate that this technique is reproducible and accurate in obtaining a well-aligned tibial implant despite underutilization of intraoperative guides for insertion of the tibial stem. Further studies are planned to evaluate the long-term outcomes with this technique, however, our preliminary results are encouraging.

References

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