HOW TO EVALUATE THREE DIMENSIONAL ANGLE ERROR FROM PLAIN RADIOGRAPHS

ChenKun Liaw, M.D.,Ph.D., Tai-Yin Wu, M.D., Ph.D., Chia-Sheng Lin, M.D., Chiou-Shann Fuh, Ph.D., Rong-Sen Yang, M.D.,Ph.D., Sheng-Mou Hou, M.D., Ph.D., MPH., Kao-Shang Shih, M.D.,Ph.D.

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Evaluating three-dimensional angle error is necessary because we cannot get every patients' CT or MRI at all times. Creating a method that can calculate angle error from plain radiographs is therefore important. Using vector and trigonometric mathematics, we gradually deduct our formula which can calculate angle error from goal angles (the angles we plan to achieve before operation) to result angles (the angles we get after operation) by two perpendicular radiographs. We also encode it into Microsoft Excel® (Redmond Campus, Redmond, Washington, U.S.) so that it becomes more user-friendly. We hope this tool can be used when evaluating TKR, corrective osteotomy, fracture fixation, and so on.

COMPUTERIZED ELLIPSE METHOD FOR MEASURING ACETABULAR VERSION AFTER THR- A PRECISION STUDY USING SYNTHETIC AND REAL RADIOGRAPHS

Background and purpose Previous work by our group to address the problem of acetabular positioning based on 2D methods resulted in the development of a measurement method with better precision-Liaw's version. This method may help early diagnosis of acetabular loosening. In this work, we hypothesized that our computerized ellipse method can improve the precision of measuring acetabular version. Methods We built our software Elliversion to measure the acetabular version. We synthesized 96 radiographs with random femoral inclination and 5o to 52o version by THR Simulator, half with femoral head and half without it. We measured these synthetic radiographs and 28 real radiographs with Elliversion and trigonometric method twice by one of the authors with one week interval. Then we calculated the difference of repeated measurements. We used student t-test for statistical analysis of measuring error and inter-measurement difference. Results In precision study, for synthetic radiographs with femoral head, the ellipse method was significantly better than trigonometric method

LIAW, Chen-Kun
Department of Orthopedics, Shin Kong Wu Ho-Su Memorial Hospital, Taipei City, Taiwan
Email: d92008@yahoo.com.tw
Co-authors: Tai-Yin Wu, Chia-Sheng Lin, Chiou-ShannFuh, Rong-Sen Yang, Sheng-MouHou, Kao-Shang Shih

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How to Evaluate Three Dimensional Angle Error From Plain Radiographs

Chen-Kun Liaw, MD, PhD [a,b,c,d], Tai-Yin Wu, MD [e], Sheng-Mou Hou, MD, PhD, MPH [a,b], Rong-Sen Yang, MD, PhD [b], Chiou-Shann Fuh, PhD [f]

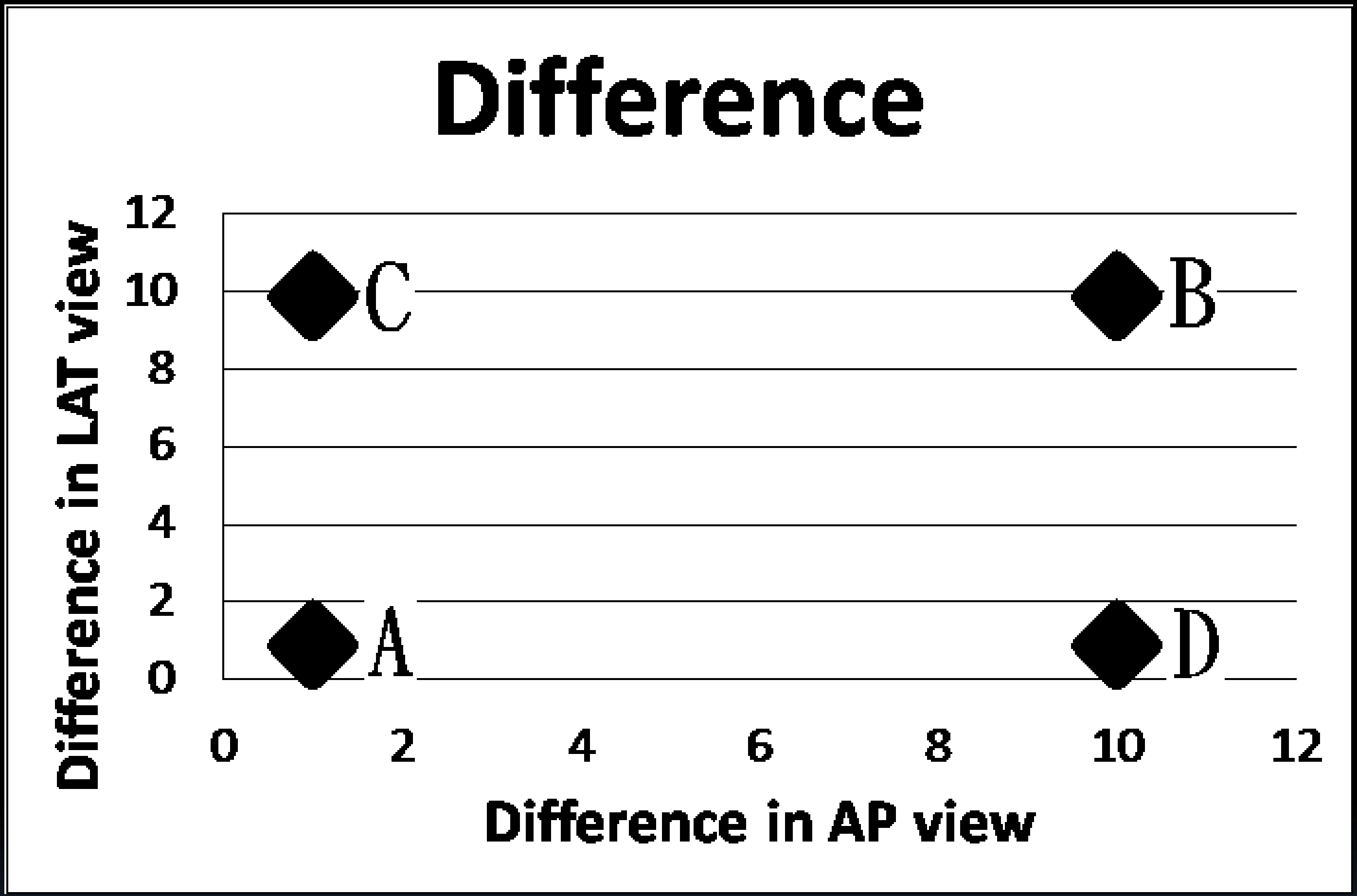
[a] *Department of Orthopaedics, Shin Kong Wu Ho-Su Memorial Hospital and Health System, Taipei city 11101, Taiwan*
[b] *Department of Orthopaedics, College of Medicine, National Taiwan University & Hospital, Taipei city 10002, Taiwan*
[c] *Department of Healthcare Information and Management, School of Health Technology, Ming Chuan University, TaoYuan city 33348, Taiwan*
[d] *College of Medicine, Fu Jen Catholic University, New Taipei city 24205, Taiwan*
[e] *Taipei City Hospital, Renai Branch, Taipei city 10629, Taiwan*
[f] *Department of Computer Science and Information Engineering National Taiwan University, Taipei city 10617, Taiwan*

Introduction

- In the past two decades, the discipline of orthopaedics has changed from “free hand” to “mechanical aided”, or more precisely “computer aided”.
- Meanwhile, evaluation tools have evolved from plain radiograph to three dimensional CT, or MRI.

Introduction

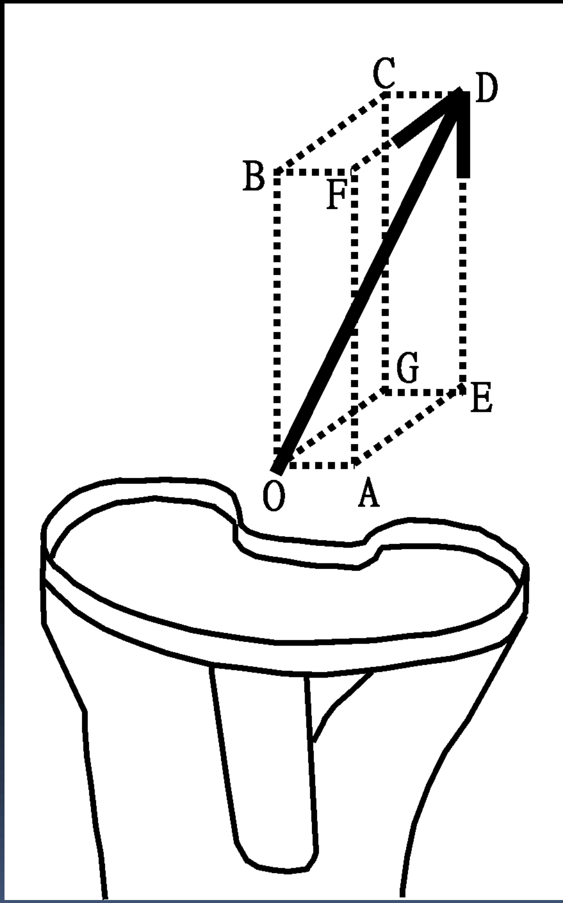
- Two dimensional radiographs have non-replaceable position due to the following reasons:
  - Some patients do not have CT or MRI. For example, in retrospective studies, the patients did not have CT or MRI at that time.
  - Some patients may refuse or are not eligible to receive CT or MRI examinations. This may be related to the costs or radiation exposure.
  - Plain radiographs have better resolution than CT or MRI.



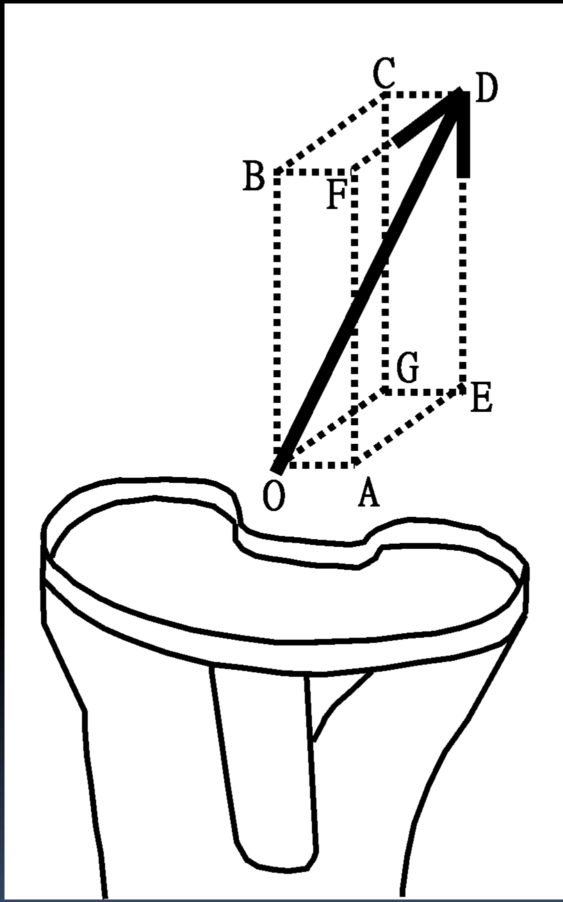
The four patients belong to two groups, group #1 (A,B), and group #2 (C,D). If we calculate the difference from AP view, there is no difference between group #1 and group #2; so is the result from LAT view. However, group #1 has got one perfect result (A) and one worst result (B), group #2 has got two median results (C,D). These two groups have different clinical meanings!


CIRCLE - LINE

- vector OD
- =(length OA, length OB,-length OG)
- = (length OA, length OB,-length FD)

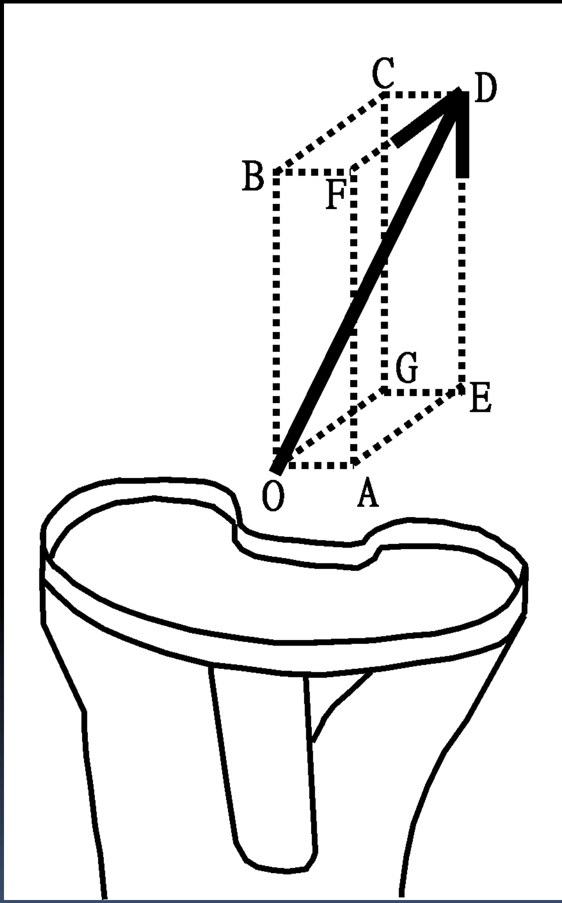


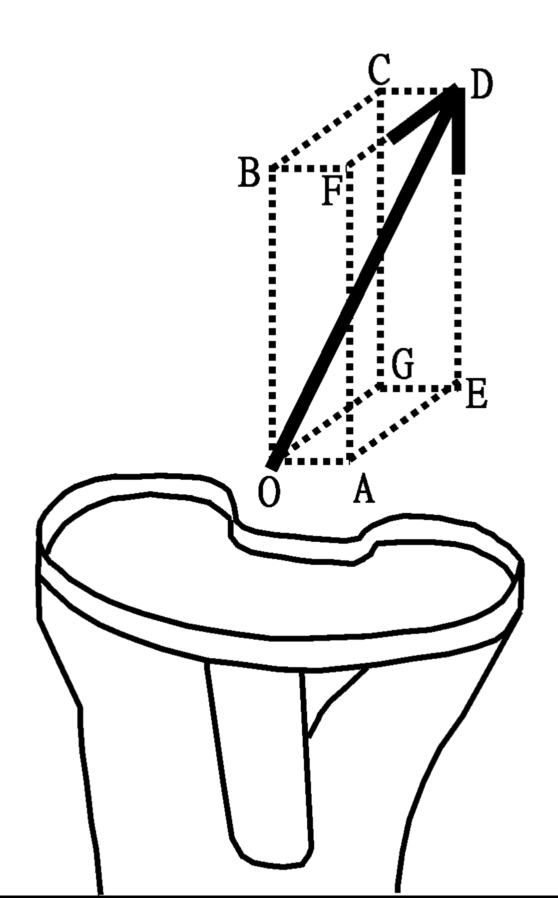
- $\angle$DOF=$\tan^{-1}$(length FD/ length FO)= $\tan^{-1}$(length BC / length OB/cos($\angle$BOF))
- = $\tan^{-1}$(tan($\angle$BOC)*cos($\angle$BOF))= $\tan^{-1}$(tan(*ps*)*cos(vg))



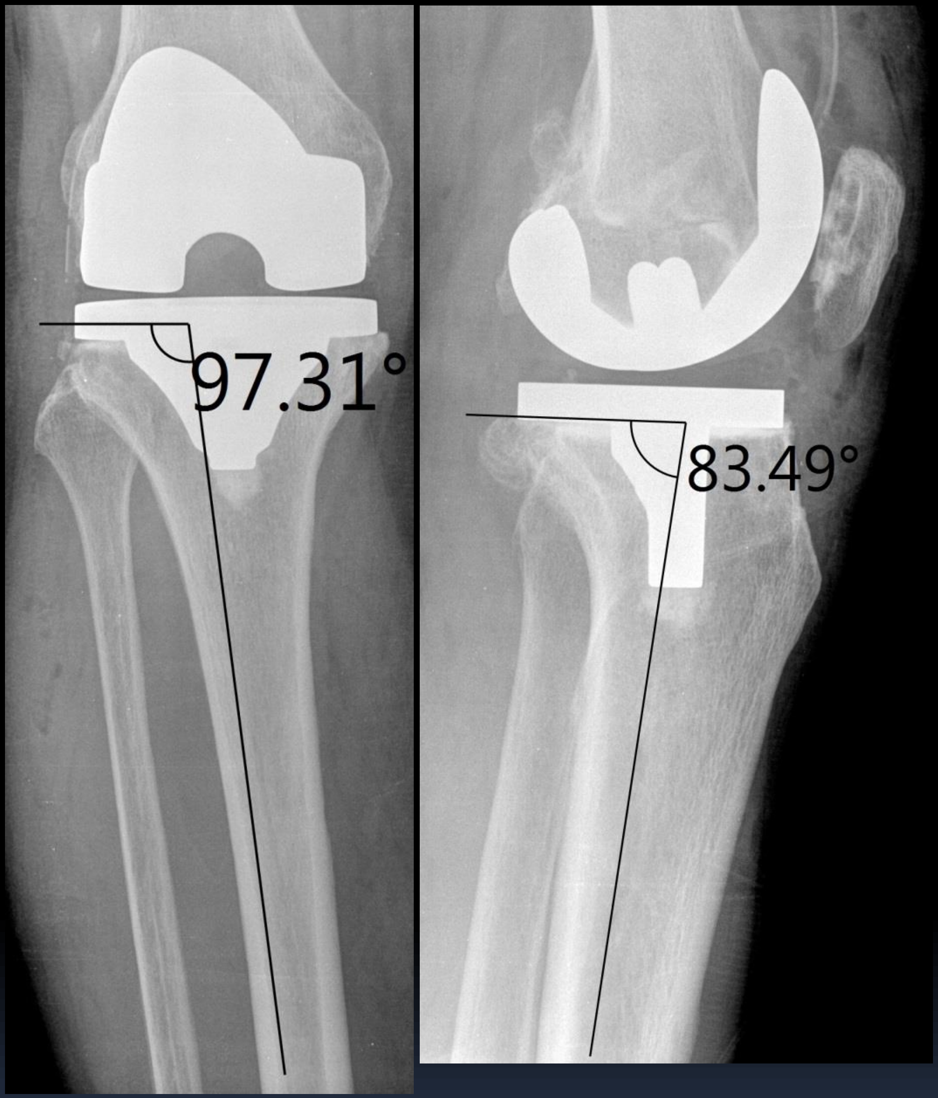
- length OA= length OF*sin(∠OFA) = length OF*sin(∠BOF)
- = length OF*sin(*vg*)= length OD*cos(∠DOF) *sin(*vg*)
- = $\cos(\tan^{-1}(\tan(ps)*\cos(vg)))*\sin(vg)$

- length OB= length AF=length OF*cos(∠OFA) = length OF*cos(∠BOF)
- = length OF*cos(*vg*)= length OD*cos(∠DOF) *cos(*vg*)
- = $\cos(\tan^{-1}(\tan(ps)*\cos(vg)))*\cos(vg)$
-
- length FD= length OD* sin(∠DOF)=$\sin(\tan^{-1}(\tan(ps)*\cos(vg)))$





unit vector (ps, vg) =
$(\cos(\tan^{-1}(\tan(ps)*\cos(vg)))*\sin(vg),$
$\cos(\tan^{-1}(\tan(ps)*\cos(vg)))*\cos(vg),$
$-\sin(\tan^{-1}(\tan(ps)*\cos(vg))))$



ps =6.51° and *vg* = -7.31°

Methods

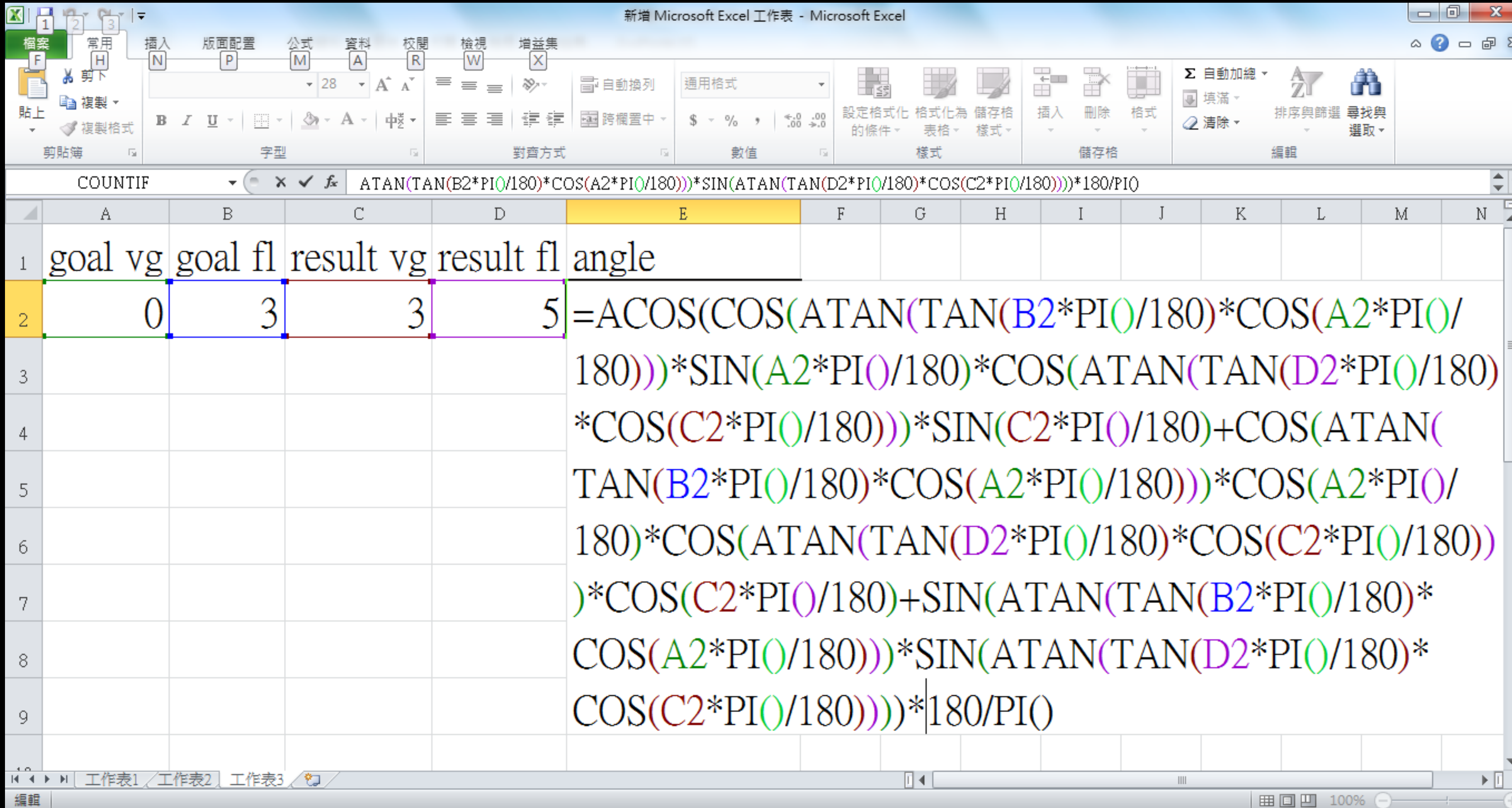
- For example, our goal is *ps* = 3° and *vg* = 0°.
- goal unit vector = $(\cos(\tan^{-1}(\tan(3°)*\cos(0°)))*\sin(0°), \cos(\tan^{-1}(\tan(3°)*\cos(0°)))*\cos(0°), -\sin(\tan^{-1}(\tan(3°)*\cos(0°))))$
- =(0, 0.99863, -0.05234)

Methods

- the result is *ps* =6.51° and *vg* = -7.31°.
- result unit vector = $(\cos(\tan^{-1}(\tan(6.51°)*\cos(-7.31°)))*\sin(-7.31°), \cos(\tan^{-1}(\tan(6.51°)*\cos(-7.31°)))*\cos(-7.31°), -\sin(\tan^{-1}(\tan(6.51°)*\cos(-7.31°))))$
- =(-0.12643, 0.985579, -0.11247)

Methods

- Angle between two unit vectors = $\cos^{-1}$(vector 1 dot vector 2)
- The angle between (0, 0.99863, -0.05234) and (-0.12643, 0.985579, -0.11247) equals to 8.062913218°.



This complex formula was combined into a simplified Excel program

- Because *ps* is only used in tibia component, we change it to flexion *fl* so that it can be used in other cases.
- For example we can use it to evaluate reduction of distal radius fracture, in this case, we can input volar tilt as *fl*, inclination as *vg*.

Conclusions

- Evaluating results three dimensionally is important.
- Our formula is convenient.
- We hope it can be used widely in other radiological evaluations.