Arthroplasty Today xxx (2017) 1–4

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Brief communication

Use of iPhone technology in improving acetabular component position in total hip arthroplasty

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ARTICLE INFO

Article history:
Received 17 April 2017
Received in revised form
2 May 2017
Accepted 7 May 2017
Available online xxx

Keywords:
Total hip arthroplasty
Total hip replacement
iPhone
Smartphone
Acetabular cup
Target angles

ABSTRACT

Improper acetabular cup positioning is associated with high risk of complications after total hip arthroplasty. The aim of our study is to objectively compare 3 methods, namely (1) free hand, (2) alignment jig (Sputnik), and (3) iPhone application to identify an easy, reproducible, and accurate method in improving acetabular cup placement. We designed a simple setup and carried out a simple experiment (see Method section). Using statistical analysis, the difference in inclination angles using iPhone application compared with the freehand method was found to be statistically significant ($F[2,51] = 4.17$, $P = .02$) in the "untrained group". There is no statistical significance detected for the other groups. This suggests a potential role for iPhone applications in junior surgeons in overcoming the steep learning curve.

Introduction

Acetabular cup positioning is an important variable for the outcome of total hip arthroplasty (THA). Cup positioning is directly related to the rate of dislocation, component impingement, pseudotumors, and other complications post THA as evidenced by numerous studies [1-4]. Despite having a target angle for safe zone as described by Lewinnek et al [1], it is often difficult to achieve the angles intraoperatively due to numerous external factors affecting the proper placement of implant [5].

Numerous studies on navigation-assisted surgery, alignment jigs, surgical techniques, and smartphone applications were conducted to improve the accuracy in achieving the target angles and improve patient outcomes [6-9]. However, it is often difficult to analyze and compare outcomes from the studies due to the wide range of techniques described and methods used.

Referring to a recent study by Peters et al [8], there is potential benefit in the use of smartphone application in acetabular cup positioning. With the increased use of smartphone technologies especially in the field of orthopaedics [10,11], we aim to improve on the application suggested in the study by Peters et al [8], and to conduct a study to objectively compare the different methods currently available. We aimed to identify an easy, reproducible, and accurate method for acetabular cup placement which will overcome the steep learning curve in surgical training [12] and improve the rate of achieving target angles in THA.

Material and methods

We designed a simple setup consisting of acetabular cup impactors, laser level tripods, protractors, iPhone, alignment jig, and wheels which allow the 2-directional movement of interest (anteversion and inclination) as shown in Figure 1.

Two free iPhone applications (AngleMeter, Neko System) and (Spirit Level Made Simple, Scaleitapp Ltd) were downloaded to iPhone from the Apple Application Store (App Store). Both applications utilize accelerometer functions in an iPhone to detect movement and indicate the angles to which the iPhone was moved from default post reset. The iPhone is mounted directly onto the impactor as demonstrated in Figure 2.

Ten medical doctors of different skills and experience levels (1 consultant, 3 registrars, 2 residents, and 4 interns) were invited to participate in this study. The assessor (one of the author of this article) will start by explaining and demonstrating the process of the experiment. The participants were invited to stand on one side of the

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.artd.2017.05.004.

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http://dx.doi.org/10.1016/j.artd.2017.05.004

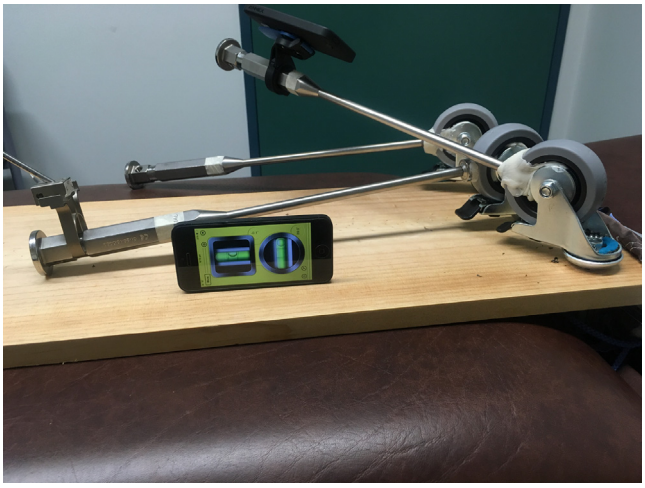

Figure 1. Simulated set-up with 3 acetabular cup impactors cemented on swivel castors with brakes, mounted on a flat piece of wood leveled using electronic level application on iPhone.

"operating table" where the setup lays and were asked to maneuver the impactor in the different directions as indicated. The setting is that of the "patient" lying on the left lateral position and the angles of interest are therefore the inclination and anteversion angles measured via methods detailed in the following. Participants were given time to familiarize with the simulated setup and the 3 methods of interest, namely (1) freehand, (2) alignment jig (Sputnik) use, and (3) iPhone application guidance were demonstrated. Attempts were made to achieve a target angle of (1) 45° inclination and (2) 15° anteversion. Once attempts were made, the assessor would project the angles of interest using 2 laser pointers (one each for inclination and anteversion) while the participants were to continue holding the impactor. This was achieved by aligning the laser beam to lie along the axis of the impactor as shown in Figure 3. There are large sheets of graph papers pasted on the background on both walls which were leveled to the "operating table" before the start of any attempts. The angle of the impactor, which is represented by the angle of the laser beams on the graph papers, was then measured by hand using a protractor (see Fig. 4). Three attempts were performed for each participant, with a minimum of 15 minutes gap in between attempts to minimize muscle memory and bias.

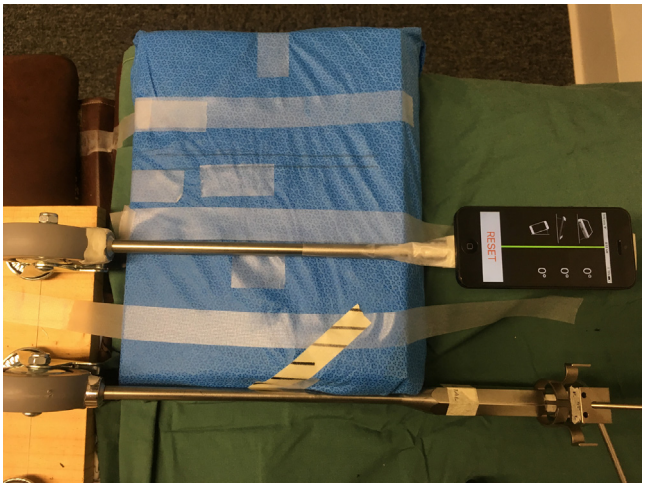

Figure 2. iPhone mounted on impactor (top) and Sputnik (alignment jig for 45 degree inclination and 15 degree anteversion) attached on impactor (bottom).

Figure 3. Laser beam aligned along the axis of the locked impactor and projected onto the sheets of graph papers in the background which were leveled to the "operating table" (using the SpiritLevel iPhone application).

Results

The data collected were analyzed using MATLAB (The MathWorks, Inc., Natick, MA). The average angle of inclination across all participants using freehand, Sputnik, and iPhone were 46.96°, 45.88°, and 45.21°, respectively. The standard deviations (SDs) of inclination angle were 5.69° in the freehand group, 2.56° in alignment jig, and 0.96° in iPhone. The mean angles of anteversion were 14.77° (SD, 4.8°) using freehand, 14.46° (SD, 3.71°) using Sputnik and 14.75° (SD, 1.66°) using iPhone (Table 1).

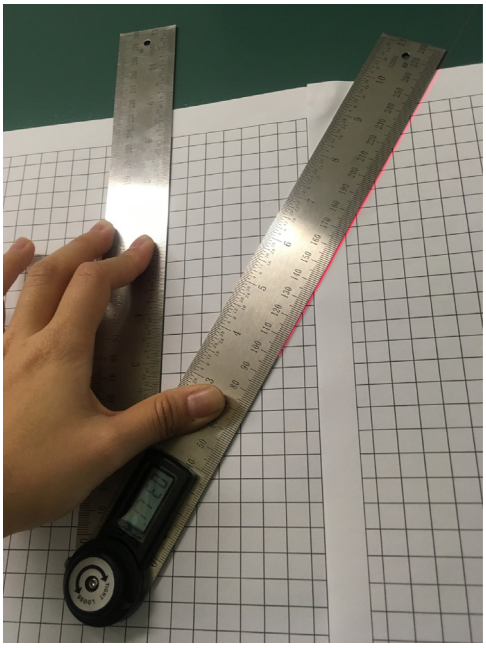

Figure 4. The figure demonstrates a measurement of the projected angle using a ruler with digital protractor.