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The compangle: a new goniometer for joint angle measurements of the hand

A technical note

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The accuracy of joint angle measurement of the hand may be negatively influenced by joint swelling, deformation and other obstacles. We developed an alternative goniometer with clear ergonomic advantages, especially for the measurement of small joints. This new concept of goniometry is described and preliminary results on the reliability of the measurements are presented. The intraclass correlation coefficients (ICCs) and the standard error of measurements (SEMs) of the alternative goniometer are greater respectively smaller than a conventional goniometer, indicating a better intratester reliability.

Key words: **Compangle - Goniometer - Joint angle measurements - Hand.**

In daily practice the range of motion of the joints of the hand are measured with a goniometer. The measurements are a component of the clinical examination and are used for the evaluation of interventions and to monitor change.

Conventional goniometers (Figure 1) with 2 legs and a scale at the intersection of the legs are also used for research purposes. These goniometers have proven to have a fair intra and interrater reliability.[1-4]

However, there are certain disadvantages in the measurement of small joints with conventional goniometers. Especially after hand trauma or in rheumatological conditions joint swelling, oedema, deformities, wounds, bandages, K-wires, splints or external fixation material may interfere with proper alignment of the legs of the goniometer with the structures proximal and distal of the joints. Direct contact of the legs with for instance a painful swollen joint or a burn injury may be uncomfortable for the patient or enhance the risk of infection.

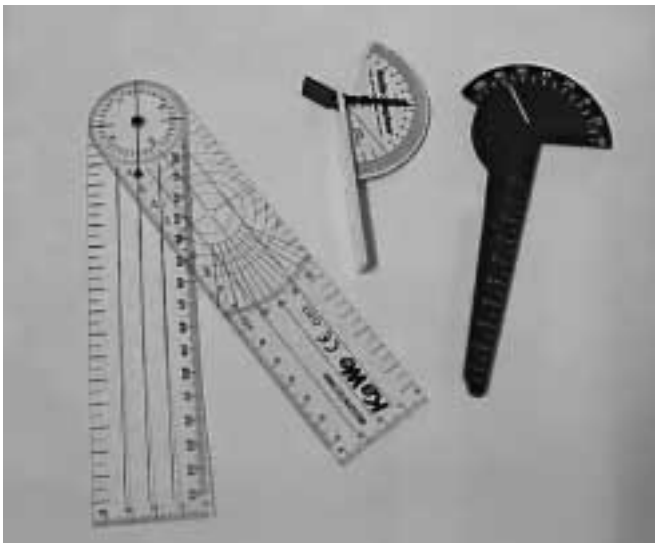

Figure 1.—Examples of conventional goniometers.

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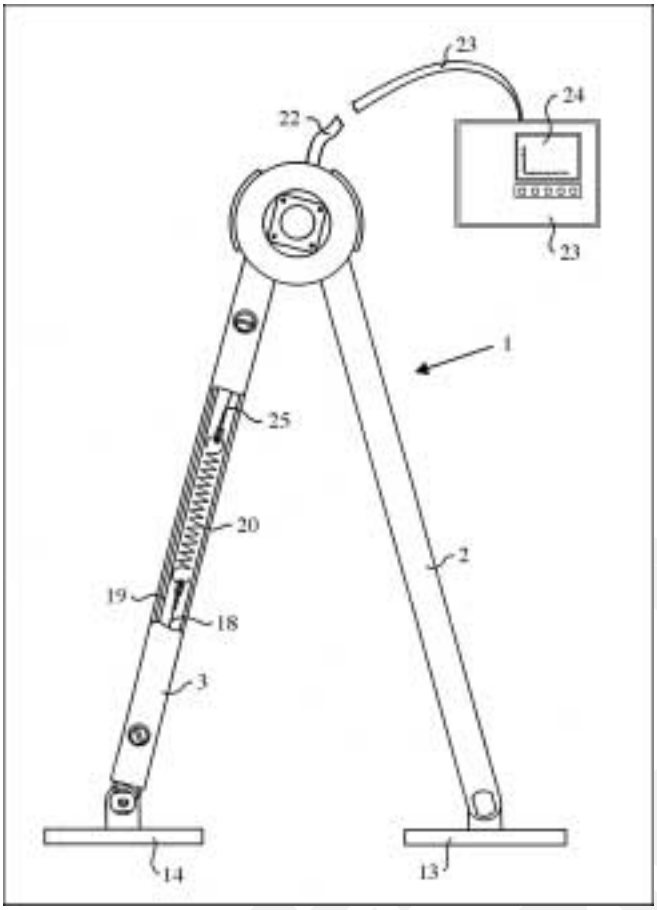

Figure 2.—Technical drawing of Compangle.

Furthermore, the small goniometer which permits measurement of the smaller joints of the hand usually has to be applied with 2 hands. This method of application results in further inaccuracy and is a threat to the reliability of the measurement.

Finally, the legs of a conventional goniometer are either too small for the metacarpophalangeal (MCP) joints or too large for the proximal interphalangeal (PIP) joints.

New device

We developed a new device (Compangle®)* to improve ergonomical properties for goniometry, to reduce the time needed for measurement of the joints of the hand and to overcome the effect of obstacles which disturb a proper execution of the measurement.

*) Patent Europe 0989286756554, USA 9424952, Japan 50214899.

Figure 3.—Measurement of metacarpophalangeal (MCP) joints with Compangle. (A) Joint swelling/MCP measurement. (B) One handed use.

The Compangle consists of 2 legs, comparable with a compass (Figure 2).

In the region of their free ends both legs are provided with a pivoting small foot, which is connected by means of pullies and steel wires to a sensor located in a housing at the intersection of the legs. The small feet are placed at both sides of the joint after which the angle between both pivoting feet is measured by the sensor and calculated in the central housing intersection of the legs. The joint angle is displayed with an accuracy of 1°.

The advantages of the Compangle are that this goniometer can be handled with one hand (Figure 3), allowing the other hand of the examiner to manipulate and support the hand of the patient, that obstacles can be avoided (Figure 4) and that negative angles (for example hyperextension of MCP joints) (Figure 5) can easily be measured. Moreover, painful joints or infected wounds are not in contact with the device, resulting in a more comfortable test for the patient and a decrease of the risk of cross infection.

A digital reading of the angle minimises the risk of incorrect reading of the joint angle. The results of the measurement can also be directly fed into the electronic patient file in a computer.

Being a completely new concept of joint angle measurement a complete set of data on the reliability of the Compangle is not available at present. Studies to determine the intra and interrater reliability in healthy

Figure 4.—Measurement of IP I joint with K-wire.

Figure 5.—Single hand application.

subjects and in patients after hand trauma are in progress.

Preliminary results

We studied the intraobserver reliability in healthy subjects. Twenty healthy subjects were measured with a 1 week interval. The MCP, the PIP and the distal interphalangeal (DIP) joints of the fingers of the dominant hand were measured in 2 standardized positions. The first position was with extension of the fingers and the second position with flexion of the fingers, defined by grasping cylinders with a diameter of 3.2 cm and 7.5 cm respectively. The finger joints were measured with the Compangle and a conventional finger goniometer (Smith and Nephew). The sequence of goniometers and positions was randomly assigned for each subject.

TABLE I.—*The intraclass correlation coefficient (ICC) of metacarpophalangeal (MCP), proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints of the fingers in 2 positions measured with body goniometers.*

ICC	Flexed position		Extended position	
	Traditional goniometer	Compangle	Traditional goniometer	Compangle
MCP joints	0.74	0.76	0.83	0.83
PIP joints	0.80	0.89	0.80	0.90
DIP joints	0.58	0.73	0.63	0.71

TABLE II.—*The standard error of the measurement (SEM) of metacarpophalangeal (MCP), proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints of the fingers in 2 positions measured with both goniometers.*

SEM (degrees)	Flexed position		Extended position	
	Traditional goniometer	Compangle	Traditional goniometer	Compangle
MCP joints	4.3	3.9	4.8	4.3
PIP joints	4.8	3	3.7	2.5
DIP joints	5.9	4.3	4.2	3.3

The intraclass coefficient (ICC) [5] and the standard error of the measurement (SEM) [5, 6] were calculated for both positions of the hand and for both goniometers.

The results are presented in Table I and Table II. The ICC of MCP joints are equal for both goniometers. However, the Compangle has a higher reliability on the PIP and DIP joints. The SEMs show a considerable improvement of the measurement error, which is most prominent in the flexed position of the PIP and DIP joints (37% and 27%, respectively). These preliminary results indicate that the reliability of the Compangle is equal or better than a conventional goniometer. It can be expected that the ergonomic advantages will result in a higher intra and interobserver reliability of the Compangle compared to the conventional

goniometer in case of patients with finger joints that are more difficult to measure accurately because of trauma or degenerative diseases.

Conclusions

The combination of good reliability, better ergonomy for the examiner and lower risk of pain and bacteria contamination justifies the conclusion that this new joint angle measurement concept needs to be further developed and implemented.

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