

THE TRAINING SYSTEM WITH CRUTCHES

for partial weight bearing and gait training



PARTIAL WEIGHT BEARING

MEASUREMENT INSTEAD OF ESTIMATION

In accident surgery and orthopaedics, practitioners at conservative and operative therapy often face the fact that the patient is not allowed or cannot put his/her complete weight onto the affected lower extremity. It has to be put into comfort to ensure a satisfactory healing. The patient must walk with medical crutches under physiotherapy with high effort to learn a walk with correct partial weight bearing.

For the healing of bones, weight loading is of great importance, because only the pressure on a cellular stimulus enhances a sufficient growing of the bones. Therefore, doubts occur if a positive therapy result (regarding the bone healing) without early, partial weight loading can be achieved.

The amount of surgical interventions in accident surgery and orthopaedics has risen during the past years.

Modern ways for intervention as chondrocyte transplantation, cruciate ligament replacement and meniscus suture are indications for the modern surgery and long time partial weight bearing.

To the benefit of a modern, fast functional treatment it is of essential importance to mobilize a patient functionally and biomechanically as early as possible.

Due to the necessity of partial weight bearing, the patient must learn to estimate the loading in the course of the rehabilitation. Yet, because of missing fine sensors in the human feet, problems appear.

Since patients cannot concentrate on weight loading and a physiological gait at the same time, a feeling of uncertainty occurs, especially with older people. A wrong gait, and thus a retarded healing process, can be the result.

Many surveys show that partial weight bearing in accordance with the actual state of the art cannot be achieved by patients without help.

The methods used so far require a great deal of discipline and participation for patients of different compliances; the present situation does not offer the opportunity of measurable self-control or feedback within the rehabilitation phase.

*Extract of declarations from
OA priv. Dozent Dr. Heimo Clar
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PIERENSTEP

SYSTEM COMPONENTS

PIERENSTEP Crutches



PIERENSTEP Software



PIERENSTEP Radio transmission stick



The intelligent PIERENSTEP crutch system comprises the individually configured pair of crutches. In addition, the therapist receives a one-off PIERENSTEP software system designed for the configuration of any number of pairs of crutches. Data transmission between the crutches and the PC is effected by radio transmission.

PIERENSTEP CRUTCHES

- Two forearm crutches
- Intelligent measurement system for the determination of weight bearing
- Vibration and acoustic signal
- Radio transmission
- Memory feature for all measurements

PIERENSTEP SOFTWARE

- Computer software for configuration and analysis
- Requirements: Microsoft Windows XP, Vista or Windows 7, mouse and USB port

PIERENSTEP RADIO TRANSMISSION STICK

- USB connection
- Wireless transmission of the measurements
- Allows communication between the crutches and the computer

PIERENSTEP

PARTIAL WEIGHT CONTROL

PIERENSTEP forearm crutches can be programmed individually with the configuration software for each patient.

A specific algorithm is calculating the partial weight on the foot by means of measurements of the forces applied on the crutches. An acoustic and vibration alarm warns the patient when he applies an incorrect weight on his foot during locomotion.

Thereby the therapist is setting a specific tolerance. The gait information of the patient can be saved in the memory function of the crutches over several weeks. If required, the therapist can readout and analyse those information by connecting the crutches to the computer. The software is giving detailed statistics over the patient's steps. This function does not require radio connection between the computer and the crutches.

REAL-TIME MODE

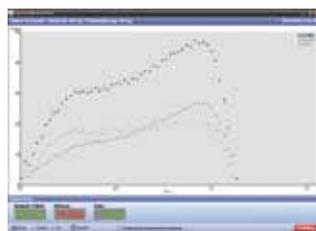
GAIT TRAINING IN REAL-TIME

This mode offers the possibility to follow each step of the patient in real-time on the computer. In this way the therapist is able to advice the patient in order to correct the gait pattern and the partial weight bearing of each step. The form of the measurement curve shown on the

computer can be analyzed on different levels: the balance between the right and left side, the partial load applied on the foot and the distribution of the force during the step. The real-time mode is very suitable to learn an efficient 3-point gait.

GAIT ANALYSIS – EXAMPLES OF STEPS

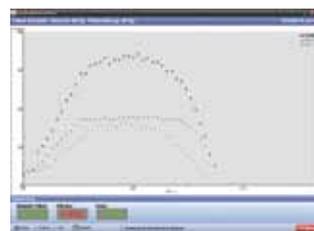
STEP NO 1



ASYMMETRICAL CURVE

- Different force on right and left side
- No constant initiation of the force

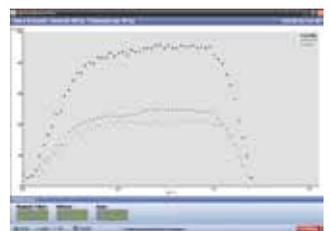
STEP NO 2



OVERLOAD

- Symmetrical curve
- Constant initiation of the force
- Insufficient force: overload

STEP NO 3



IDEAL SETUP

- Symmetrical curve
- Constant initiation of the force
- Correct load

GAIT TRAINING

THE 3 PHASES OF THE 3-POINT GAIT



PHASE 1

Simultaneous touch of the injured foot and the crutches.

PHASE 2

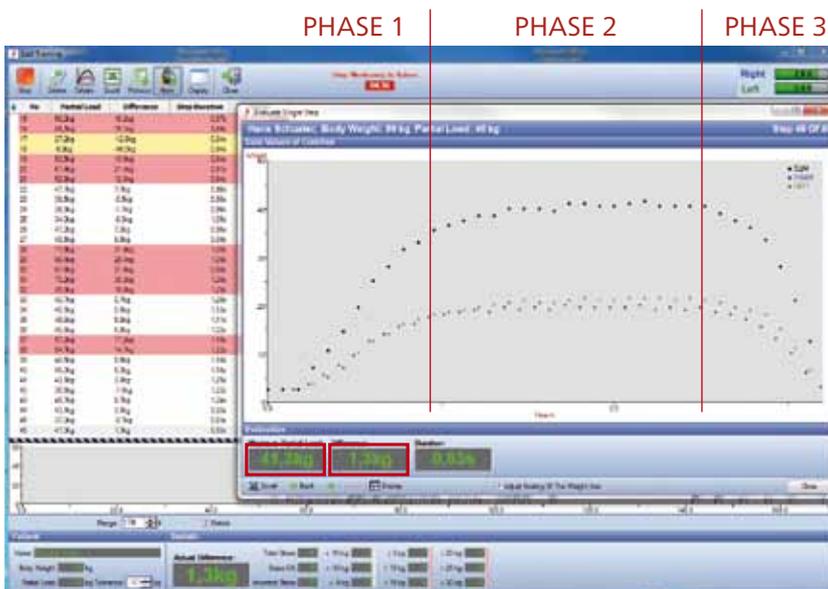
Controlled, constant and uniform initiation of the force on the crutches while rolling the injured foot into a step.

PHASE 3

Simultaneous release of the injured foot and the crutches.

RESULT

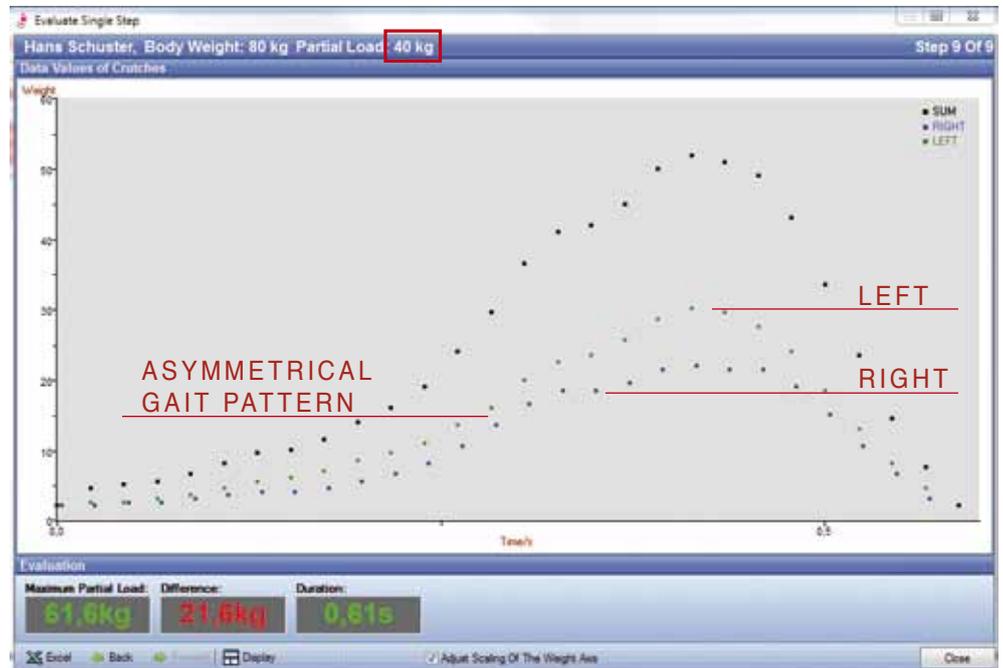
FOR DIRECT READING



Predetermined partial load: 40 kg
Realized partial load: 41.3 kg
Overload: 1.3 kg

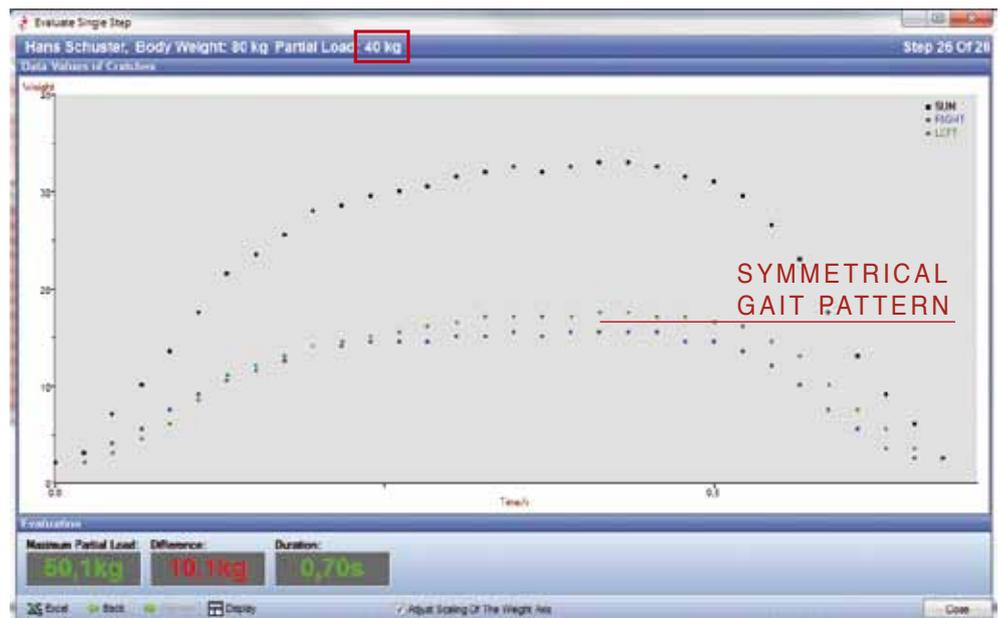
This curve shows an ideal 3-point step. The force on the crutches is constant: strong in the first phase, uniform while the injured foot rolls to the front in the second phase and decreasing while setting the healthy foot in the front.

MEASUREMENT CURVES OF INCORRECT 3-POINT STEPS



ASYMMETRICAL CURVE

Irregular force during the 3-point step, considerable over load of the injured foot
Pre-set weight: 40 kg, realized weight on injured foot: 61.6 kg, Overload: 21.6 kg.



OVERLOAD, INSUFFICIENT FORCE ON THE CRUTCHES

Constant but insufficient force during the 3-point step: Not enough force on the crutches during the first phase of the step, overload on the injured foot.
Pre-set weight: 40 kg, realized weight on injured foot: 50.1 kg, Overload: 10.1 kg.

PIERENSTEP

DISCUSSION, BENEFIT, FUTURE

PIERENSTEP shall contribute to reduce the big existing uncertainty with practitioners and patients for the partial weight bearing with medical forearm crutches.

Especially critical and old patients in the rehabilitation phase show fear and scepticism toward the not visible partial weight bearing.

With PierenStep, a patient now can learn how to use the partial weight bearing feedback method of our crutch prior to the intervention.

Osteosynthesis implants of minimal invasive kind, such as LISS, are not stable for loading. The indication to such a system can be provided completely by the PIERENSTEP system of crutches and continuous feedback after the intervention.

The academic discussion on methods for early mobilizing is an actual subject, which is directly solved by our system. With the help of fast learning of how to walk with the medical crutches, the patient can concentrate better on his gait. This avoids the consolidation of limping automatisms. A physiological gait may be achieved easier and faster thanks to the feedback crutch system.

Liebs et al. showed that patients with a partial weight bearing after the operation had significantly better rehabilitation results – up to one year after surgery – than patients who were allowed to put full weight on the operated leg.

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