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Poster · September 2017

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DINABANG: Explosive Force Hamstring Rehabilitation Biomechanics Instrument

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ICABBE & ICBB 2017

1. Rehabilitation after repaired ACL

Surgical repair of the Anterior Cruciate Ligament (ACL) with hamstring graft technique includes partial removal of semitendinous tendon (autologous implant [1]).

Part of rehabilitation is done by quadriceps training [2] with balanced agonist/antagonist type quadriceps/hamstring strengthening. Backwards explosive force is controlled by physiotherapist (Fig. 1) but there is no quantification clinically available to measure the force and power, putting the weakened semitendinous tendon at risk.

Fig. 1 - Hamstring muscle and backwards power exercise.

2. Design of DINABANG

Name **DINABANG** refers to explosive=*bang* and force= *dynamis*.

A new instrument, **DINABANG**, to measure leg dynamics and thus guide the patient in his effort and as a reference for therapist. Variables to be taken into account are:

- **leg weight and length**
- **backwards kick force at heel**
- **heel displacement**
- **leg angle to vertical**
- **therapist line of action (elastic band)**
- **angular velocity and angular acceleration.**

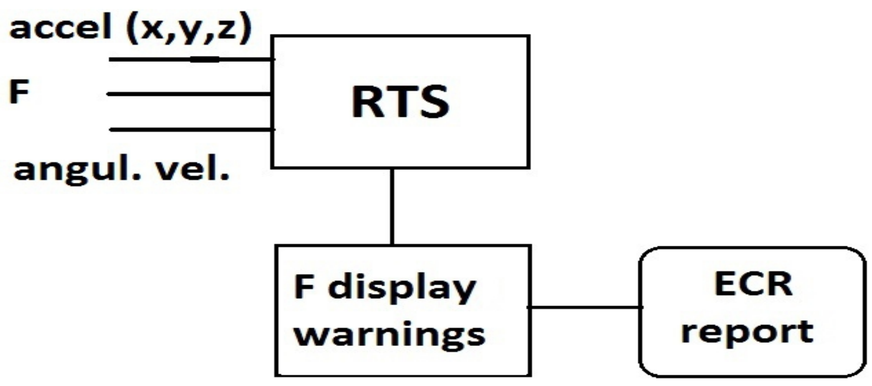

Fig. 2 - Schematic of DINABANG. A Real Time System (RTS) reads heel accelerations x y & z(t), angular velocity (gyro) & band force F.

The design of **DINABANG** includes force sensor in series with the band, 3-axes-acceleration sensor and gyroscope at the ankle, all sensors connected to a microcontroller (TI model MSP430) in turn connected (Bluetooth) to a processing unit. A standard large display placed behind the patient will guide the rehab technician during exercise: such feedback avoids strains and optimizes follow up rehabilitation.

3. Real Time System Implementation

A simple real time system (RTS) is implemented in a MSP430 circuit by TI with ports and MPU-6050 six-axis gyro & accelerometer (Fig.3)

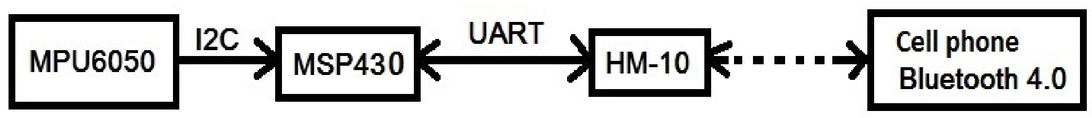

Fig. 3 - Implementation of DINABANG. Cell phone App shows first results of lower limb dynamics to guide rehabilitation.

4. Results

Preliminary measurements were performed on a healthy informed volunteer (Fig. 4), giving satisfactory results, (Fig. 5).

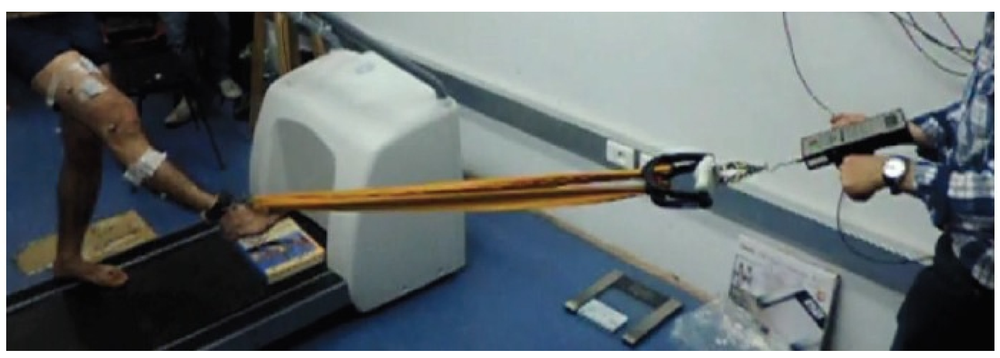

Fig. 4 - Volunteer kicking backwards, therapist sees parameters

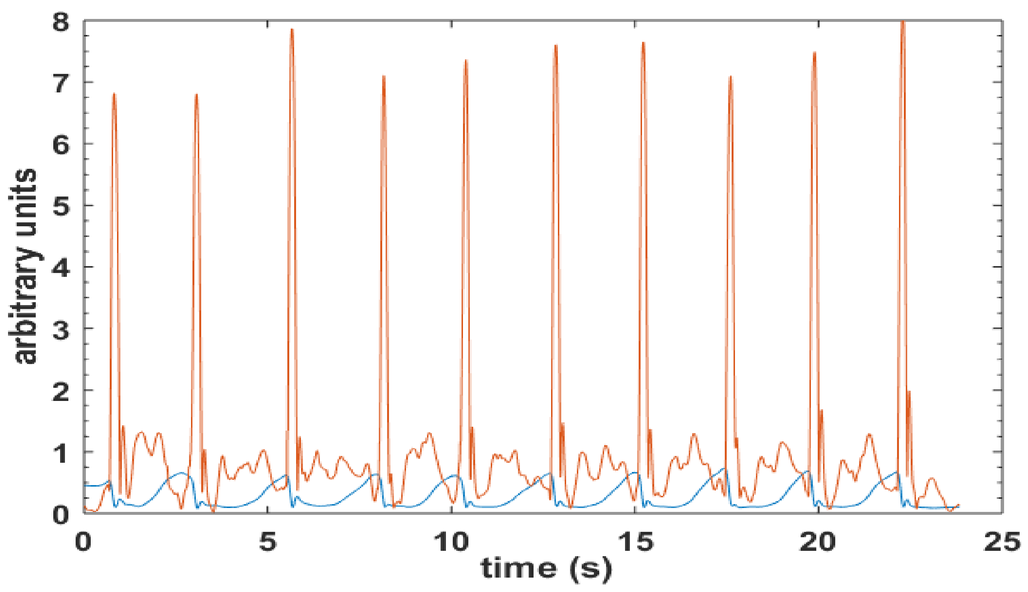

Fig. 5 - Basic limb dynamics obtained with motion capture system (Vicon) shows heel ladmark position (small signal) and heel velocity.

5. Conclusion

DINABANG has a preliminary configuration to record dynamic parametres of a moving leg, specifically during a quick backwards movement, controlled by a therapist holding a rubber band. **DINABANG** is designed to include the total force involved and maximum power into a standard clinical report, to be combined with subsequent reports for a rehabilitation process documentation [3].

References

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International Conference on Advances in Biomedicine and Biomedical Engineering
& 6th International Conference on Biotechnology and Bioengineering
26 – 28 September 2017 Offenburg, Germany