ORTHOSIS "COMARNA" – FORCES ACTING ON THE JOINT ORTHOSIS

RANCEA ADY*

"Gheorghe Asachi" Technical University of Iaşi, Bd. Mangeron, nr.53A Iași, 700050, Romania

Abstract: If the Achilles tendon stalks, the emergency surgery involves the ligation and the recovering of the tendon of interest. The interest in physical therapy is for a model that would allow adjustment dorsifled stages, the number of degrees, and the final stage the same orthosis to submit a joint motion for free care. The Comarna orthosis solution is for these stages, a cut in the leg support in making a dynamic orthosis to assist. The paper addresses the leg in terms of biomechanical and choosing the right type of mechanism.

Key words: mechanism, orthosis, tendon.

1. INTRODUCTION

This paper approaches the forces that acting on the orthosis. It must be said that the size of this device is made to be used for the recovering patients in the hospitals, in the fitness rooms, at the based sports clubs and at the home user.

2. MODEL

The orthosis is being used for the recovery of the Achilean Tendon after the surgical treated injury. The „Comarna" orthosis was used for the first time in 2007 by Bogdan Dimitriu for the recovery of a patient from the village with the same name.
Analyzing the gaits phases, from the time to initiate the contact and separation of the ground leg, we observed that the maximum demand on the screws of the adjustable parts of the orthosis appears at its end. At the leg separation on the ground, the reactions tend to close the angle formed by the two arms of the orthosis [1-4].

The Figure 1 presents the forces acting on the arms and joint the elements:

- *G*-the weight of the patients (N);
- *R*-the reaction that appears to support the foot on the ground (N);
- *Fp*-the force that acts perpendicular to the orthosis arms, which is fixed to the leg (N);
- *Fl*-the longitudinal force that acting on the orthosis arm, which is fixed to the leg (N).

Taking into account the unipodal support a patient weighing 90 kg and a maximum angle of the foot from the ground at the time of separation in plantar flexion of 45, the decomposition of the joint forces that occur following requests orthosis maximum.

Reaction R is equal and opposite to the patient's weight G.

* Corresponding author, email: rancea_ady_2008@yahoo.com

$$R = G = m \cdot g = 90 \cdot 9.8 = 882N \tag{1}$$

$$F_p^{\ 2} + F_l^2 = R^2 \tag{2}$$

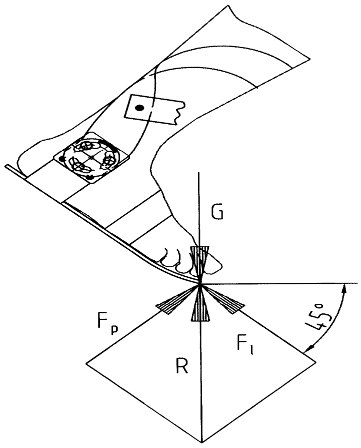

Fig.1. Scheme of the forces that acting on the arms and joint the elements [5].

The maximum angle of the foot above ground of 45 results:

$$F_n = F_1 \tag{3}$$

$$F_p = F_l = \frac{R}{\sqrt{2}} = 623.7 \text{ N} \tag{4}$$

Calculated the forces that resulting from static loading scheme orthosis during walking demands are greater, for it takes into account the impact coefficient = 1.8 [4], dynamic forces are:

$$F_{pd} = F_p \cdot 1.8 = 1122.6 \text{ N} \tag{5}$$

$$F_{1d} = F_1 \cdot 1.8 = 1122.6 \text{ N} \tag{6}$$

Operating condition is that the screws tightened parts must not move under the effect of dynamic force F_{pd}, perpendicular to the arm is fixed to the foot orthosis.. The screws must be tightened with a time able to create a friction contact surface parts, high dynamic force F_{pd} .

$$\mu \cdot F_s \geq F_{pd} \text{ N} \tag{7}$$

where
- Fs is the force that required the collection (N);
- $\mu = 0.4$ is the coefficient of friction between the plate I of the metal joint orthosis and the arm 2.

If we adopt a value higher than one for safety slip coefficient $\beta = 1.3$ results:

$$F_s = \beta \cdot F_{pd} / \mu = 3648 \text{ N} \tag{8}$$

Knowing that the collection is made with three screws, adopting the hypothesis that the force Fs is distributed equally, that a screw tightening force is given by:

$$F_{so} = F_s / 3 = 1216 \text{ N} \tag{9}$$

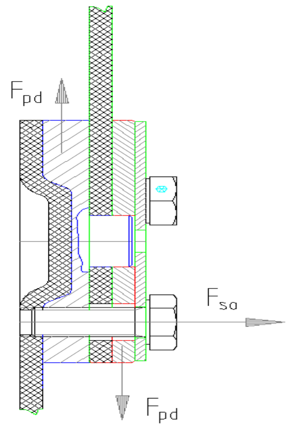

Fig.2.The scheme of the screw tasks.

Sizing the screw (Figure 2) provided that blood is made from the tensile to be less than allowable the tensile tension:

$$\sigma_t = \frac{F_{so}}{\frac{\pi}{4} \cdot d_1^2} \le \sigma_{at} \text{ N/mm}^2 \tag{10}$$

$$\sigma_{at} = 0.6 \cdot R_{p0,2} \text{ N/mm}^2 \tag{11}$$

where:

- σ_t - is the diameter of the screw (mm);
- σ_{at} - allowable tensile strength at-N/mm2 the bolt material;
- $R_{p0,2} = 640$ N/mm^2 yield strength of bolt material, corresponding to 8.8 group;

In the Table 1 are extracts the features mechanical fasteners, in accordance with EN 28839:1999.

Table 1. Mechanical Fasteners.

The symbol of the quality class		r Mpa	0,2 MPa	Sample material
Screw	**Nut**			
3.6	-	30	180	OL34, OL37
4.6	4	400	240	OL37, OL42 OL44, OLC10 AUT20, AUT20M
4.8			320	
5.6	5	500	300	OLC35 , OLC25 OLC15 , AUT30
5.8			400	
6.8	6	600	480	OLC35 normalized
8.8	8	800	640	OL52 , OLC45, OL60
9.8	9	900	720	18MoCrNi06, 15MoCrNi12 20Cr8
10.9	10	1000	900	41VmoCr17, 34MoCrNi15

The inner diameter of the bolt is given by:

$$d_1 = \sqrt{\frac{F_{so}}{\frac{\pi}{4} \cdot \sigma_{at}}} = 6.35 \quad \text{mm} \qquad (12)$$

According to STAS 981-74, setting the standard nominal diameters and thread up ISO screw M8, the step adopted is 1.25, which is the inner diameter $d_1 = 6.647$ mm.

3. CONCLUSIONS

The standard SR EN 13291:2007 (EN 132921:2007) "Individual protection equipment. Ergonomic principles" is a guide related to the ergonomic characteristics of such products. Among the things that must be taken in consideration we are mentioning:

- "Comarna" orthosis ensures the protection against specified risks and is from an ergonomically point of view proper for the provided utilization;
- "Comarna" orthosis allows making specifically movements
- "Comarna" orhosis achieves adaptability and maintaining on the body: adjustment, stability of adjustments
- "Comarna" orthosis doesn't causes rashes and discomfort;
- the orthosis doesn't make worst the biomechanically characteristics: weight distribution, inertial forces distribution on the human body, limitation or stopping movements, abrasion or compression on teguments and muscles, raising of vibration;
- the orthosis isn't a stress factor for the patient.

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