Investigation of Friction Condition Between Human Skins at Lower Limb Stump with Different Textiles

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Abstract **- Human skin considered as an important organ in the human body since it works as a barrier between outside environment and the internal components, also it covers approximately two squared meter in total area and around 18% of human weight in adult. In case of lower limb amputation, the stump will be in direct and continuous touch with textile material in between the polymeric socket and stump itself, so to avoid skin injuries or ulcers which are causes if bad contact conditions occur for long time duration. In present work coefficient of friction of different textiles with in-vivo human skin for both male and female at the stump region are investigated, this specific contact area is influenced by many factors such as skin humidity, nature of the employed textile itself, temperature, and other factors. This paper will clarify how coefficient of friction varies together with different textile to provide comfortable ambient at this sensitive region.**

Keywords - Skin friction; Biotribology; Lower limb; Viscoelastic materials.

I. INTRODUCTION

Biotribology defined as the science that deals with tribological aspect of biological systems like human skin, bone, etc. This field is still relatively recent and need more investigations due to the various cases of medical problems like limps amputation **[1].** More complicated cases are friction between human skins in vivo with other artificial textile materials; this is because of the complex nature of the human skin topography furthermore the contact conditions such as humidity, temperature, the nature of the other surface in touch. Human skin consists of multilayers and treated as a viscoelastic material and its thickness varies from less than one millimetre in the eyelid up to few centimetres at the abdomen. In this paper the employed skin is at the above knee region with thickness of approximately 1 centimetre. Figure (1) below shows in details the main layers of the skin; they are Epidermis, Dermis, and Hypodermis, for two cases, thick (hairless) and thin skin (hairy).

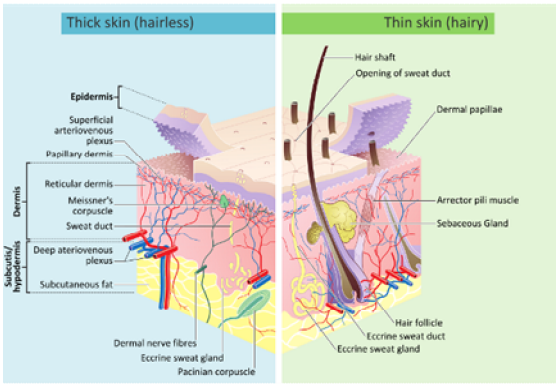

Fig. 1. Schematic representation of natural human skin [2]

Human skin considered as a viscoelastic material as a result of its behavior when loaded and shows similarity to viscoelastic mechanical system due to its specific structure with fibers and others **[2]** it is well known that elastic materials obey the general laws of friction where friction force is always proportional directly to the normal force $F_{friction} \propto Normal\ Force$ and independent of the generated contact area between the two mated surfaces, but the situation in viscoelastic materials is completely different where two important components of friction where raised: adhesion and deformation: adhesion component (major contribution) of friction sometimes is called the pull-off force i.e. negative force required to break down the adhesive links between the surfaces, mean while the other component is named deformation (minor contribution) refers as to the deformation contacted bodies **[3]**. Other parameters have taking into account: volunteer sex, age, anatomical region. Many other recent papers investigated other parameters but in other places in human body i.e. interaction between hands and daily handled objects **[4],** interaction between human skin for two regions started with index finger then lower edge of the human hand and rough and smooth glass plate was investigated by S. Derler et al **[5]** with two conditions dry and wet. Another study of skin friction with smooth steel ball tip probe at the forearm dry skin with humidity ratio of 50% was done by M. Kwiatkowska et al **[6]** Comparison to values of the effective indentation stiffness of the skin presented variances in the effects of the applied