Min Review

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# Determination of life time through slide wear tests

## Abstract

The use of ankle joint endoprosthesis has recently increased its application due to several various diseases affecting the bone structure conditions. The most common illnesses are osteoarthritis, osteoporosis, bone fractures, obesity and diabetes. Additionally, high cost and specialized knowledge make it impossible to develop this type of equipment for low class economies. Nevertheless, the use of endoprosthesis devices are more common now a days and the main problem with endoprosthesis it´s short service life, which are a permotion of wear between components and material composition. It is very important to determine and quantify the effect of wear in this devices. However, equipment design and manufacture to assess this kind task is not available (or is not confinable) and evaluating the service life of ankle joint endoprosthesis is not possible. For these reasons, a machine designed and manufactured at the Instituto Politécnico Nacional was carry out performed to perform wear analysis between the UHMW-PE insert and the Titanium component to predict the life of the endoprosthesis. Additionally, is a development which was carried out at a low cost, but it´s capable to perform analyses in all the real degrees of freedom that the ankle capable of produce.

**Keywords:** endoprosthesis, ankle joint, ostreoarthrosis, obesity, diabete

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## Introduction

Various diseases, such as ostreoarthrosis, osteoporosis, obesity, diabetes, among many others, cause serious complications at the bones which affect people's daily living conditions.[1] When the joint bones are damaged, the patients best option is to the apply different common techniques to reduce pain and allows the patient to recover functionality. Additionally, there are physical therapies and the use of supplements to help recovery.[2] If the desirable results are not produced by the application of any of the above methods, patients' alternative is to incorporate the use of artificial devices to assist with their daily activities and reduce deficiencies.[3] These devices are known as prosthesis. To address deficiencies problems in any joint (as in ankle, elbow, etc.) prosthesis are applied (Figure 1) which allow patient regain mobility and decrease pain.

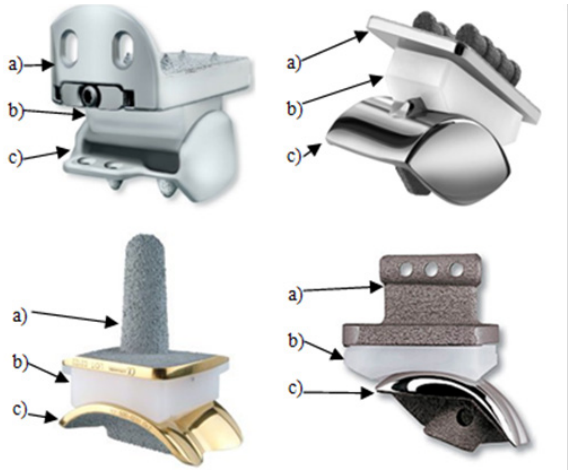


**Figure 1** Different types of prosthesis for the ankle joint[4] and different components; a) Tibial component. b) UHMW-PE insert. c) Astragaline component.

The main disadvantage of these devices is that, by now, their expected life time remains undetermined and as a consequence the patients using these artificial attachments should recur to constant and repetitive surgical interventions to solve this problem.[4,5] Therefore, for the especial case of an ankle joint prosthesis, it was proposed to develop a self-driven mechanism to apply the loading cycling conditions to the ankle joint. The main objective of this device to perform cycle slide wear test on different prosthesis, simulating the surface contact under loading conditions and considering the surface relative motion. Therefore, by using such a mechanism (Figure 2)[6] designed at the Instituto Politécnico Nacional, slip wear endoprosthesis test can be carried out in such a way as to determine the lifetime of these elements. The device designed in Figure 2 allows all the simulation of gait and is able to reproduce the movements of ankle join while it moves under: Flexion– Extension, Inversion–Eversion and Abduction – Adduction (Figure 3). Additionally, the mechanism can be programmed to work under accelerated cycling conditions in order to produce wear in a shorter time.

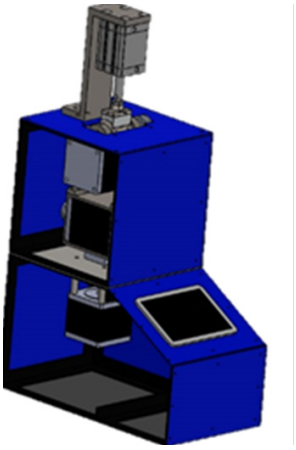

**Figure 2** Ankle slide wear machine.

 

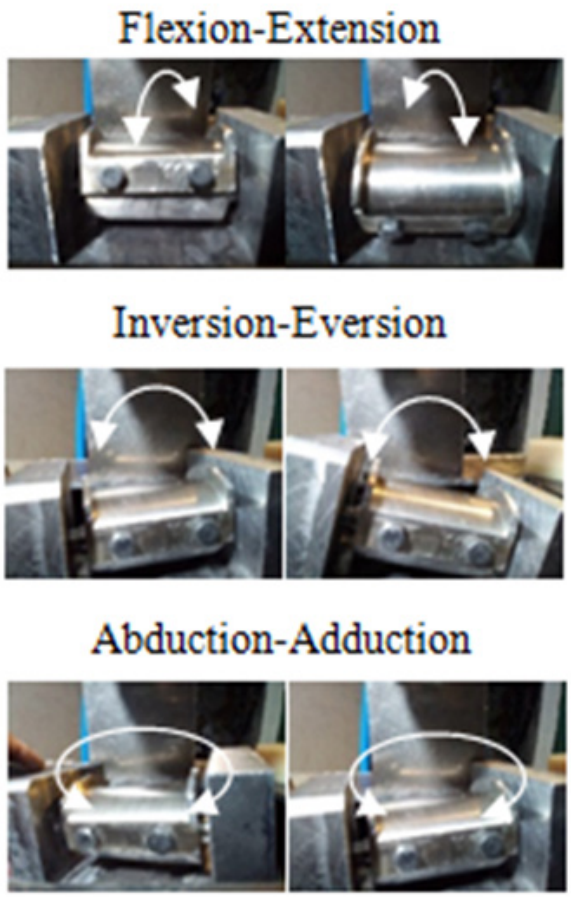


**Figure 3** Relative surface movements to be produce by the device to generate wear.

## Proposal

The joint ankle prosthesis is placed directly in the mechanism, which generated the action that causes wear by slippage under loading with an accelerated frequency so as to generate an elevate number of loading cycles.

It you be noted that it expected that wear by slippage good accord on the insert (Figure 4), which is an ultra-high molecular weight polyethylene known as UHMW-PE.[7] So by determining the loss weight during the test it should possible to determinate the life time scan for the joint ankle prosthesis.

**Figure 4** UHMW-PE insert joint ankle prosthesis.

## Discussion

Life cycle scan considering that person can walk between 3 and 5 km at day, with which you can keep healthy.[8] Being a user of endoprosthesis, the kilometers that can travel per day are 5 km. Starting from this data and knowing that the average step is 0.65m proceeds to obtain the number of cycles to which the machine is programmed using equation 1.

$$Cycles_{day} = \frac{D_{recorrida}}{D_{paso}}$$

$$Cycles_{day} = \frac{5000\,m}{0.65\,m/\,paso}$$

$$Cycles_{day} = 6\,666\ pasos$$

In a span of one month, the person goes through 200 000 steps. The UHMW-PE insert is subjected to the cycle of the wait known as walking to 200 000 cycles, so that its behavior can be observed and with this know the parameter (difference of weight by wear is determinated). The results obtained so far have allowed to determine the behavior of these devices or attachments. For 200000 cycles, the wear produced in the inserts of the endoprosthesis is shown in Figure 5.

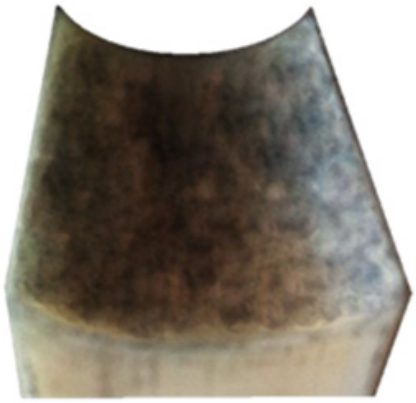

**Figure 5** Slip wear produced on endoprosthesis inserts

This wear caused by mechanism programming result to be between 3% and 5%, which equates to one month of life performing normal activities for a person with an endoprosthesis implant. The wear produced on the insert is high, this data is affected because the manufacture of the inserts was carried out personally within the institute. It should be noted that the type of wear produced on the inserts is real because all the conditions present in the gait cycle are applied as they are; variable load, speed of gait, as well as duty cycles. A larger number of tests are needed to get reliable results.

## Conclusion

The wear and tear produced in the insert is a real one, since the wear tests were applied directly on the prostheses controlling all the mechanism parameters for the operation of the prostheses. This wear caused by mechanism programming result to be between 3% and 5%, which equates to one month of life performing normal activities for

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a person with an endoprosthesis implant. It should be mentioned that the endoprosthetic inserts were manufactured within the IPN. So far, the test carried out on the device have proved the right operation of the device. It has been possible as well to check by weight difference the wear sliding occurrence on the polyethylene UHMW-PE and establish by this means delay cycles span the prosthesis.

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## Conflict of interest

Author declares that there is no conflict of interest.

## Funding details

None.

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