Wear Depth Distribution of Articulating Surfaces of Retrieved Hip Prosthesis using Non-Contact Interferometer

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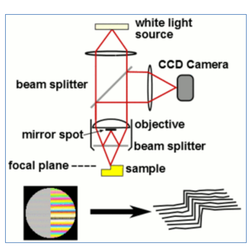
Introduction

With an increasing demand for prosthesis hip implantation, there is an increasing need for a more sophisticated wear testing device which would simulate the geometrical parameters, kinematic motions, load profile and biological lubricating conditions across the articulating surfaces of pair of materials of hip implants. Investigations on wear mechanisms and quantifying the wear depth distribution in acetabular cups have been extensively undertaken by researchers over the last two decades using in-vitro studies. While the load profile is well defined in ISO–14242 for a gait cycle, numerous investigations are performed using hip simulators and computational techniques to propose wear rate, wear tracks and wear depth distribution in acetabular cups. However, there is a need to understand wear depth distribution and wear tracks from in-vivo studies to integrate kinematic motion and load profile across articulating surfaces of hip joint and design a wear mechanism for a wear screening device.

In this work, retrieval study is carried out on a non-contact white light interferometer using 9 retrieved acetabular cups from Indian patients in order to study and compare patient specific issues like physiology or activity level and its effect on wear depth distribution for the wear track under consideration.

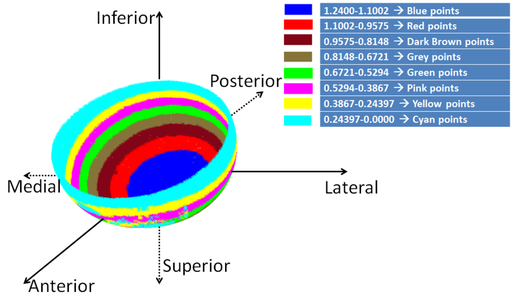
Non-Contact Interferometer

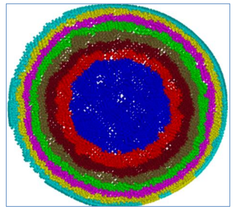
White light scanning is a form of noncontact scanning and is a 3D digitizing technology that measures the physical characteristics of an object with an optical measuring system. It is also refereed as white light digitizing. It is the most accurate process for taking the dimensional measurements of an object and then modeling in 3D digitally.



Wear Depth Distribution

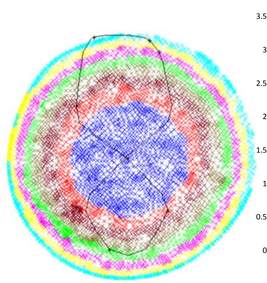
Maximum linear wear was observed to be in the supero-posterior region of the cup. New wear sliding track is derived from the wear depth distribution using Archard's wear law and load profile in a gait cycle (as per ISO–14242). Procedure has been devised to plot the most dominant wear sliding track and a complete protocol of wear sliding tracks has been proposed to customize wear screening device in order to closely simulate the natural hip joint conditions. Comparative results show that wear distribution and wear track is primarily dependent on the materials of the contact pair constituting the acetabular cup and the femoral head, type of motion and load profile during human gait cycle over the functional life of the artificial hip joint.

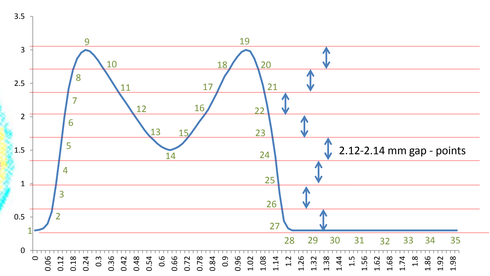


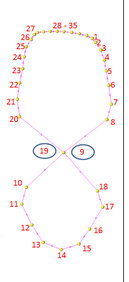


Proposed Wear Track

The wear track on a wear pattern of a scanned retrieved cup is drawn based on the 'wear pattern' and 'division of load profile' for Fl–EX cycle as per ISO-14242)







Clinical Wear Data

Wear Data: Wear Pattern | Period of Implantation | Linear Wear | Volumetric Wear of Various Patients: (P-5, P-6, P-7, P-8)