

## Role of Bio-Tribology in Medical Insertion

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**Abstract:** Tribology is the study of rubbing, friction and wear. When it applied to biological entities then Bio-Tribology came into consideration. The principle of Tribological study and understanding is not just constrained for solving Mechanical Engineering problems. In fact, effective solutions of friction, wear and lubrication related problems can be entertain by Bio-Tribology in human daily life. Bio-Tribology has a critical role in medical processes like medical insertion. This paper describes the role of Bio-Tribology in medical insertion especially in urinary catheterization, which is an essential process in medical field. Catheterization causes rubbing action which causes friction as patient discomfort. Lubrication plays an important and vital role in the operation of any machine/device. Therefore the role of lubrication for human body can be explained under the environment of Bio-Tribology.

**Keywords:** Bio-Tribolgy, Medical Insertion, Catheter, Lubrication, Lubricating Layer, Human Comfort.

### Introduction:

Word Tribology came from Greek word “Tribos” means Rubbing. Tribology is the study about wear, friction and lubrication [1]. Bio-Tribology is the science of Tribology applied to biological entities. In human being Tribology considered with interacting surfaces. Bone joints are the major area of Bio-Tribology, which is an articulating bearing with one end of a bone rubbing against another [2].

**Table. 1 Classifications of representative Bio-Tribology research and associated research focuses [2].**

| Classification Type                            | Major Investigations   |
|--|--|
| Joint Tribology                                | Hip Joint, Knee Joint, Articular Cartilage, Joint Fluid, Implant Interfaces, etc.  |
| Skin Tribology                                 | Skin Care, Synthetic Skin, Skin in contact with articles (such as tactile texture, shaving devices, shoes, socks) for daily use, Various Medical as well as Sport Devices, Medical and Cosmetic Treatment, Skin Friction and Grip of Objects, Skin Irritation and Discomfort, etc. |
| Oral Tribology                                 | Natural Teeth, Tongue, Saliva, Implant Teeth, Toothpaste, Swallow, etc.  |
| Tribology of the Other Human Bodies or Tissues | Hairs, Bone, Cells, Contact Lenses, Capillary Blood Flow, etc  |
| Medical devices                                | Scalpel, Operation Forceps, <b>Urinary Catheters</b> , Gastroscope, Artificial Cardiovascular System, Medical Gloves, etc.   |

Others instances of Bio-Tribology are:

- Wear of dentures
- Friction of skin and garments affecting comfort
- Tribology of contact lens with eye tissue
- Blinking of an eye
- Fetus moving in a womb

In medical field there are various processes by which medical professionals insert a device (tube, valve, cardiac or urinary catheter etc.) to human body. Catheters are generally used by medical professionals by inserting a tube into body cavity, to allow drainage [3]. Friction is the definite outcome by medical insertion and causes patients discomfort. Lubrication is most important agent/ tool for minimizing rubbing action and reducing patient discomfort.

A urinary catheter is a thin, clean hollow tube which is usually made of soft plastic or rubber. Urinary catheterisation is the insertion of a catheter (tube) into the bladder via urethra. Urinary catheterization used for urinary retention (urinary failure, inability to urinate). It reduces the risk of infection and kidney damage by ensuring the bladder is emptied adequately, continuously or at regular intervals.

### **Friction and Lubrication:**

Friction is the force that acts at the surface of two articulating solid bodies so as to resist sliding on one other. Simply it is the resistance to motion of surfaces in relative motion, this force which tends to prevent one surface sliding over another [4]. Lubrication may be defined as any means capable of controlling friction and wear of interacting surfaces in relative motion under load [5]. Lubrication has been applied to solve friction problems far longer [4].

There are various lubrication mechanisms, which have developed to control friction. Some time friction is helpful and necessary. But in some areas it causes trouble and uncomfortable, especially in medical insertion. Without proper lubrication some of the medical insertion cannot be possible. Appropriate lubrication is recommended in medical insertion for reducing the risk of trauma, minimizes discomfort and friction which in turn may reduce infection.

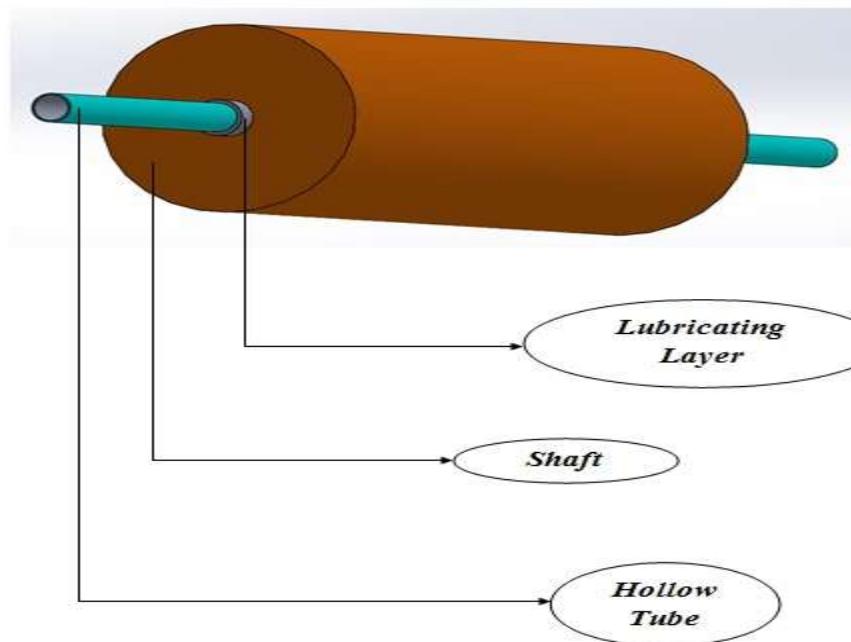
### **Role of Bio-Tribology in Medical Insertion:**

Medical device industry has influenced by Bio-Tribology due to its importance and challenges. Bio-Tribology focuses on friction, wear and lubrication in biological system. Lubrication is the reduction in friction through a third body that separates two solid surfaces in relative motion. In biological system interactions between medical devices and soft surfaces of living being are still a challenging area. Lubricity has a critical role in the functionality and safety of these devices [6].

The essential roles of Tribology are controlling friction, reducing wear and improving lubrication. Similarly Bio-Tribology focuses on minimizing friction and better lubrication for living being. Obviously, in this regard, Bio-Tribology is much better able to fulfil the demands of human comfort. Human comfort is the most important parameter of any society.

The major area of Bio-Tribology is related to lubrication. Therefore, Bio-Tribology may be thought, as the study of biological lubrication processes, for example, lubrication in urinary catheterization. Urethra is the most sensitive area of human body. It is very difficult to insert a rubber tube into the body through urethra, it causes discomfort, burning sensation and pain. Catheterization is not easy for patients especially in male. Fiction during insertion and removal of the catheter must be controlled by proper lubrication to avoid tissue damage and enable the device to be inserted smoothly into the proper location. Catheters are widely used by medical professionals to allow drainage, administration of fluids or gases. For reducing patients discomfort lubricants are placed between tube and the internal walls of urethra.

Before catheterization medical professional provides lubrication for entire length of urethra. Urethra has a tubular shape and a layer of lubrication should be build up around the walls of urethra. Catheter moves to bladder with guiding of lubricating layer. But in general cases this lubricating layer dropped by catheter insertion and tube come up to direct contact with urethra walls. When catheter touches urethra walls then friction arises and it causes more discomfort to patients. If there can be a proper technique to build-up a lubricating layer and it does not destroyed by catheter insertion then there will be less friction between urethra walls and catheter.



**Figure 1**

Figure 1 is the representation of urethra and catheter insertion simulation design, with the help of SolidWorks designing software in enlarges view, in which urethra as a shaft and a hollow tube as catheter. As shown in figure a lubricating layer between inner walls of the shaft and hollow tube reduces friction and prevents direct contact of tube with shaft. If lubricating layer does not destroyed until catheter reaches to bladder then high level of comfort can be achieved.

Thus the role of Bio-Tribology in medical insertion is important and it is beneficiary for living creatures or in simple language of engineering, Bio-Tribology is the integration of human comfort level.

### **Conclusion:**

Bio-Tribology is the study of rubbing in which friction and wear are in critical role. Rubbing always causes friction. In medical insertion especially in urinary catheterization friction is directly proportional to discomfort (more friction more discomfort). This discomfort can be overcome by the Lubrication. Lubrication plays an important and vital role in urinary catheterization. Without proper lubrication urinary catheterization will be more difficult for health care professionals and discomfort for patients.

Discussion was made about the selection of different types of lubricants for human ease but still there is a scope for the selection of healthier technique which can be more comfortable and favourable for living being. If health care professionals concentrate on Bio-Tribology, then they can reduce friction during rubbing action of medical insertion especially in urinary catheterization. Friction during rubbing action depends on the sliding surface. In urinary catheterization there is a lubricating layer between tube and urethra wall, but in general cases it has destroyed and dropped by the tube movement. If tube does not touch the urethra walls and slide with lubricating layer then role of lubrication will be fulfil in catheterization.

Due to very small diameter of urethra it is not easy to catheter movement without patient discomfort. It is not possible to fully disappearance of patients discomfort but it can be minimized by a temporary lubricating layer.

Bio-Tribology will continue to make possible progress in the quality of life, which will be great challenge and understanding for Bio-Tribologist.

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