iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2 **Issue:** XII **Month of publication:** December 2014

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Review of Custom Made Implant

Nitin Borode[1], Tushar Deshmukh[2], Nilesh Pohokar[3]
Department of Mechanical Engineering, S. G. B. Amravati University, Amravati

Abstract—The last twenty years have seen an increase in research activities and technological development in orthopedic, implants and biomedical field. The main purpose of this review is formulating an integration of technologies model for design and evaluation implants. The literature related to implant and custom made implant, their feasibility into human body structure related anatomy are discussed. This paper also gives the application of custom made implant used in human body and outline and direction in the field of biomedical research.
Keywords— Anatomy of joint, CT scan, CAD, FEA. Custom implant

I. INTRODUCTION

A custom-made implant is used to compensate a bone deficiency or a malformation that is either congenital or accidental in a person. The success and long life of implants depend upon factors like material characteristics, design of the implant. Advances in image processing and manufacturing technologies have made it possible for the accurate perception of the defect, custom designed implants as the best option for reconstruction of joint defects. Custom implants for the reconstruction of joint defects have recently gained importance due to their better performance over their generic counterparts. This is attributed to, the precise adaptation to the region of implantation.

What is Custom Made Implant?
Custom made implant is specifically made in accordance with a request by a health professional specifying the design characteristics or construction of the medical device; and is intended to be used only in relation to a particular individual. A custom-made implant is used to compensate a bone deficiency or a malformation that is either congenital or accidental in a person.
Advantages of custom made implant
With the patient-specific approach the replacement systems offer unique advantages including:
Individualized fit that virtually eliminates sizing compromises common with off-the-shelf implants and associated with residual pain after surgery
Designed to follow the shape and contour of each patient's joint, which provides an increased potential for a more natural feeling
Designed for optimal bone preservation

A. Study of the body

The human body is a combination of organ systems, with a supporting framework of muscles and bones and an external covering of skin. The study of the body is divided into [1].
Anatomy: Anatomy is the study of body structures and the relation of one part to another.
Physiology: Physiology means study of the processes and functions of the body tissue and organs.
Physiology is the study of how the body works and how the various parts function individually and in relation to each other [1].

B. Joint

The area where two bones are attached for the purpose of permitting body parts to move. A joint is usually formed of fibrous connective tissue and cartilage. Joints are grouped according to their type of motion: ball-and-socket joint; hinge joint; condyloid joint, which permits all forms of angular movement except axial rotation; pivot joint; gliding joint; or saddle joint. Joints can move in only four ways: gliding, in which one bony surface glides on another, without angular or rotatory movement; angular, a movement that occurs only between long bones, increasing or decreasing the angle between the bones; circumduction, which occurs in joints composed of the head of a bone and an articular cavity, with the long bone describing a series of circles and the whole forming a cone; and rotation, in which a bone moves about a central axis without moving from this axis.

C. Classification of joint according to motion

Joints may be classified functionally based upon how much movement they allow.

1) A joint that permits no movement is known as a synarthrosis. The sutures of the skull and the gomphoses that connect

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

the teeth to the skull are examples of synarthroses.

2) An amphiarthrosis allows a slight amount of movement at the joint. Examples of amphiarthroses include the intervertebral disks of the spine and the pubic symphysis of the hips.

3) The third functional class of joints is the freely movable diarthrosis joints. Diarthroses have the highest range of motion of any joint and include the elbow, knee, shoulder, and wrist. It is also known as synovial joint.

D. Classification of synovial joints

There are many different classes of synovial joints in the body, including gliding, hinge, saddle, and ball and socket joints.

1) Gliding joints, such as the ones between the carpals of the wrist, are found where bones meet as flat surfaces and allow for the bones to glide past one another in any direction.

2) Hinge joints, such as the elbow and knee, limit movement in only one direction so that the angle between bones can increase or decrease at the joint. The limited motion at hinge joints provides for more strength and reinforcement from the bones, muscles, and ligaments that make up the joint.

3) Saddle joints, such as the one between the first metacarpal and trapezium bone, permit 360 degree motion by allowing the bones to pivot along two axes.

4) The shoulder and hip joints form the only ball and socket joints in the body. These joints have the freest range of motion of any joint in the body – they are the only joints that can move in a full circle and rotate around their axis. However, the drawback to the ball and socket joint is that its free range of motion makes it more susceptible to dislocation than less mobile joints.

E. Implants

An orthopaedic implant is a medical device manufactured to replace a missing joint; it has a manmade device. Implants are used to support a damaged bone. Enhance an existing biological structure. Internal fixation is an operation in orthopedics that involves the surgical implementation of implants for the purpose of repairing a bone. Among the most common types of medical implants are the pins, rods, screws and plates used to anchor fractured bones while they heal.

The implants are fitted as pre-planned; the physician can simultaneously check the total length of the leg and the femoral offset against the pre- plan, and orientation of axis of femur length. Customized implants is not necessary for physician to perform these modifications because the implant has been designed as per adapted to the patient from direct scanned information such as CT and X-ray etc. Customization of implant geometry is adapts perfectly to the anatomy and injury of the patient.

Principal benefits of customized implants are:

1) Less time in surgery
2) Faster recovery
3) Greater range of motion
4) A longer-lasting implant
5) No compromise with the size of the implant.
6) Provides better fit of the implant as the implant conforms to the patient’s unique
7) Preserves more natural bone

The patient’s anatomy, pathology and mechanical properties of material are required for design of custom implant and to check stress, deformation and other parameter of implant using FEA. Hence there is a need of finite element analysis of custom made implant.

F. Anatomy of Joints and Physiology

Bowman Karl F. et. al. [2] elaborated the hip is a complex anatomic structure composed of osseous, ligamentous, and muscular structures responsible for transferring the weight of the body from the axial skeleton into the lower extremities. This must be accomplished while allowing for dynamic loading during activities such as gait and balance. The evaluation of hip pain and periarticular pathology can be challenging because of the complex local anatomy and broad differential diagnosis. Recent advancements in the evaluation and surgical treatment of hip pathology have led to a renewed interest in the management of these disorders. An understanding of the basic biomechanical and kinematic function of the hip and the consequences of associated pathology can greatly assist the orthopaedic surgeon in appropriately diagnosing and treating these problems. In this review we discuss the basic biomechanical concepts of the native hip and surrounding structures and the changes experienced as a result of various pathologies including dysplasia, femoroacetabular impingement, labral injury, capsular laxity, hip instability, and articular cartilage injury. We will also discuss the clinical implications and surgical management of these pathologies and their role in restoring or preserving the native function of the hip joint.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The hip is a ball-and-socket joint surrounded by powerful and well-balanced muscles, enabling a wide range of motion in several physical planes while also exhibiting remarkable stability. As the structural link between the lower extremities and the axial skeleton, the hips not only transmit forces from the ground up but also carry forces from the trunk, head and neck, and upper extremities Consequently this joint is crucial to athletic activities in which it is often exposed to many greater than normal axial and torsional forces. The hip joint is unique anatomically, physiologically, and developmentally; and therefore the diagnosis of pathologic conditions is more difficult than for most joints Because of these diagnostic challenges, the hip has received considerably less attention than other joints in the past, particularly in reference to sports medicine and surgery literature. The clinical setting of a plain x-ray of the pelvis exhibiting non-arthritic joints was a difficult situation – patients were potentially diagnosed erroneously with a 'groin strain' or otherwise. With the advent of improved magnetic resonance imaging (MRI) enhanced by arthrography, we now have a better comprehension of pathological processes within the hip joint. Byrne Damien P. et. al. (2012) [3] understanding the evolving potential to treat these problems. For one, hip arthroscopy is undergoing continued development and excellent results have been reported treating a variety of intra articular conditions while we can now access and treat patients with newer diagnoses, we must also ensure that our knowledge of hip anatomy and biomechanics also evolves. Only with this fundamental understanding can the clinician or engineer provide adequate treatment for the patient suffering from hip disease or malfunction. In this review we outline the function of the key anatomical components of the hip and discussed the relevant related biomechanical issues.

Pramanik Sumit. et. al. (2005) [4]; explained the hip joint consists of a ball and socket joint. The top of the thighbone (femur) is a largest bone of human body, called femur joins with the horizontal pelvic coxal bone and lower end of that is fixed at the knee. The ball (femoral head) at the top of the thighbone fits into a portion of the pelvic bone forms the cup (acetabulum) or socket between joining surfaces of the acetabulum and femoral lies a smooth glassy substance called cartilage. It provides frictionless cushion for constrained motion to femoral head within acetabular socket Any failure eminating from acetabulum to femoral bone produces most common hip joint diseases in human body. Humans suffer from the various hip joint problems namely osteolysis, osteoarthritis, a vascular necrosis, rheumatoid arthritis, fracture neck of femur, other inflammatory arthritis, developmental dysplasia, Paget's disease, arthrodesis (fusion) takedown, tumour, road accidents, soldier's injuries etc. Meaning of the medical terminology of some of these diseases is discussed below. Distribution of the bony trabeculae in the neck. The incidence of fracture neck of femur is higher in old age.

The anatomy and biomechanics of the knee is critical for successful rehabilitation following knee injury and or surgery. Biomechanics of both the tibiofemoral and patella femoral joints must be considered. McGinty Gerald. et. al. (1999) [5] explained the knowledge related to rehabilitation of the knee by reviewing the biomechanics of the tibiofemoral and patellofemoral joints. This will include discussion of the relevant arthro kinematics as well as the concept of open and closed chain exercises.

The lower limb prosthesis is a device that substitutes a part of a limb missing either due to amputation or a congenital defect. The prosthesis is assembled using off-the-shelf components and a custom-made socket for its attachment to the residuum For amputees, multiple replacement limbs and repairs are necessary over a lifetime. Children between the ages of four and sixteen grow at an average rate of 2 cm annually. For example, if a child becomes limb deficient at the age of 10, he will need approximately 25 limbs throughout the course of his or her lifetime. However, if persons become limb deficient while they are adults, they typically will go through about 15-20 limbs during their lifetime (Prosthetics Outreach Foundation, 2005). A prosthetic replacement is needed typically every 6-12 months for children, and every 3-5 years for adults. For children amputees, although many prosthetic principles used in treating adults apply to the treatment of children as well, the child with a lower-limb deficiency presents the prosthetic designer with a unique range of considerations, both practical and philosophical. Most techniques used with adult amputees must be downsized, sequenced in degree of complexity, modified or completely altered to match the ever changing needs of children. At the growing age in children there is a need of change of prosthesis after 6 months or even earlier to keep the force distribution equal in both limbs and to avoid limb length discrepancy. Yousif Albert E. et. al. (2012) [6] studied to design and develop lower limb prosthesis including foot, ankle joint, adjustable length shank and knee joint. This artificial limb can be used by adult amputees and also by children amputees during a significant period of time without having to change the limb during their growth.

The total knee arthroplasty is a high-complexity surgical procedure that is basically indicated for patients with a diagnosis of knee osteoarthrosis or rheumatic diseases. Albuquerque Rodrigo Pirese . et. al. [7] explained surgical procedure has been constantly evolving since its creation. Implants with more modern designs resemble the anatomy of the normal knee as much as possible, together with instruments that are increasingly precise and cause less aggression to soft tissue, have been making the

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

coverage of surgical indications ever wider. The good results obtained after carrying out total knee arthroplasty (TKA) have been well documented in the literature, with regard both to pain relief and to maintenance of these results over long-term follow-up Hoff fractures are rare injuries. Pseudarthrosis of coronal fractures of the lateral femoral condyle gives rise to pain and valgus deviation of the knee. Since the knee is a weight-bearing area, it presents greater risk of developing early osteoarthrosis. The aim of this study was to present a case of Hoffa fracture pseudarthrosis in an alcoholic patient with genu valgum in association with venous insufficiency who underwent total knee arthroplasty (TKA).

Sathappan S. et. al. (2011)[8] discuss about the case reports in the literature that describe total knee and total hip arthroplasty (THA) in below-knee amputees, but we could find no case reports on above-knee amputees (AKAs) who have severe osteoarthritis of the hip. We present a case involving an AKA who developed severe osteoarthritis of the ipsi lateral hip. Our patient underwent THA with a satisfactory postoperative outcome. Technical considerations for AKAs undergoing THA also are reviewed. Patients with lower-limb amputations can have various musculoskeletal problems, such as osteoporosis (in the amputated limb), osteoarthritis (in the amputated or nonamputated limb), and spinal disorders. Both hip and knee arthroplasty in below-knee amputees (BKAs) have been described previously. We present a case of a patient who underwent total hip arthroplasty (THA) of the amputated limb as treatment for severe posttraumatic osteoarthritis. To our knowledge, there have been no other reports on above-knee amputees (AKAs) undergoing THA.

II. SCAN DATA FOR CUSTOM MADE IMPLANT

Ligamentous injuries of the knee and ankle are a common entity among athletes. Tham Seng Choe. et. al. (2008) [9] investigated accurate and reliable diagnosis of such injuries following trauma is crucial to both the athlete and the sports medicine physician. Magnetic resonance (MR) imaging with its exquisite soft tissue contrast resolution and multi planar capability is increasingly seen as the modality of choice for the confirmation and prognostic evaluation of such ligamentous injuries of the knee and ankle joints. A sensitivity and specificity of up to 93%3 to 96%4 and 89%3 to 98% respectively are reported for the diagnosis of anterior cruciate ligament (ACL) injuries with MRI. Lateral ligamentous complex injuries of the ankle are also relatively well picked up on MR imaging, with a sensitivity and specificity of 74% and 100% respectively,5 amongst other ligamentous injuries.

The patients undergoing primary total hip replacement (THR) and hence the incidence of peri-prosthetic disease, continues to rise as the population ages. Numerous reports have documented the increasing incidence of peri-prosthetic fracture, for which conventional treatment includes plating, cerclage wiring, and use of the Mennen plate and revision of the femoral component to a longer, cemented or uncemented stem. A patient who has had ipsi lateral total knee and hip replacements poses a major challenge should a sub prosthetic fracture occurs, particularly when the knee replacement is stemmed. Revision to a long-stemmed THR, proximal femoral replacement, or even total femoral replacement can be undertaken, Tillman R. et. al. (2006) [10] studied the risk sacrificing an existing stable THR. Above-knee amputation may be offered to such patients with end-stage prosthetic disease but may be emotionally unacceptable. It also poses a huge physical challenge for a patient, with poor functional results. We present one solution to this problem, which may be applicable to a small proportion of patients with difficult sub prosthetic fractures, and which does not require removal of the existing femoral component if this is functioning well. The technique involves the use of a custom-made hollow cylindrical section which is cemented to the distal aspect of the existing femoral component. Distally, this custom-made cylinder can be connected to the long stem of a revision total knee replacement, or to a diaphyseal replacement. In selected cases, it offers a means of salvaging a challenging situation with less morbidity than the traditional alternatives.

The measurements on the cadaveric hip joints have not been carried out. Patel Jayshree. et. al. [11] stated as the environment plays an important role in the development of human being it was thought that the change in the environment might have laid to some kind of change in the parameters of the bony component of the hip joint. Therefore, 56 cadaveric hip joints with soft tissue in situ were studied. Dimensions of acetabulum and femoral head were obtained with Vernier scale. It was observed that these dimensions were greater in males when compared with that of females but the difference was statistically insignificant. On the right side the parameters measured were greater than those of the left side in both the sexes but of no statistical significance. Acetabular diameter was greater than the diameter of femoral head in both the genders. Clinically, this knowledge plays an important role in understanding the rarity of occurrence of primary osteoarthritis in Indians. The present study is of value to the forensic experts, orthopaedics and prosthetics as it gives the dimensions of acetabulum and femoral head in the present area.

Raos Pero et. al. [12] discussed about the scanning techniques and computer Aided design and manufacturing of the products, widely Applied in industry are feasible to take a place in medicine also the medical surgery results. Approach which is described in this paper in implant manufacturing is based on scanning, computer modelling and machining process Procedure contains rendering of 3D-models created from CT-data to design and to machine a customized implant on machine tool. As a

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

result implants geometry is unique and raises the precision of implantation surgery and consequently, customized can serve for as twice the time for standard implants. This paper will show the procedure of obtaining customized hip bone implant.

The importance of orthopedic surgeons to understand the nature of biomaterials, their structural configurations, and their properties, as well as the effects of their interaction with soft and hard tissues, blood, and intra- and extracellular fluids of the human body. The orthopaedics' field has benefited from the great efforts of many orthopaedic surgeons, experimental surgery laboratories, and research centres and from research work at universities, academies, societies, scientific organizations, and many interdisciplinary groups. F. A. Rodríguez-González [13] explained many challenges in the development of new biomaterials that will improve the long-term performance of clinical results in orthopaedic surgery. The main biomaterials used in orthopedic surgery are divided into two groups: metals and non metals. The use of metals in therapeutic procedures dates back several centuries. Metallic implants were used in the 17th century. In the 18th century a metal screw implant was used for the first time. The majority of elements in the periodic table are metals. Metallic biomaterials have their main applications in load-bearing systems such as hip and knee prostheses and for the fixation of internal and external bone fractures. It is very important to know the physical and chemical properties of the different metallic materials used in orthopedics surgery as well as their interaction with the host tissue of the human body. The metallic implants most widely used in orthopedic surgery are Low carbon grade austenitic stainless steels: 316LTitanium and titanium-base alloys commercially pure titanium (CPTi), Ti-6Al-4V, and other titanium-base alloys Cobalt alloys: Co-Cr-Mo, and other cobalt-base alloys

The scientific studies have been conducted to quantify attributes that may be important in the creation of more functional and comfortable lower-limb prostheses. The prosthesis socket, a human-machine interface, has to be designed properly to achieve satisfactory load transmission, stability, and efficient control for mobility. The biomechanical understanding of the interaction between prosthetic socket and the residual limb is fundamental to such goals. Mak Arthur F.T. et. al. (2001) [14] explained in this paper is to review the recent research literature on socket biomechanics, including socket pressure measurement, friction-related phenomena and associated properties, computational modeling, and limb tissue responses to external mechanical loads and other physical conditions at the interface. There is no doubt that improved biomechanical understanding has advanced the science of socket fitting. However, the most recent advances in the understanding of stresses experienced at the residual limb have not yet led to enough clinical consensus that could fundamentally alter clinical practice. Efforts should be made to systematically identify the major discrepancies. Further research should be directed to address the critical controversies and the associated technical challenges. Developments should be guided to offer clinicians the quantification and visualization of the interaction between the residual limb and the prosthetic socket. An understanding of comfort and optimal load transfer as patterns of socket interface stress could culminate in socket design expert systems

III. CAD AND FEA

The advances computing power and software, custom prostheses are becoming a more practical option for patients with complex orthopedic problems. Marcellin Denis J. [15] explained Custom prostheses involve multiple steps: implant and instrument (CAD) design, implant and instrument fabrication and finish, quality control, and surgical rehearsal. Custom prostheses may be done for a variety of purposes including limb sparing, revision arthroplasty, and placement of implant in patients with unique anatomy Custom prostheses are used to manage complex orthopaedic situations. For total joint arthroplasties, custom implants are used to manage bone loss, abnormalities in bone shape or structure, or unusual bone sizes. Custom implants may be used as part of limb-sparing procedures, to fill large bone defects or to replace a missing bone or limb segment. Custom metal implants are generally designed and fabricated by bioengineers within commercial or academic laboratories.

The methods to predict contact stresses in femoral prostheses can provide an improved understanding of load distribution studied Abo Elkhair M. S., et. al.[16]. The objectives of this study is to apply advanced computer aided engineering techniques (CAE) for predicting stress transfer to femur after implantation of standard and short femoral stems (Proxima stem). A perspective three-dimensional geometry model for the femoral bone using subject-specific geometry from X-ray computed tomography image data (CTI) is used to create 3D CAD model. Forces acting on the femur in different gait regimes were reviewed and compared while loaded with standard and then with Proxima stem. And finally a developed finite element analysis model based on the created CAD model with forces acting on both femurs loaded with standard and Proxima stem is analyzed. Computer aided engineering, Biomechanics, Femur modelling, implant, Hip joint Anatomic short femoral prostheses with a prominent lateral flare have the potential to reduce stress-shielding in the femur through a more physiological stress distribution to the proximal femur. Femur bone crack and fracture is one of the most common forms of injuries during accidents. Body weight is transferred through pelvis to femur by hip joint. Bone is a living tissue, which continuously rebuilds its structure according to the direction of loads exerted on it. After insertion of a metal prosthesis into the medullary canal, the load

ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

equilibrium and the remodel tissues in the bone are disturbed. Stress-shielding activity of the implant which is stiffer, makes the bone atrophies Reduction of stresses in bone with respect to the natural state causes its adaptation to the new conditions manifested by mass changing (external remodelling) or bone density changing (internal remodelling).The latter is especially dangerous because, as already indicated, it can cause aseptic loosening of the implant. Studying different factors affecting stress-shielding activity required appropriate modelling and simulation of the hip stem and femoral bone along with cemented media used in hip.

The finite element (FE) model of the human lower leg in order to investigate the mechanisms that causes severe ankle injuries in frontal impacts. Predictions from the model have been validated against the results from two separate sets of sub injurious and injurious PMHS tests. The model correlated well against the test results and it was estimated that a predicted von Mises stress of 120 MPa correlates to a predicted risk of injury to the calcaneus and talus bones in the model. A series of predictive model runs were also carried out to investigate the influence that environmental and subject variations have on the predicted injury risk of the ankle. The set-up of all these model runs were based on sled impact tests in which PMHS legs were mounted on a sled rig with the feet resting on a heel and mid-foot pad. Neale Michael. et. al. [17] environmental investigations included model runs with and without the heel pad and loading the foot in eversion and a neutral position. Subject variations investigated the influence that the stiffness of the ligaments joining the mid-foot to the hind-foot have on the predicted injury risk. Without the heel pad there was considerable dorsiflexion of the foot and a predicted increased injury risk to the neck of the talus and a reduced injury risk to the calcaneus. Loading the foot in eversion it was predicted that the greatest injury risk was to the lateral aspect of the talus where the lateral malleolus of the fibula articulates with the talus. Increasing the ligament stiffness reduced the shearing motion in the joints between the mid-foot and the hind-foot and there was an increased injury risk to the neck of the talus.

The finite element (FE) analysis has become an increasingly popular technique in the study of human joint biomechanics, as it allows for detailed analysis of the joint/tissue behaviour under complex, clinically relevant loading conditions. A wide variety of modeling techniques have been utilized to model knee joint ligaments. However, the effect of a selected constitutive model to simulate the ligaments on knee kinematics remains unclear. Kiapour Ata M. et. al. (2013)[18] studied and determine the effect of two most common techniques utilized to model knee ligaments on joint kinematics under functional loading conditions. We hypothesized those anatomic representations of the knee ligaments with anisotropic hyperelastic properties will result in more realistic kinematics. A previously developed, extensively validated anatomic FE model of the knee developed from a healthy, young female athlete was used. FE models with 3D anatomic and simplified uniaxial representations of main knee ligaments were used to simulate four functional loading conditions. Model predictions of tibiofemoral joint kinematics were compared to experimental measures. Results demonstrated the ability of the anatomic representation of the knee ligaments (3D geometry along with anisotropic hyper elastic material) in more physiologic prediction of the human knee motion with strong correlation and minimum deviation from experimental findings. In contrast, non-physiologic uniaxial elastic representation of the ligaments resulted in lower correlations and substantially higher deviation from experimental results. Findings of the current study support our hypothesis and highlight the critical role of soft tissue modelling technique on the resultant FE predicted joint kinematics.

The hip fractures are a major cause for disability in patients. They require immediate attention as they could otherwise cause death. Hip fractures are almost always treated with surgery by implantation. Implants are of various types accounting for the many variations in hip fractures. This paper presents the design and analysis of a hip implant using Finite element analysis. Fracture conditions are determined and the optimal design of the implant is obtained for improving healthcare and patient safety. Anthropometric parameters of the human femur bone are collected from a particular age group. These are then used to obtain a CAD model of the bone using CATIA. The standard Charnley hip implant, used in total hip replacement surgery is also modeled. The proposed models are analyzed using ANSYS software by assigning appropriate material properties to the bone and implant. Ganapathi Sathya. et. al. (2013) [19] discussed about the stress distribution is observed when loads corresponding to normal gait conditions are applied. The load at which fracture occurs is then determined experimentally.

Nautiya Ashutosh Nayan et. al. (2014) [20] investigated knee prosthesis has done a lot of advancement in the recent decade as this facilitates people to do various activities even after their old age or some injury. Knee-joint is a complex structure of the human body having a complex shape femoral condyle which moves over the complex shaped meniscus of the tibial bone and acquires various critical loads at various walking, moving and sitting activities. From a biomechanical point of view, clinicians need relevant knowledge in order to properly implant a knee-prosthesis. The purpose of this paper is to give people and clinicians a better understanding about the knee joint mechanism and the loads & forces acting on it at different conditions. In this context, a three-dimensional model of femoral and tibial bones of knee joint is made in Pro/E Wildfire 4.0 and finite element analysis of loads at different conditions and at different weights is done in ANSYS 15.0 software in order to evaluate the results in form of von-mises stress which can be used to make implant for knee prosthesis.

The good quality mesh generation for the finite element method is investigated for artificial hip joint simulations. In general,

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

bad meshes with a large aspect ratio or mixed elements can give rise to excessively long computational running times and extremely high errors. Shin Jaemin et. al. (2011) [21] explained about hexahedral elements outperform tetrahedral elements during three-dimensional contact analysis using the finite element method. Therefore, it is essential to mesh biologic structures with hexahedral elements. Four meshing schemes for the finite element analysis of an artificial hip joint are presented and compared:

1) Tetrahedral elements
2) Wedge and hexahedral elements
3) Open cubic box hexahedral elements
4) Proposed hexahedral elements.

The proposed meshing scheme is to partition a part before seeding so that we have a high quality three-dimensional mesh which consists of only hexahedral elements. The Von Misses stress distributions were obtained and analyzed.

IV. CONCLUSIONS

By studying the joints, anatomy of lower limb structure have immense knowledge of the relation of one part to another. Anatomy of joint gives the morphology of the human joints for inserting the implant in the human body and provides the major areas for the design parameters consideration. It also provides the help for selection of design criteria. By studying the physiology of lower limb pointed out the functions and relation between tissue and organs. Also helps for finding of reaction and direction of forces on the joints. By indentifying the design criteria of custom made implant as per the physician opinion and the anatomy and physiology the data for cad model was prepared with accurate and exact size. FEA analysis of custom made implant gives us better and easy method of validation of stresses developed in the implant before implantation .With the accurate and exact size of implant so that patient can have minimum complications such as infection, blood clotting, loosening, dislocations or failure of implant.

REFERENCES

[1] S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
[2] F. B.Karl, F. Jeremy, K. S .Jon, A Clinically Relevant Review of Hip Biomechanics ,vol. 26, pp18- 29, 8Aug 2010.
[3] Damien P. Byrne, Kevin J. Mulhall and Joseph F. Baker, Anatomy & Biomechanics of the Hip, vol.4 march 2010, pp 51-57.
[4] C. T. Seng, Y.Y Tsou, Knee and Ankle Ligaments: Magnetic Resonance Imaging Findings of Normal Anatomy and at Injury, 2008, vol.37 pp 324-329.
[5] M.Gerald, J James. Irrgang, P.Dave, Biomechanical considerations for rehabilitation of the knee,vol.15, 1999,pp 160-166
[6] Y E. Albert., A. S. Ahmed, The Design, Development and Construction of an Adjustable Lower Extremity, vol.2 Oct 2012, pp 30-42
[7] P. A. Rodrigo., G.Vincenzo, P. A. Ney, C. P. C. Antônio, M. B Joao, Total Knee Arthroplasty in a Patient With Hoffa Fracture Pseudarthrosis - Case Report, March 2011, pp 460-463.
[8] S. S. Sathappan, J. Wee, D. Ginat, M. Teicher, P. Meere, Paul E. Di Cesare, Total Hip Arthroplasty in Patients With Above-Knee Amputation: A Case Report, feb.2011,pp 17-19
[9] S. C. Tham, I. YY. Tsou, *Knee and Ankle Ligaments: Magnetic Resonance Imaging Findings of Normal Anatomy and at Injury,*2008, vol.37 pp 324-329.
[10] R. Tillman, S. Kalra, R. Grimer,S. Carter, A. Abudu, A custom-made prosthesis attached to an existing femoral component for the treatment of peri- and sub- prosthetic fracture, Vol. 88-B, Oct 2006, pp 1299-1302.
[11] J. Patel, M.Bansal, D. Arya, C.D Mehta., A Study of Anatomical Parameters of Hip Joint In Cadavers and Its Clinical Importance,Vol.2 Aug 2013,pp 44-50.
[12] P. Raos, A. Stoic, An approach in manufacturing of medical implant. ESAFORM conference,Cluj-Napoca,Romania, 2005,pp-683-686.
[13] F.A. Rodríguez-González, Biomaterials in Orthopaedic Surgery, ASM International Publisher, first edition, 2009, pp. 1-7.
[14] F.T. Arthur, M. M. Zhang, D. A. Boone, State-of-the-art research in lower-limb prosthetic biomechanics socket interface: A review, vol.38 no.2, April 2001, pp 161-174.
[15] J. Denis, M.Little, Custom Prostheses, North Carolina State University, Raleigh, North Carolina, pp 430-434.
[16] M. S. A.Elkhair, M. E. AboElnor, A. E. Radi, *Computer Aided Engineering (CAE) Techniques Applied To Hip Implant,* Vol.3 issue 3 ,March 2013,pp 219-225.
[17] M. Neale, R .Thomas, H.Bateman, & D. Hynd, A Finite Element Modelling Investigation of Lower Leg Injuries, TRL Limited, 2012, 07-0077.
[18] A. M. Kiapour, V. Kaul, A. Kiapour, C. E. Quatman, S. C. Wordeman, T. E. Hewett, C. K. Demetropoulos, V.K. Goel, The Effect of Ligament Modeling Technique on Knee Joint Kinematics: A Finite Element Study, April 2013, pp 91-97.
[19] S. Ganapathi, S. T. Premkumar, T. Malaikannu, K. Anandan, Musculoskeletal Modeling of Hip Joint and Fracture Analysis for Surgical Planning Using FEA, Volume 9 Issue 2, (2013), pp27-36.
[20] *N. N. Ashutosh., P.K.S. Nain, P. Kumar, Study of Knee-Joint Mechanism before Implanting a Knee Prosthesis by Modeling and Finite Element Analysis of Knee-Joint Bones,*Vol.4 No.7 ,2014,pp 721-727.
[21] *J. Shin, D. Lee, Sungki Kim, D.Jeong, H. G. Lee1, And Junseok Kim1y, The Effects of Mesh Style on The Finite Element Analysis for Artificial Hip Joints,* Vol.15,No.1, March 2011,pp 57-65.
[22] S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
[23] J. Breckling, Ed., *The Analysis of Directional Time Series: Applications to Wind Speed and Direction*, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.

ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

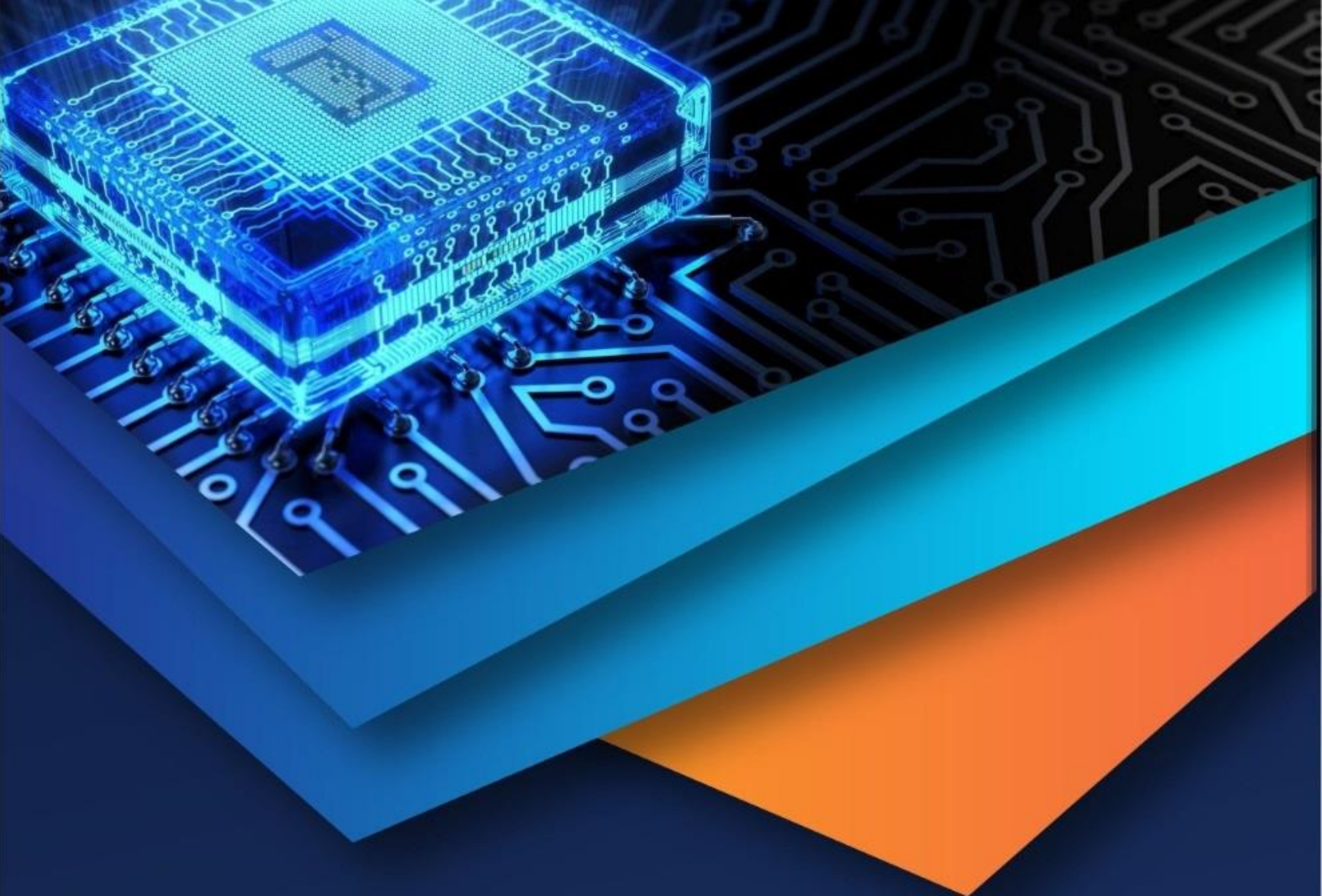
[24] S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.

[25] M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, "High resolution fiber distributed measurements with coherent OFDR," in *Proc. ECOC'00*, 2000, paper 11.3.4, p. 109.

[26] R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, "High-speed digital-to-RF converter," U.S. Patent 5 668 842, Sept. 16, 1997.

[27] (2002) The IEEE website. [Online]. Available: http://www.ieee.org/

[28] M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY