1. **Mitsugu Todo. (2018)**, in “Biomechanical Analysis of Hip Joint Arthroplasties using CT-Image Based Finite Element Method”. In the present study, medical CT images were utilized to develop 3D-computational models of hip joints and femoral bones. The finite element analysis was then performed to characterize the biomechanical problems associated with the bone models. The FEA results clearly exhibited dramatic changes of stress and SED profiles due to osteoarthritis and hip arthroplasty. Furthermore, a damage modelling was also introduced into the FEA to characterize the fracture problems of femoral bone with prostheses under a downstairs step and sideways fall conditions. Micro-damage formations are well predicted in the vicinity of the prostheses for bone cases. It is thus confirmed that CT-FEA can be very useful to understand the biomechanical problems in the field of orthopaedics.

2. **Jana R. Montgomery, et. al. (2018)**, in article “The contributions of ankle, knee and hip joint work to individual leg work change during uphill and downhill walking over a range of speeds”, The muscles surrounding the ankle, knee and hip joints provide 42, 16 and 42%, respectively, of the total leg positive power required to walk on level ground at various speeds. However, each joint’s contribution to leg work when walking up/downhill at a range of speeds is not known. Determining each biological joint’s contribution to leg work over a range of speeds and slopes can inform the design of biomimetic assistive devices (i.e. prostheses). The ankle significantly contributes to walking on slopes and this contribution changes during sloped compared with level-ground walking, thus assistive devices that provide biomimetic ankle function must adapt to accommodate walking at different speeds and slopes; whereas assistive biomimetic devices for the knee only need to adapt at different speeds.

3. **Derek J. Rutherford, et. al. (2018)**, in “Differences in Hip Joint Biomechanics and Muscle Activation in Individuals With Femoroacetabular Impingement Compared With Healthy, Asymptomatic Individuals”, Femoroacetabular impingement (FAI) is a recognized cause of hip and groin pain and a significant factor in hip joint function during sport. Objective tests for understanding hip function are lacking in this population. To determine whether biomechanical and electromyographic features of hip function during level-ground walking differ between a group diagnosed with FAI and those with
no symptoms of FAI. Individuals with FAI were generally deconditioned and reported significantly more functional limitations. No biomechanical differences existed between groups during level walking, yet hamstring and gluteus maximus activation differed when the symptomatic group was compared with the asymptomatic group. Clinical Relevance: The field lacks objective testing of hip joint function to understand implications of FAI for dynamic movements, particularly with applications to biomechanics and electromyography. Level walking was of limited value for understanding FAI hip function, and the development of a more challenging gait assessment is warranted

4. Ana Maria Bumbea, et. al. (2017), in “New and old theories in hip biomechanics”, Knowledge of kinematics, the physiological load bearing during statics and dynamics, and all forces that act on the hip joint have been and still are a major challenge even today, and this subject was also the purpose of the authors’ study. The authors suggest that through this work the qualitative analysis of the movement, patterns and motion geometry, forces and anatomy of the movement should be encouraged. The aim of this paper was to draw an up-to-date picture of the normal anatomical and biomechanical knowledge of the hip.

5. Monan Wang, et. al. (2017), “A novel modelling and simulation method of hip joint surface contact stress”, Understanding the hip joint surface contact stress distribution characteristics is helpful to determine hip joint biomechanical features and abnormal pathological behavior. Firstly, a 3dimensional static hip joint biomechanical model is built using analytical method of model in order to study biomechanical properties including bearing area, stress distribution and the peak value of the contact stress of the femoral head, which reveals the relationship between the biomechanical properties and its geometric parameters. Secondly, based on the finite element analysis of the hip joint model, the contact stress distribution on the surface of femoral head is acquired under the condition of the different joint force and the acetabulum coverage rate. Finally, according to the evaluation of the femoral head surface stress and contact stress peak under different load distribution, accuracy and universality of the biomechanical model is verified.

6. Jakub Gryka, (2017), in “Hip Joint And Hip Endoprosthesis Biomechanics”, This article contains a description of the basic issues related to anatomy, loading of hip joint and its endoprosthesis research methods. The methods of testing and simulating hip joint
loads, factors that influence the selection of parameters during the design of prostheses, typical solutions to engineering problems related to this topic are presented. The article concludes with short summary of the finite element method for the design of hip replacements.

7. **W.A. Siswanto, et. al. (2016)**, in “Computational Modelling and Movement Analysis of Hip Joint with Muscles”, In this study, the model of hip joint and the main muscles are modelled by finite elements. The parts included in the model are hip joint, hemi pelvis, gluteus maximus, quadratus femoris and gamellus inferior. The materials that used in these model are isotropic elastic, Mooney Rivlin and Neo-hookean. The hip resultant force of the normal gait and stair climbing are applied on the model of hip joint. The responses of displacement, stress and strain of the muscles are then recorded. FEBio non-linear solver for biomechanics is employed to conduct the simulation of the model of hip joint with muscles. The contact interfaces that used in this model are sliding contact and tied contact.

8. **Richard J. et. al. (2016)**, in “In vitro hip testing in the International Society of Biomechanics coordinate system”, Many innovative experiments are designed to answer research questions about hip biomechanics, however many fail to define a coordinate system. This makes comparisons between studies unreliable and is an unnecessary hurdle in extrapolating experimental results to clinical reality. The aim of this study was to present a specimen mounting protocol which aligns and registers hip specimens in the International Society of Biomechanics (ISB) coordinate system, which is defined by bony landmarks that are identified by palpation of the patient's body. Engineering drawings are provided to allow others to replicate the simple fixtures used in the protocol.

9. **Lunn, DE, et. al. (2016)**, in “Basic Biomechanics of the Hip”, The basic mechanical principles which govern how the hip joint maintains equilibrium and balance during standing and performing activities is explained along with the consequences when this balanced system is compromised. A description of the movements and forces acting around the hip joint that are expected during activities of daily living is offered and also how these movements are affected following total hip replacement, with particular reference to femoral offset and leg length inequality.
10. **Ng KCG, et. al. (2016)**, in “Hip Joint Stresses Due to Cam-Type Femoroacetabular Impingement: A Systematic Review of Finite Element Simulations”. The cam deformity causes the anterosuperior femoral head to obstruct with the acetabulum, resulting in femoroacetabular impingement (FAI) and elevated risks of early osteoarthritis. Several finite element models have simulated adverse loading conditions due to cam FAI, to better understand the relationship between mechanical stresses and cartilage degeneration. Our purpose was to conduct a systematic review and examine the previous finite element models and simulations that examined hip joint stresses due to cam FAI.

11. **K. Colic, et. al. (2016)**, in “The current approach to research and design of the artificial hip prosthesis: a review”, One of the most successful techniques in restoration of degenerated joint functions is total hip replacement. This surgical approach includes removal of diseased cartilage and bone parts, and replacement by the corresponding joint prostheses. By using metal alloys, high quality plastic and polymer materials, orthopaedic surgeons can reconstruct hip fractures, or replace a painful, dysfunctional joint with highly functional, long-lasting prostheses, enabling hundreds of thousands of people to live a more fulfilling and active life. However, most of these implants only last for 10-15 years, and one of the most common problems for both patients and doctors is implant failure. Observed in long-term, implant loosening is the main cause of failure. Occasionally, dislocation or bending of implants may occur. Fatigue fracture and wear were identified as the main problems related to loosening of implants, stress shielding, and final implant failure. This paper presents a review study of factors influencing design process and structural integrity of the hip implant.

12. **Reiko Hara, et. al. (2016)**, in “Predicting the location of the hip joint centres, impact of age group and sex”, Clinical gait analysis incorporating three-dimensional motion analysis plays a key role in planning surgical treatments in people with gait disability. The position of the Hip Joint Centre (HJC) within the pelvis is thus critical to ensure accurate data interpretation. The position of the HJC is determined from regression equations based on anthropometric measurements derived from relatively small datasets. We propose a range of new regression equations, derived from the largest dataset collected for this purpose to date.
13. **Raffaella Aversa , et. al. (2016)**, in “Biofidel FEA Modeling of Customized Hybrid Biological Hip Joint Prostheses, Part I: Biomechanical Behavior of Implanted Femur”, Biofidel femur Finite Element Models have been developed using specific combination of Computer Tomography segmentation and solid modeling software tools able to represent bone physiology and structural behavior. These biofidel Finite Element Models (FEM) is used to evaluate the modification of the physiological stress distribution in a prosthesis femur and to assess new design criteria for the development of biomimetic hybrid biological hip prostheses. The faithful models proposed allowed us to properly consider the not isotropic characteristics of the proximal epiphysis of the femur and for the isotropic behavior in diaphysis to explain the critical alterations of the stress distribution in a resected femur following the implantation of a traditional hip joint prostheses. It has been shown that a wide region of the femur diaphysis is completely shielded by the rigid prosthesis significantly altering the physiological stress distribution that should guaranty a healthy bone growth and regeneration.

14. **Sandeep Kumar Parashar and Jai Kumar Sharma, (2016)**, in“A review on application of finite element modeling in bone biomechanics”, In the past few decades the finite element modeling has been developed as an effective tool for modeling and simulation of the biomedical engineering system. Finite element modelling (FEM) is a computational technique which can be used to solve the biomedical engineering problems based on the theories of continuum mechanics. This paper presents the state of art review on finite element modeling application in the four areas of bone biomechanics i.e. analysis of stress and strain, determination of mechanical properties, fracture fixation design (implants), and fracture load prediction. The aim of this review is to provide a comprehensive detail about the development in the area of application of FEM in bone biomechanics during the last decades. It will help the researchers and the clinicians alike for the better treatment of patients and future development of new fixation designs.

15. **Hans Kainz Christopher P. et. al. (2015)**, in “Estimation of the hip joint centre in human motion analysis: A systematic review”, Inaccuracies in locating the three-dimensional position of the hip joint centre affect the calculated hip and knee kinematics, force- and moment-generating capacity of muscles and hip joint mechanics, which can lead to incorrect interpretations and recommendations in gait analysis. Several functional
and predictive methods have been developed to estimate the hip joint centre location, and
the International Society of Biomechanics recommends a functional approach for use
with participants that have adequate range of motion at the hip, and predictive methods in
those with insufficient range of motion. The purpose of the current systematic review was
to substantiate the International Society of Biomechanics recommendations. This
included identifying the most accurate functional and predictive methods, and defining
‘adequate’ range of motion.

with and without symptomatic femoroacetabular impingement”, Femoroacetabular
impingement (FAI) is a morphological hip condition that can cause hip/groin pain and
impaired function in younger active adults, and may lead to stiffness, muscle weakness,
structural damage, and hip osteoarthritis. Understanding the impairments associated with
FAI is crucial to guide treatment and rehabilitation strategies. Evidence is limited and
conflicting about whether hip biomechanics are impaired during walking in people with
symptomatic FAI. The objective of this study was to determine whether kinematics and
kinetics during gait differ between people with symptomatic FAI and control
participants. More pronounced deficits in hip kinetics and kinematics may be evident
during functional tasks that challenge the hip towards the position of impingement.

17. **Karl E. Zelik** et. al. (2015), in “Six degree-of-freedom analysis of hip, knee, ankle and
foot provides updated understanding of biomechanical work during human walking”,
Measuring biomechanical work performed by humans and other animals is critical for
understanding muscle–tendon function, joint-specific contributions and energy-saving
mechanisms during locomotion. Inverse dynamics is often employed to estimate
joint-level contributions, and deformable body estimates can be used to study work
performed by the foot. We recently discovered that these commonly used experimental
estimates fail to explain whole-body energy changes observed during human walking. By
re-analyzing previously published data, we found that about 25% (8 J) of total positive
energy changes of/about the body’s center-of-mass and >30% of the energy changes
during the Push-off phase of walking were not explained by conventional joint- and
segment-level work estimates, exposing a gap in our fundamental understanding of work
production during gait. Here, we present a novel Energy-Accounting analysis that
integrates various empirical measures of work and energy to elucidate the source of unexplained biomechanical work. We discovered that by extending conventional 3 degree-of-freedom (DOF) inverse dynamics (estimating rotational work about joints) to 6DOF (rotational and translational) analysis of the hip, knee, ankle and foot, we could fully explain the missing positive work. This revealed that Push-off work performed about the hip may be 50% greater than conventionally estimated.

18. **Syed Zameer and Mohamed Haneef, (2015)**, in “Fatigue Life estimation of Artificial Hip joint model using Finite Element Method”, The loads acts on the hip joint are repetitive and fluctuating depending on the various activities, which may leads to failure of Hip joint. In this study analysis of Hip joint model was carried out using finite element software Ansys. Stress distribution obtained from result of static analysis and material properties of fabricated UHMWPE/50 wt% short E glass fibres+40 wt% TiO2 Polymer matrix composites specimens, were used to estimate fatigue life of Hip joint model. Factor of safety calculated from linear Palmgren linear damage rule is less than one, which indicates the component is safe under design.

19. **Mohammad Hodaei, et.al. (2014)**, in “A Contact Model for Establishment of Hip Joint Implant Wear Metrics”, Wear is an important issue in hip implants. Excessive wear can lead to toxicity and other implant associated medical issues such as patient discomfort and decreased mobility. Since implant wear is the result of contact between surfaces of femoral head and acetabulum implant, it is important to establish a model that can address implant surface roughness interaction. A statistical contact model is developed for the interaction of femoral head and acetabulum implant in which surface roughness effects are included. The model accounts for the elastic-plastic interaction of the implant surface roughness. For this purpose femoral head and Acetabulum implants are considered as macroscopically spherical surfaces containing micron-scale roughness. Approximate equations are obtained that relate the contact force to the mean surface separation explicitly. Closed form equations are obtained for hysteretic energy loss in implant using the approximate equations.

20. **Bhaskar Kumar Madeti and Ch.Srinivasa Rao, (2014)**, in “Biomechanics of hip joint: review. The purpose of the present paper is to provide an overview of the current biological and biomechanical knowledge on the hip. Various model formulations by
researchers are discussed. Hip geometry is one of the crucial parts of human body movement. Researching on how various views of the hip is shown in different planes and how the forces act on the femur leads to learning of the various forces and torques acting on the hip joint. Hip anatomy, musculoskeletal model and FEA models are shown, forces acting on hip shown by various researchers are discussed and experimental studies are made. In addition, joint kinematics of the hip is also discussed to some extent.

21. **Eko Saputra, et. al. (2013)**, in “Finite Element Analysis of Artificial Hip Joint Movement during Human Activities”, The range of motion of artificial hip joint during human activities, measured from the postoperative total hip arthroplasty patients, has been reported previously. A three-dimensional nonlinear finite element (FE) method was used in the simulation. The acetabular liner cup positions were varied. Results show that in the Western-style activities, the picking up activity induces prosthetic impingement in a certain acetabular liner cup position, whereas in the Japanese-style activities there is no prosthetic impingement observed. However, the Japanese’s Zarei activity has a critical value in the range of motion. The von Mises stresses during the prosthetic impingement have been shown and the value is higher than the yield stress of the material.

22. **Michael Morlock, et. al. (2011)**, in “Biomechanics of Hip Arthroplasty”. The biomechanics of the hip joint has been of great interest to researchers and clinicians since the early days of anatomical studies. Julius Wolff addressed the relation between the inner architecture of the bone and the functional loading already in the nineteenth century [31] and Friedrich Pauwels built the foundation for a mechanical approach to understand joint loading 65 years later [24]. Both researchers, despite dealing with very different questions (bone remodeling vs. fracture mechanics), are good examples for the spread of the biomechanics field. The varus and valgus situation as well as the hip joint center are determined by the position of the implant in the pelvis and femur. This positioning also influences the local loading situation at the implant component bone interface. For example, a slightly superior, posterior, and medial hip joint center after replacement can be associated with markedly higher joint forces.

23. **Jerome Thevenot and Juvenes Printtampere, (2011)**, in “Biomechanical Assessment of Hip Fracture Development of Finite Element Models To Predict Fractures”, Hip fracture is the most severe complication of osteoporosis. The occurrence of hip fracture is
increasing worldwide as a result of the ageing of the population. The clinical assessment of osteoporosis and to some extent hip fracture risk is based on the measurement of bone mineral density (BMD) using dual X-ray absorptiometry (DXA). However, it has been demonstrated that most hip fractures occurring after a fall involve non-osteoporotic populations and that the geometry plays a critical role in the fracture risk assessment. Finally, a new method to generate patient-specific volumetric finite element models automatically from a standard radiographic picture was developed. Preliminary results in the prediction of failure load and fracture type were promising when compared to experimental fractures.

24. Karl F. Bowman, et. al. (2010), in “A Clinically Relevant Review of Hip Biomechanics”, 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

25. Donald A. Neumann PT et. al. (2010), in “Kinesiology of the Hip: A Focus on Muscular Actions”, the hip joint serves as a central pivot point for the body as a whole. This large ball-and-socket joint allows simultaneous, triplanar movements of the femur relative to the pelvis, as well as the trunk and pelvis relative to the femur. Lifting the foot off the ground, reaching towards the floor, or rapidly rotating the trunk and pelvis while supporting the body over one limb typically demands strong and specific activation of the hips’ surrounding musculature. The discussion of muscle action will be organized according to the 3 cardinal planes of motion of the hip: sagittal, horizontal, and frontal. For each plane of motion, a muscle’s action is based primarily on the orientation of its line of force relative to the joint’s axis of rotation.

26. Damien P. Byrne, et. al. (2010), in “Anatomy & Biomechanics of the Hip”, The hip joint is unique anatomically, physiologically, and developmentally; therefore understanding the basic structure and biomechanics of the hip is essential for clinicians, physiotherapists and engineers alike. In this review we outline the function of the key anatomical components of the hip and discuss the relevant related biomechanical issues.
Understanding the forces that cross the hip and the details of the anatomy leads to a better understanding of some of the failures of the past and gives credence to current and future solutions.

27. **T. Achour, et. al, (2010)**, in “Finite element analysis of interfacial crack behaviour in cemented total hip arthroplasty”, In this study, the finite element is used to analyze the fracture behaviour of the cement of the femoral part in the total hip prosthesis. This one is articulated around two phases. The first consists of analyzing the propagation of the cement/bone interfacial cracks in the cement. The obtained results show that the presence of interfacial crack (cement/bone) in the distal and medial zones can be propagated by opening and shearing; it can provoke a risk of brutal failure. In the proximal zone, the risk of crack propagation is less important compared to the other zones of the outside part of the total hip prosthesis. In the second phase, the propagation of the cement/stem interfacial cracks is analyzed, the obtained results prove that the interfacial crack (cement/stem) can propagate greatly by shearing mode (mode II).

28. **Carolina Dopico-Gonzalez, et. al. (2009)**, in “Probabilistic finite element analysis of the uncemented hip replacement-effect of femur characteristics and implant design geometry”, In the present study, a probabilistic finite element tool was assessed using an uncemented total hip replacement model. Fully bonded and frictional interfaces were investigated for combinations of three proximal femurs and two implant designs, the Proxima short stem and the IPS hip stem prostheses. The Monte Carlo method was used with two performance indicators: the percentage of bone volume that exceeded specified strain limits and the maximum nodal micromotion. Values of maximum nodal micromotion agreed with results from previous studies, confirming the robustness of the implemented computational tool. It was demonstrated that results from a single model study should not be generalised to the entire population of femurs and that bone variability is an important factor that should be investigated in such analyses.

29. **Robert L. et. al.,** in “Recent developments in canine locomotor analysis: A review”, Subjective evaluation of canine gait has been used for many years. However, our ability to perceive minute details during the gait cycle can be difficult and in some respects impossible even for the most talented gait specialist. The evolution of computer technology in computer assisted gait analysis over the past 20 years has improved the
ability to quantitatively define temporospatial gait characteristics. These technological advances and new developments in methodological approaches have assisted researchers and clinicians in gaining a better understanding of canine locomotion. The use of kinematic and kinetic analysis has been validated as a useful tool in veterinary medicine. This paper is an overview of the kinematic and kinetic analytical techniques of the last decade.

30. Nicolae Iliescu et. al. (2008) in “Biomechanical changes of hip joint following different types of corrective osteotomy– photoelastic studies.” The paper presents the results of some comparative experimental studies that show the biomechanical changes which appear following different types of corrective osteotomy. The photoelastic technique was applied to plane models. The modifications in the stress distribution on the contour after the osteotomy in comparison with the situation before surgery were studied. Three types of osteotomy are considered: valgus osteotomy, varus osteotomy and Chiari pelvis osteotomy. Using the same experimental technique, the distribution of the contact pressure at the interface between the polyethylene cup and the femoral head is investigated, for a total hip prosthesis, as the extreme solution in the case of advanced hip arthroses. Both a normal situation and the malposition of prosthetic components were analyzed.

31. Kirkwood RN, et. al. (2007) in “Biomechanical analysis of hip and knee joints during gait in elderly subjects.” The objective of this study was to quantify the range of motion, force momentum, power and the mechanical work performed by hip and knee joints during gait in a group of subjects aged between 55 and 75 years. As a common activity of daily life, walking is often prescribed as a therapeutic exercise in elderly adults’ rehabilitation. Kinematic and kinetic analyses during gait were obtained from optical tracking, force plate, standardized x-ray imaging and anthropometric data. The total effort generated by the hip joint during gait was greater than the one of the knee joint. The hip joint generated a total effort of 0.40J/kg, with 22% on the frontal plane, 76% on sagittal plane, and 2% on transverse plane. The total effort generated at the knee joint during gait was 0.30J/kg, with 7% occurring on frontal plane, 90% on sagittal plane, and 3% on transverse plane. The biomechanical analysis of the joints during different activities
would help clinicians to identify and understand important variables required for improving the performance and deficits of elderly individuals.

32. Kurz, Max J. et. al. (2005). in "An artificial neural network that utilizes hip joint actuations to control bifurcations and chaos in a passive dynamic bipedal walking model" Chaos is a central feature of human locomotion and has been suggested to be a window to the control mechanisms of locomotion. In this investigation, we explored how the principles of chaos can be used to control locomotion with a passive dynamic bipedal walking model that has a chaotic gait pattern. Our control scheme was based on the scientific evidence that slight perturbations to the unstable manifolds of points in a chaotic system will promote the transition to new stable behaviours embedded in the rich chaotic attractor. Our simulations provide insight on the advantage of having a chaotic locomotive system and provide evidence as to how chaos can be used as an advantageous control scheme for the nervous system.

33. Xishi Wang, et. al. (2004), in “The Human Hip Stress Analysis: A Ball-Socket Elastic Contact Modelling”, The peak stress, the weight bearing area and the stress distribution of the articular contact at the human hip joint is the most important factors, which determine the location of the degenerative foci that later result in degenerative damage and in the development of osteoarthritis. In the paper, a ball-socket articular elastic contact modelling of the human hip joint is successfully established. This modelling can be used to predict the peak stress, the weight bearing area and the stress distributions of the articular contact at the human hip joint. In order to verify the validation of current modelling, an example is examined. The results show that the predictions from the current modelling are basically agreement with those reported in literatures. This shows the validity of the current modelling.

34. Joao F.Manho, et. al. (2003), in “Bioinert, biodegradable and injectable polymeric matrix composites for hard tissue replacement: state of the art and recent developments”, The present review paper examines the use of different types of polymeric matrix composites in hard tissue replacement applications. The review presents the actual state of the art in the fields of bioinert composites for permanent applications, biodegradable matrix composites for temporary applications and the emerging area of injectable composites. In all cases some recent developments are also discussed. The paper starts with an
introduction to locate the reader. Bone–analogue composites are then extensively discussed. Several other systems based on an inert polymeric matrix are described, focusing on their proposed applications. A great emphasis is afterwards given to biodegradable matrix systems. The most widely used synthetic bioresorbable systems are analysed and compared with an example of natural origin degradable composites–starch based composites. Finally, composite systems that are non-processable by melt based routes and in many cases injectable are discussed in detail, including several recent developments on this emerging area of research.

35. G. Bergmann, et. al. (2001), in “Hip contact forces and gait patterns from routine activities”, In vivo loads acting at the hip joint have so far only been measured in few patients and without detailed documentation of gait data. Such information is required to test and improve wear, strength and fixation stability of hip implants. Measurements of hip contact forces with instrumented implants and synchronous analyses of gait patterns and ground reaction forces were performed in four patients during the most frequent activities of daily living. From the individual data sets an average was calculated. The paper focuses on the loading of the femoral implant component but complete data are additionally stored on an associated compact disc. It contains complete gait and hip contact force data as well as calculated muscle activities during walking and stair climbing and the frequencies of daily activities observed in hip patients.