EGE ÜNİVERSİTESİ
MÜHENDİSLİK FAKÜLTESİ

Yeni Nesil Kişiye Özgü Tıbbi Cihazlar

Mahmut Pekedis, PhD
Mak. Müh. Bölümü

Amaç

Sorun:

•Her hastanın anatomik yapısı farklıdır. Standart implantlar her vakaya tam olarak uymaz.

•Uyumsuzluklar nedeniyle tekrar ameliyatlar, komplikasyonlar ve hasta memnuniyetsizliği

Çözüm:

•Kişiye özel implantlar vücut yapısına biyomekanik açıdan uyumlu çözümler sunar.

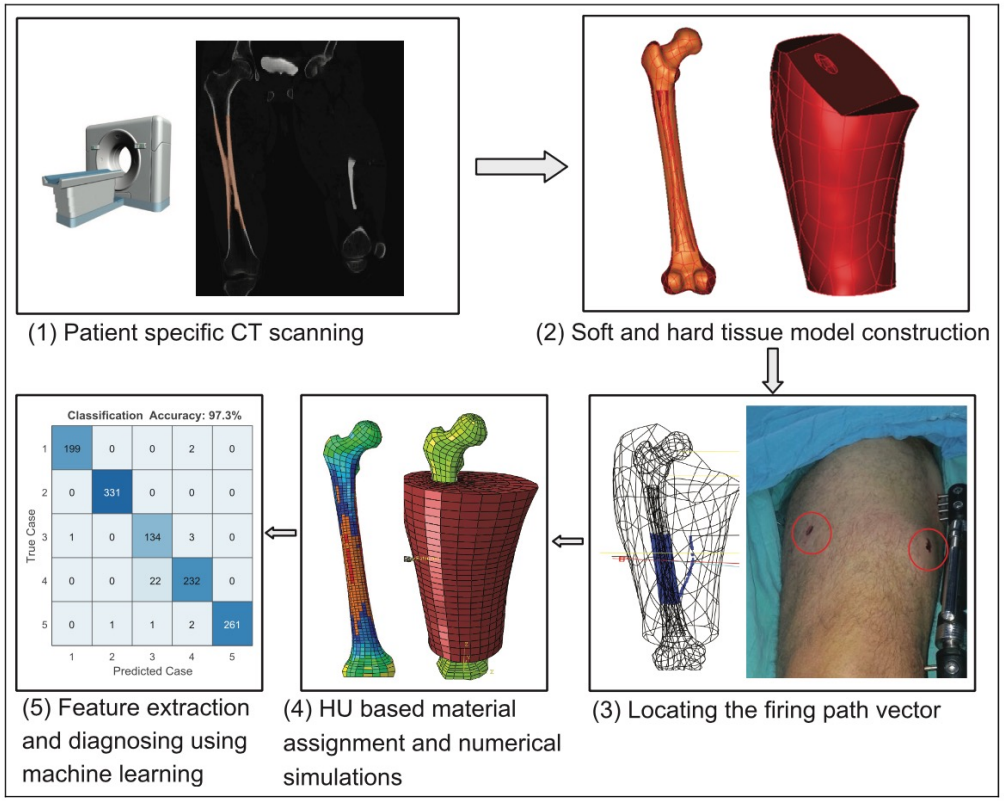
Faydalar:

•Daha hızlı iyileşme

•Daha az cerrahi komplikasyon

•Daha yüksek başarı oranı

Alanlar: Ortopedi, plastik cerrahi, beyin cerrahi, diş hek



Pekedis M., Ozan F. The finite element method-based pattern recognition approach for the classification of patient-specific gunshot injury. Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, 236(5):665–675, 2022. doi:10.1177/09544119221086397

Küresel Pazar

•2024 itibariyle global medikal implant pazarı: **~130 milyar USD**

•Kişiye özgü çözümler bu pazarın en hızlı büyüyen segmenti

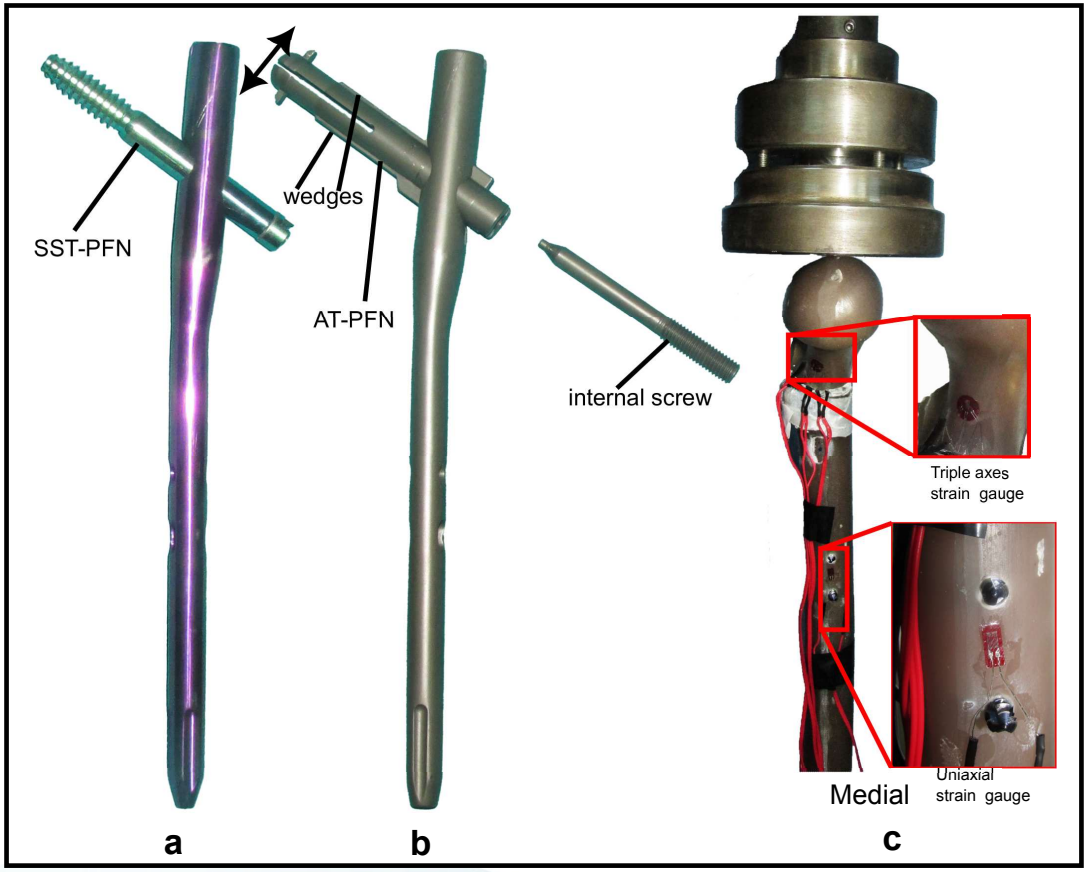
Türkiye İçin Fırsatlar

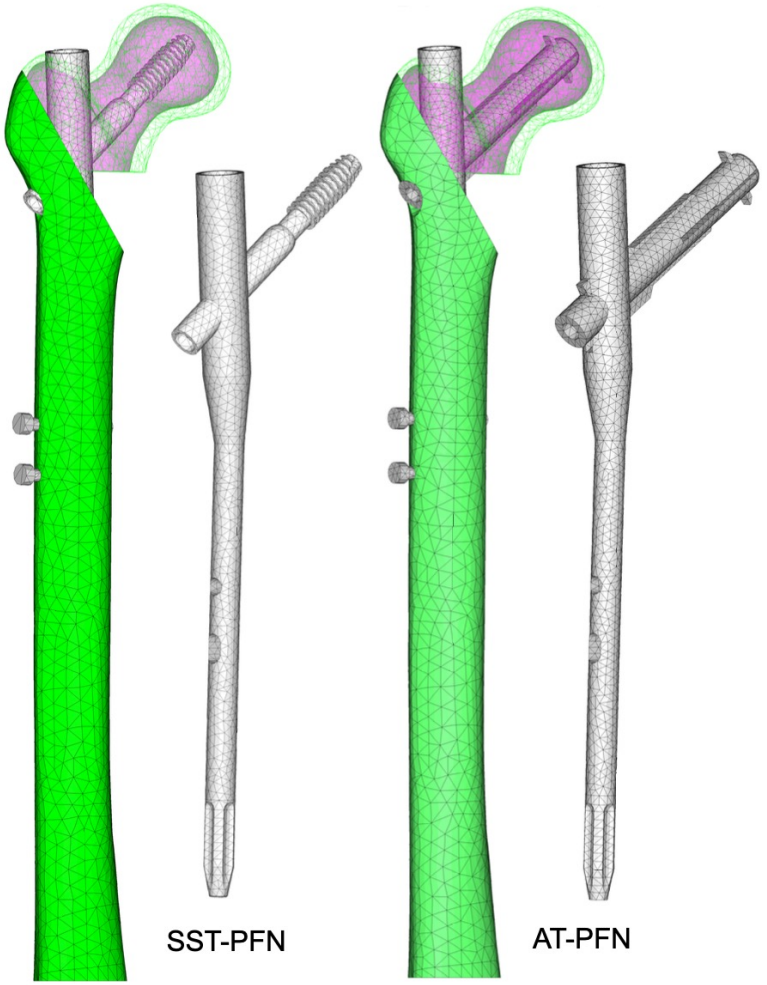
•Tıbbi cihazdaki dışa bağımlılık oranı % 77. Sağlıkta yerlileşme politikaları ile bu oranın azalması.

•Üretim altyapısı güçlü, ama yüksek teknolojiye ihtiyaç var

•Üniversite-sanayi işbirliği için elverişli ortam

1. Yeni Nesil Proksimal Femur Çivisi





Pekedis M., Karaarslan AA., Ozan F., Tahta M., Kayali C. Novel anchor-type proximal femoral nail for the improvement of bone-fixation integrity in treating intertrochanteric fractures: an experimental and computational characteri- zation study. Computer Methods in Biomechanics and Biomedical Engineering, 1-17.2025

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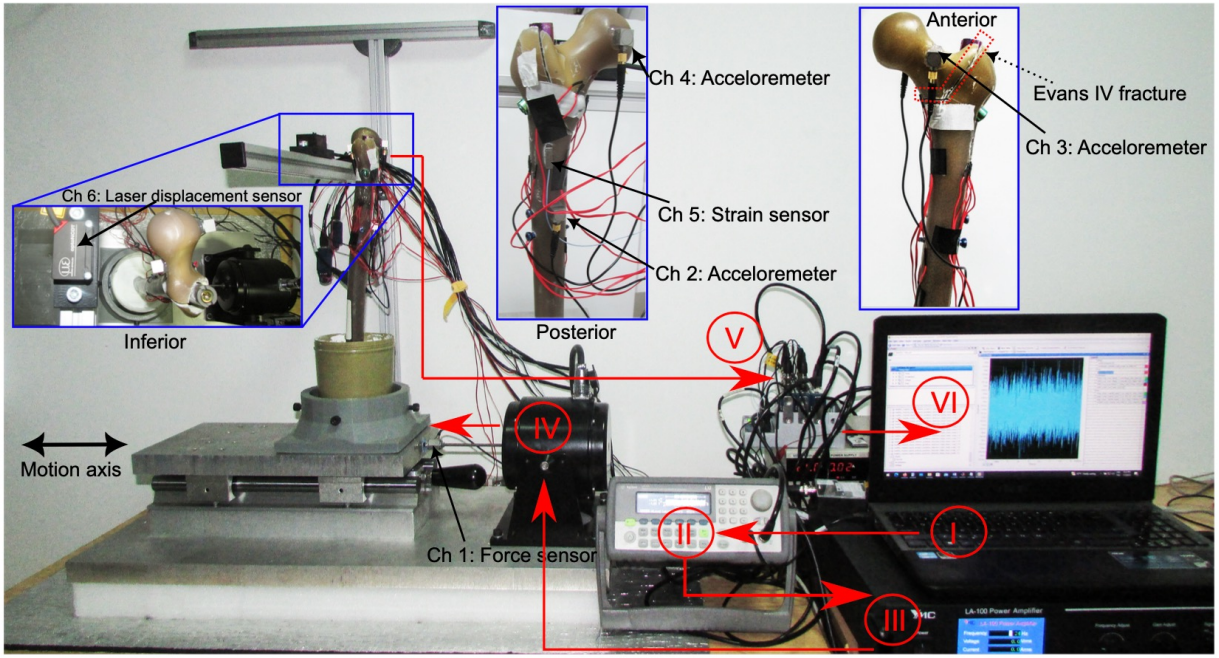

COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING
https://doi.org/10.1080/10255842.2025.2456985

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Novel anchor-type proximal femoral nail for the improvement of bone-fixation integrity in treating intertrochanteric fractures: an experimental and computational characterization study

Mahmut Pekedis[a], Ahmet Adnan Karaarslan[b], Firat Ozan[c], Mesut Tahta[b] and Cemil Kayali[b]

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ABSTRACT

This study introduces a novel anchor-type proximal femoral nail (AT-PFN) to improve the bone-fixation integrity over the standard screw-type nail (SST-PFN). Quasi-static incremental cyclic load test was performed to investigate load-displacement, cumulative deformation energy, time-strain, and backbone curves. The finite element analysis (FEA) was implemented to identify the stress and strain distributions. Additionally, non-destructive dynamic tests were conducted, and the measurements were processed using statistical pattern recognition, based on vector autoregression and principal component analysis to investigate the nonlinearity due to bone-fixation interface. The results demonstrate that the AT-PFN significantly improves the bone-fixation integrity compared to SST-PFN.

Abbreviations: AP: anterior-posterior; AT-FPN: anchor-type proximal femoral nail; AUC: area under curve; FEA: finite element analysis; FPR: false positive rate; FRF: frequency response function; MAS: maximum absolute strain; ML: medial-lateral; PCA: principal component analysis; PFN: proximal femoral nail; post-QSICLT: post-quasi-static incremental cyclic load test; pre-QSICLT: pre-quasi-static incremental cyclic load test; QSICLT: quasi-static incremental cyclic load test; RF: resonance frequency; ROC: receiver operating characteristics; SPR: statistical pattern recognition; SST-PFN: standard screw-type proximal femoral nail; TPR: true positive rate; VAR: vector autoregression

ARTICLE HISTORY
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KEYWORDS
Intertrochanteric fracture; proximal femoral nail; bone-fixation non-linearity; computational methods; statistical pattern recognition

Introduction

Intertrochanteric fractures pose a major concern, with its incidence increasing and comprising half of all hip fractures (Koyuncu et al. 2015; Ceynowa et al. 2020). Advances in medical instrumentation and surgical techniques have enabled surgeons to address complex intertrochanteric fractures more effectively (Hassankhani et al. 2014; Zhang et al. 2018). Although intra/extramedullary fixation has been widely implemented for stabilizing these types of fractures, the complication rates related to instrumentation failures remain high (Boukebous et al. 2018; Yu et al. 2018; Ng et al. 2022). Therefore, the stabilization of intertrochanteric fractures presents distinctive biomechanical and clinical challenges.

There are different PFN designs used in surgery, each with its own complications. Generally, complications related to PFN include screw cut-out, non-union, malunion, screw withdrawal, Z-effect, reversed Z-effect, iliotibial tract irritation, and shortening of the femur (Lee et al. 2007; Koyuncu et al. 2015; Caruso et al. 2017; Morvan et al. 2018). Although effective implant designs are crucial in reducing complication rates, there is no consensus on the ideal PFN type (Lee et al. 2007; Koyuncu et al. 2015). The instrumental improvements in proximal femur devices have focused on enhancing the load resistance of bone fixation by modifying the surface geometry of the nail, such as incorporating a lag screw, helical blade, or two parallel screw systems (Rog et al. 2017; Ceynowa et al. 2020; Ng et al. 2022). The interfacial shear and normal stresses, which are significant parameters exhibiting bone-fixation integrity, are passive in lag screw or helical blade configurations and cannot easily be controlled by surgeons during surgery.

The femoral hip fractures influence the biomechanical integrity of the femur, potentially causing instability (Cegoñino et al. 2004; Esposito et al. 2018;

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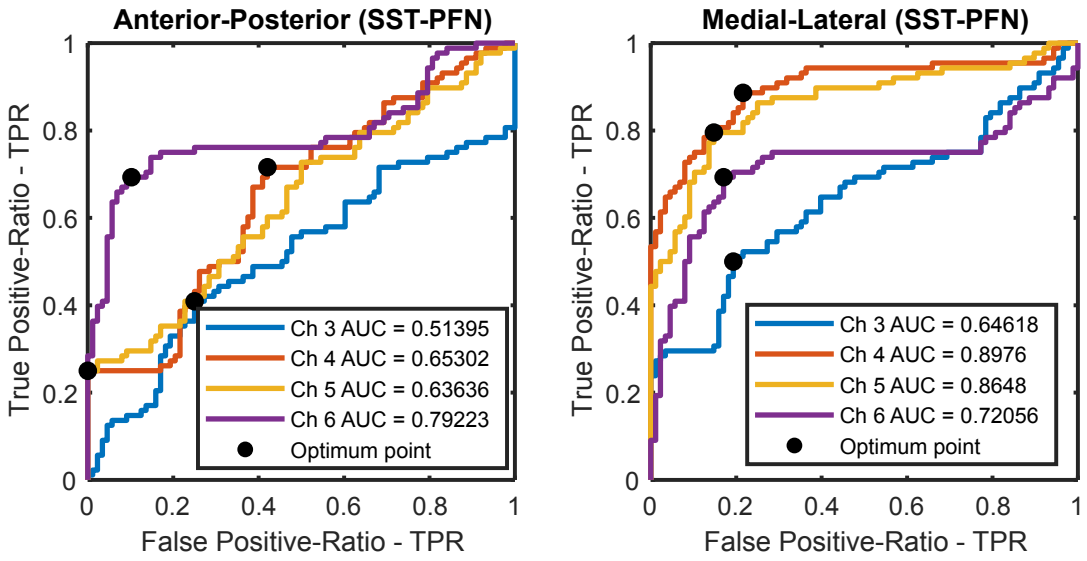

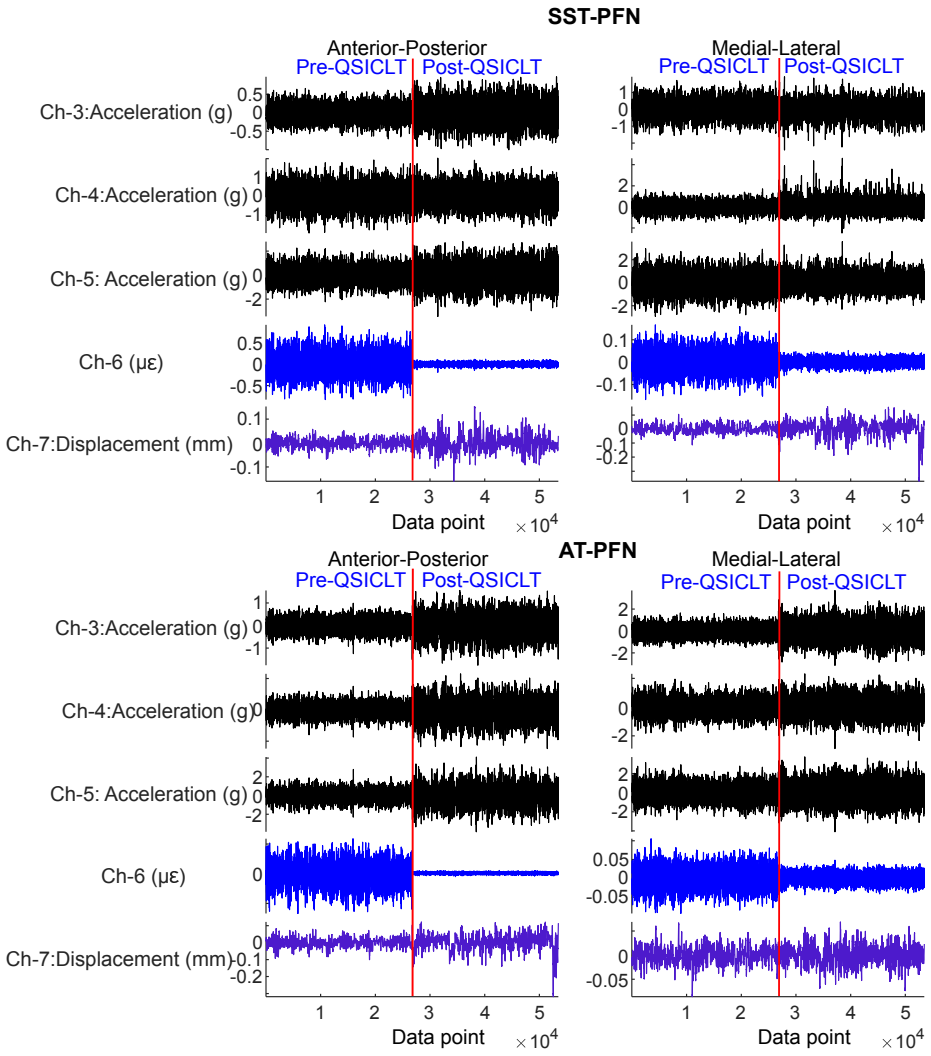

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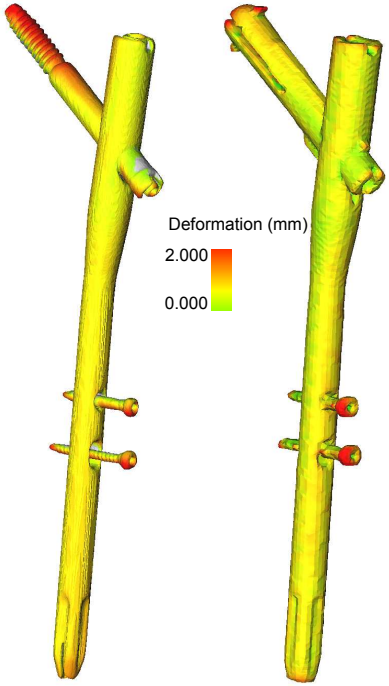

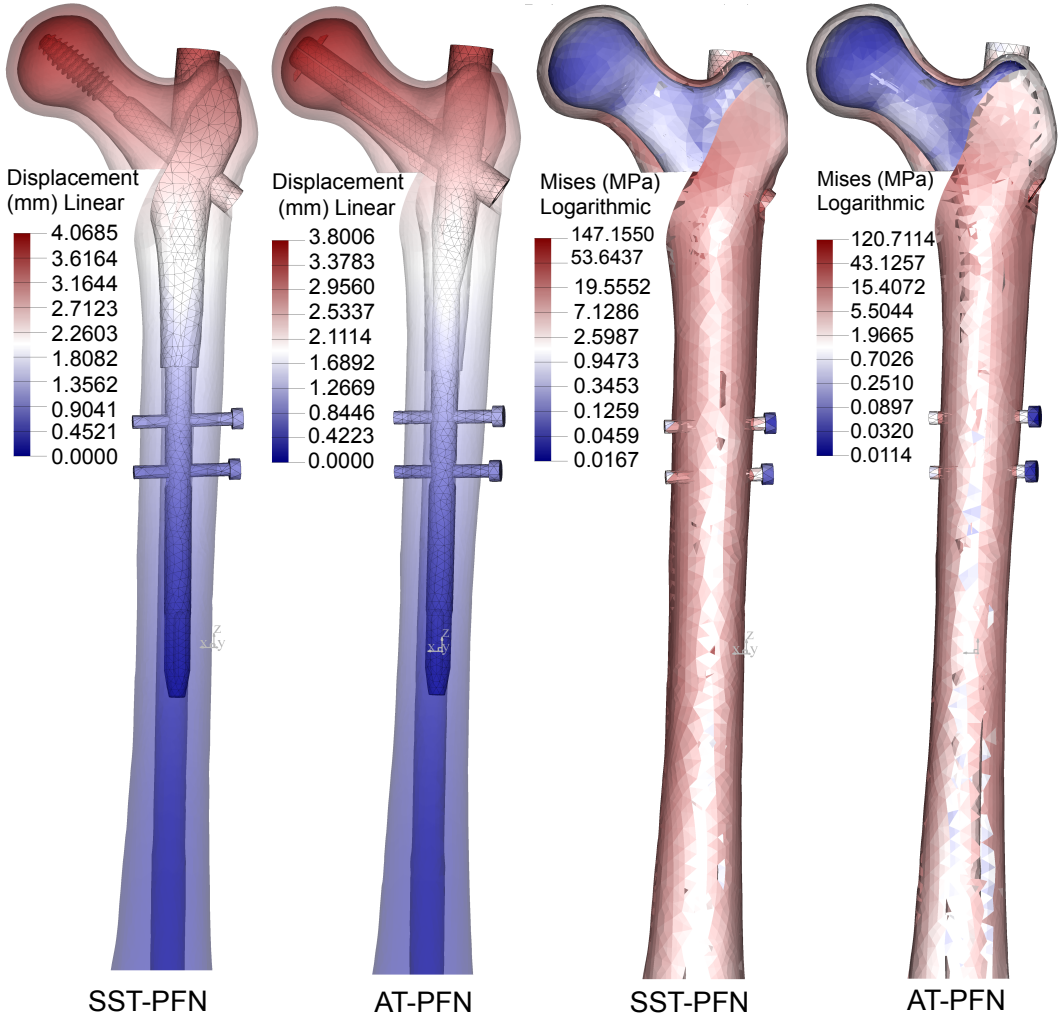

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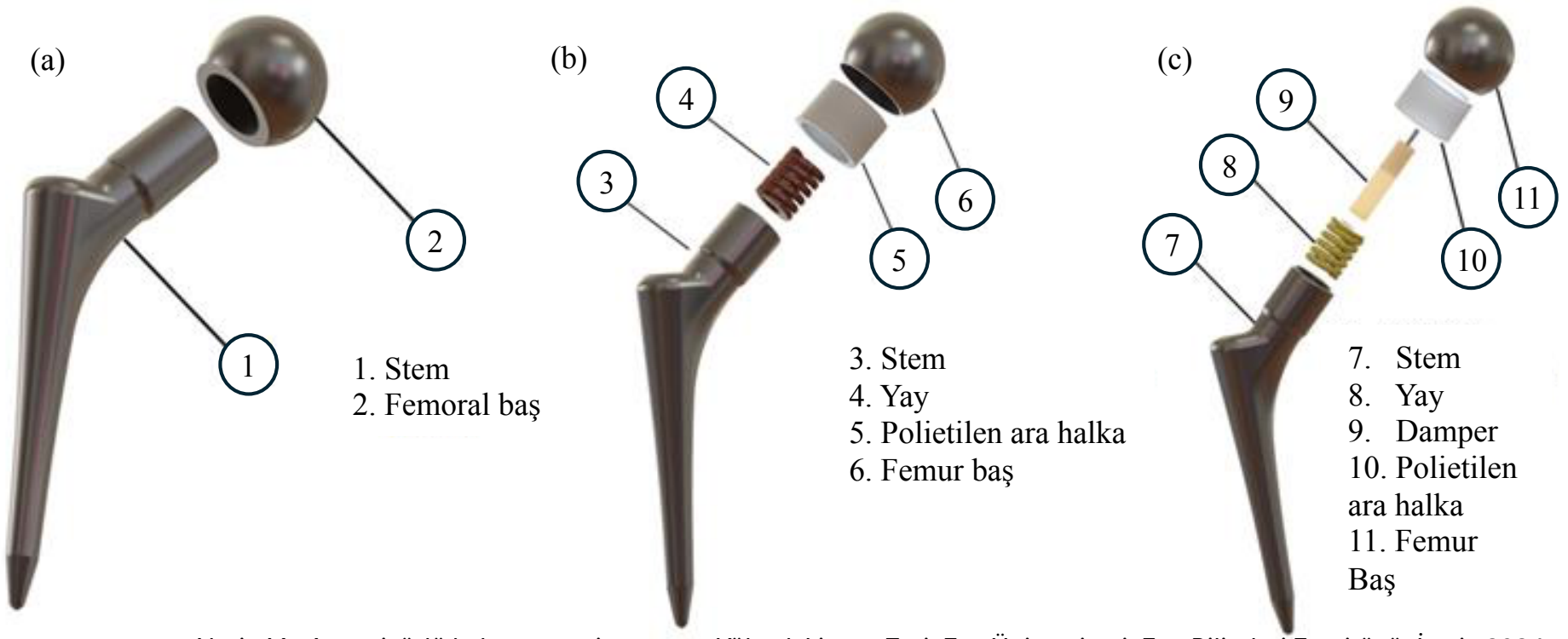
2. Amortisörlü Kalça Protezi



Narin M., Amortisörlü kalça protezi tasarımı, Yüksek Lisans Tezi, Ege Üniversitesi, Fen Bilimleri Enstitüsü. İzmir, 2024.

Narin M., Pekedis M., Hip Prosthesis Design with a Shock Absorber, J. Gazi Journal of Engineering Sciences, Submitted, 2025.

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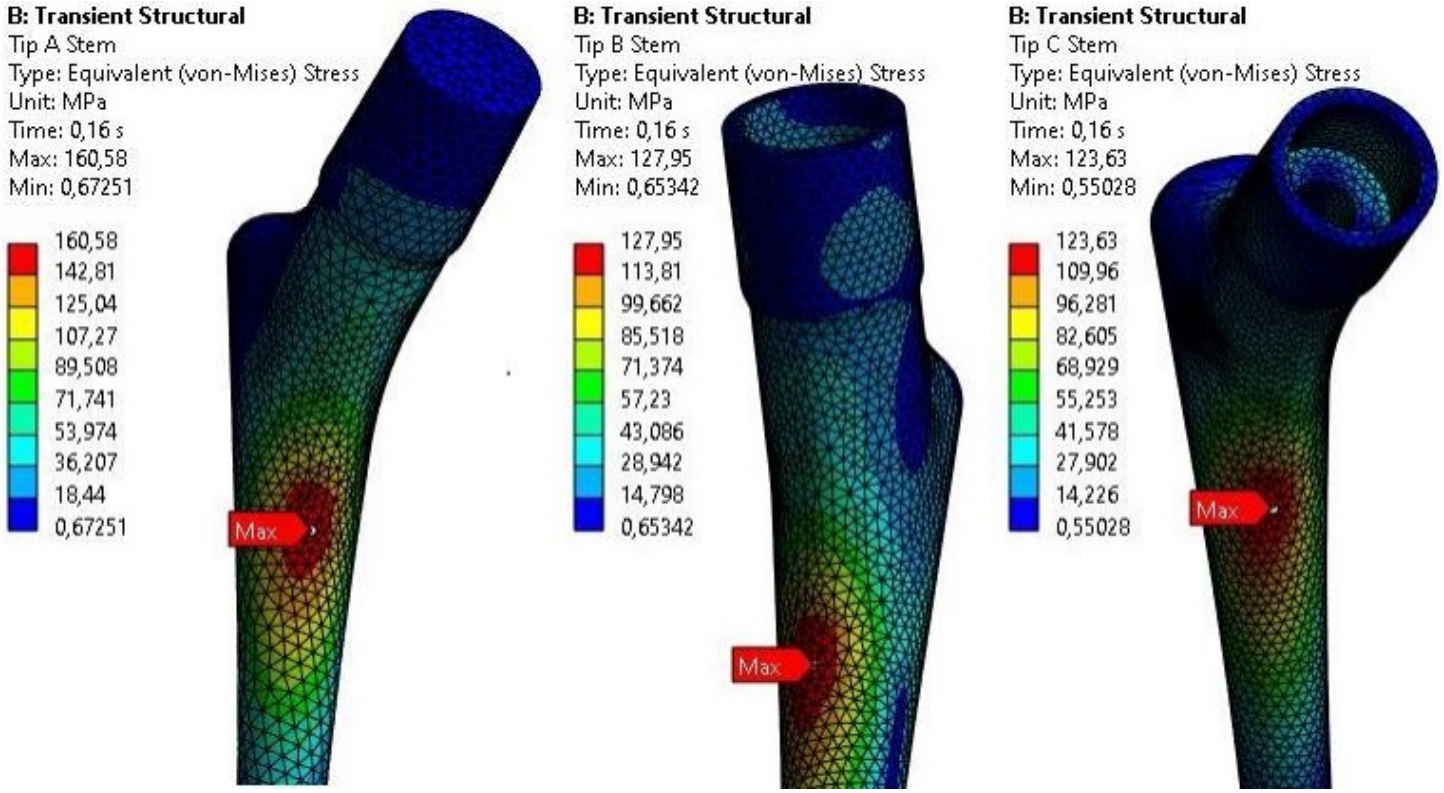

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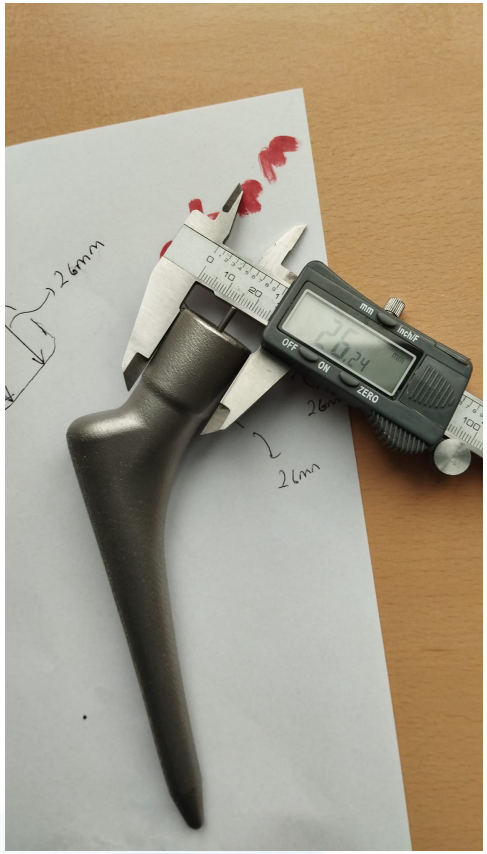

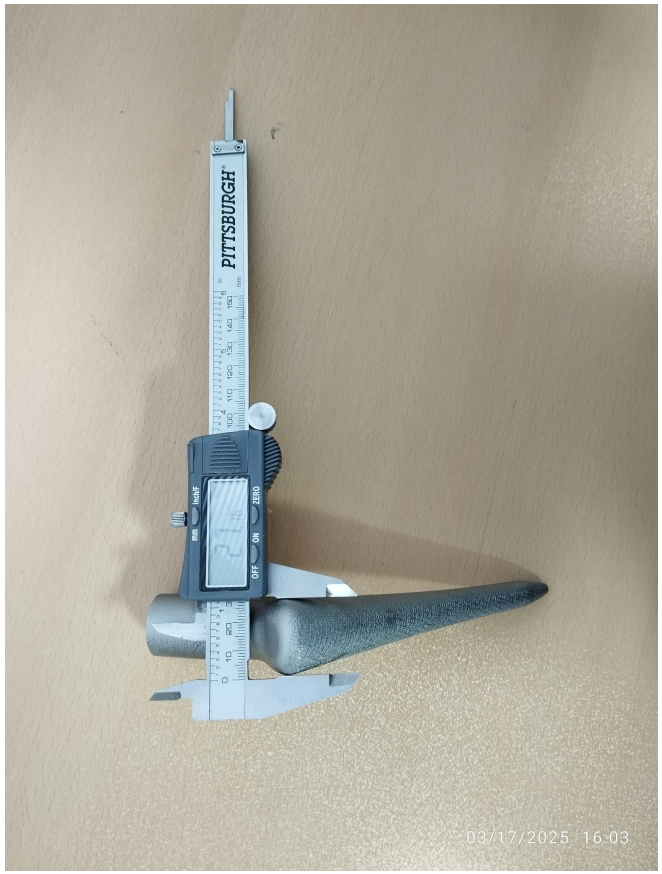

3. Peek tam ark protezi

Titanyum alaşımları klinikte yaygın olarak kullanılmasına rağmen, elastisite modüllerinin insan kemiğine kıyasla oldukça yüksek olması bazı biyomekanik uyumsuzluklara neden olabilmektedir.

PEEK malzemeden implant destekli tam ark sabit tam protezi geliştirip mekanik özelliklerini hem deneysel hem de sonlu elemanlar analizi (FEA) yöntemiyle karakterize ettik.

EGE ÜNİVERSİTESİ
Mühendislik Fakültesi

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ORIGINAL ARTICLE

AMERICAN COLLEGE OF PROSTHODONTISTS
Your smile. Our specialty.

Biomechanics of the implant-supported full arch fixed complete denture manufactured by milling and injection techniques: An experimental and FEA study

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Funding information
Ege University, Project of Scientific Research, Grant/Award Number: TDK-2021-22994

Abstract

Purpose: This study aims to characterize the mechanical properties of implant-supported full arch fixed complete dentures manufactured by milling and injection techniques.

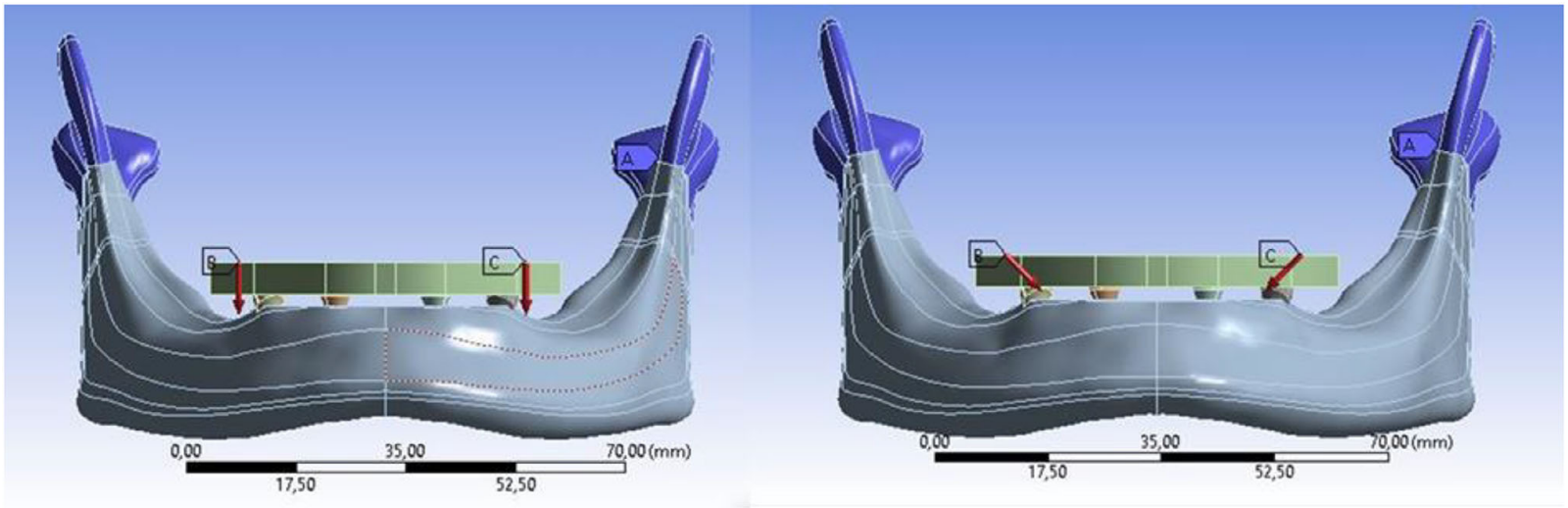
Materials and Methods: Twenty-two samples with milling and injection manufacturing techniques were fabricated. Twenty-two titanium samples were manufactured to be used as the control group. Additionally, eight PEEK samples from both the injection and milling groups were manufactured and tested using a uniaxial tensile test, and the obtained results were used as input data for finite element analysis (FEA). All-on-four PEEK hybrid prostheses supported with 2 implants on the mandible were used for the simulations. The FEA computations were performed for a bilateral 150 N force applied in both vertical and oblique directions.

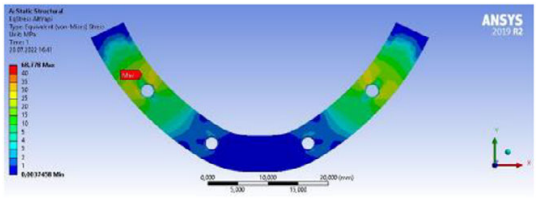
Results: A significant difference was observed between the injection and milled PEEK groups in terms of modulus of elasticity (Injection PEEK group: 3.1 ± 0.6 GPa, Milling PEEK: 4.6 ± 0.9 GPa) and flexural rigidity (Injection PEEK group: 28.0 ± 5.8 kNmm^2, Milling PEEK: 41.2 ± 8.4 kNmm^2) ($p < 0.05$), while no significant differences were observed between the injection and milled PEEK groups in terms of other parameters ($p > 0.05$). The finite element results showed that the highest stresses were observed in the Injection PEEK group, while the lowest were observed in the Milling Titanium group. Both injection and milled PEEK frameworks exceeded the yield stress limit during vertical and oblique loading.

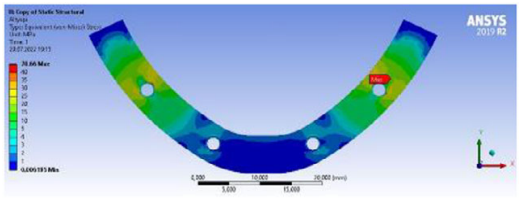
Conclusion: It was concluded that the forces implemented on rigid framework material such as titanium were better distributed to the implants supporting the all-on-four prosthesis.

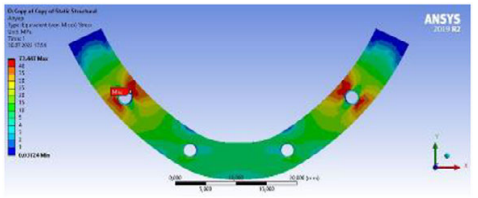
KEYWORDS
All-on-Four, finite element analysis, PEEK

3. Peek tam ark protezi









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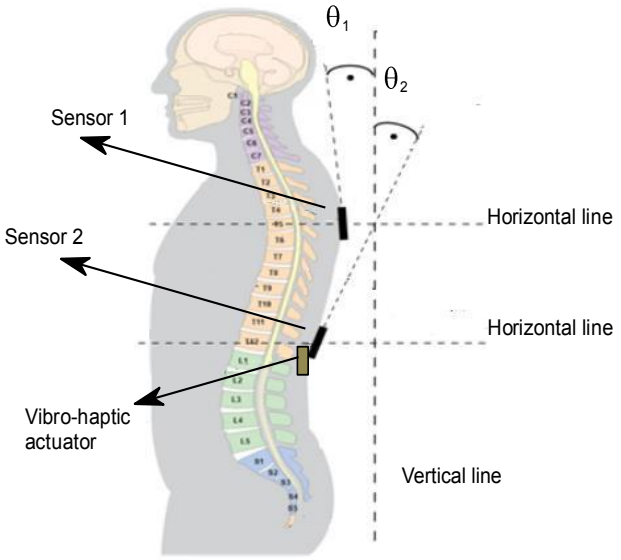
Mühendislik Fakültesi

Gurkan M., Ovul T., Sahan H., Narin M., Kandas H., Arman Y., Yildiz H., Pekedis M. Biomechanics of the implant supported full arch fixed complete denture manufactured by milling and injection techniques: An experimental and the FEA study. Journal of Prosthodontics, 1-11, 2025. doi:10.1111/jopr.14058

4. Akıllı Vibro Haptik Korse



Özden M.A., Acar E., Yildiz H., Güner M., Pekedis M. A vibro-haptics smart corset trainer for non-ideal sitting posture. Textile and Apparel, 32(4), 304 - 313, 2022. doi:10.32710/tekstilvekonfeksiyon.994444

TÜBİTAK 1005

5. Biyomekanik Test Tasarım

Research article

Bio-Medical Materials and Engineering
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Biomechanical and clinical assessment of dissociation in bipolar hip hemiarthroplasty

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Abstract

Background: Dissociation is a special type of dislocation that is rarely seen in bipolar hemiarthroplasty.
Objective: To investigate the clinical and biomechanical causes of dissociative dislocation of acetabular cup components in the hips of patients after bipolar hemiarthroplasty (BHA).
Methods: BHA heads were divided into three groups according to their design. Cam-out and pull-out biomechanical tests were conducted to investigate the separation strengths of the BHA heads.
Results: Among the 1684 BHA surgeries performed, the revision surgery rate was 4% (68 hips) and dissociation rate was 0.8% (15 hips). According to the cam-out test result, the highest values in the parameters ultimate force (F_{max}) ultimate torque (T), vertical displacement at maximum force (δ_m), rotation at maximum force (ϕ_m), maximum principal strain (ε_{max}), minimum principal strain (ε_{min}), average normal strain (ε_{av}), maximum shear strain (γ_{max}), uniaxial normal strain (ε_{un}) were detected in Type 2 BHA head. The pull-out values of the implants were sufficient to prevent the distraction force that may occur on the implant due to manual traction applied to the hip dislocations. However, in closed reduction maneuvers, cam-out-shaped deformation forces may cause dissociation in Types 1 and 3, but not in Type 2 BHA heads. According to the pull-out test results, while high values were detected in the parameters Fmax and stiffness (*k*) in the Type 2 BHA head, δm and maximum force (E) parameters were found to be high in the Type 1 BHA head. In the cam-out test, a strong positive relationship was found between the thickness and width of the polyethylene locking ring and F_{max}, T, δ_m, ϕ_m, ε_{max}, γ_{max}, ε_{un}.
Conclusion: Better BHA head designs and polyethylene designs may help resolve the rare problem of dissociation, which almost always leads to resurgical procedures.

Keywords
dissociation, biomechanics, dislocation, bipolar hemiarthroplasty, polyethylene locking ring

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Introduction

Primary bipolar hemiarthroplasty (BHA) is widely used in the treatment of low-energy upper-end fractures of the femur, which usually develop secondary to senile osteoporosis owing to rapid healing and low complication rates.[1–4] BHA has become a standard surgical procedure because it has a lower economic burden, better functional results, and reduces the risks of mortality and morbidity.[2,4,5]

The most common complications associated with BHA are dislocations, periprosthetic fractures, infections, aseptic loosening, acetabular wear and unexplained chronic pain.[2–5] Complications that develop are important, as recurrent surgical procedures cause higher morbidity, length of hospital stay, and increased financial costs owing to the old age of patients and their multiple comorbidities.[4,5]

Dislocation remains the most common reason for BHA revision.[1–4] Dislocation rates are similar in unipolar and BHA cases and vary between 0.8–16%.[1,3,4] Although hemiarthroplasty dislocations may be simple and easily reducible,

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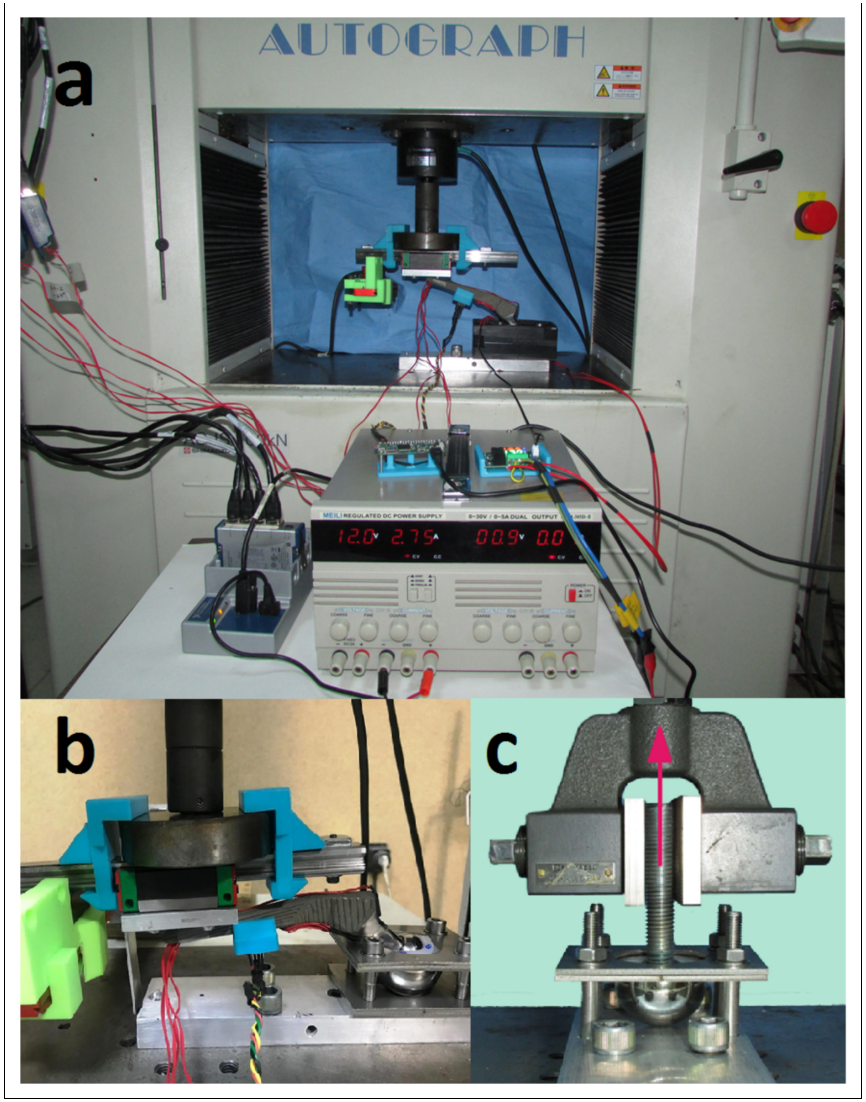
5. Biyomekanik Test Tasarım



Ozan F., Okur KT., Mavi F., Pekedis, M. Biomechanical and clinical assessment of dissociation in bipolar hip hemiarthroplasty. Bio-Medical Materials and Engineering, 2025. doi:10.1177/09592989241306688

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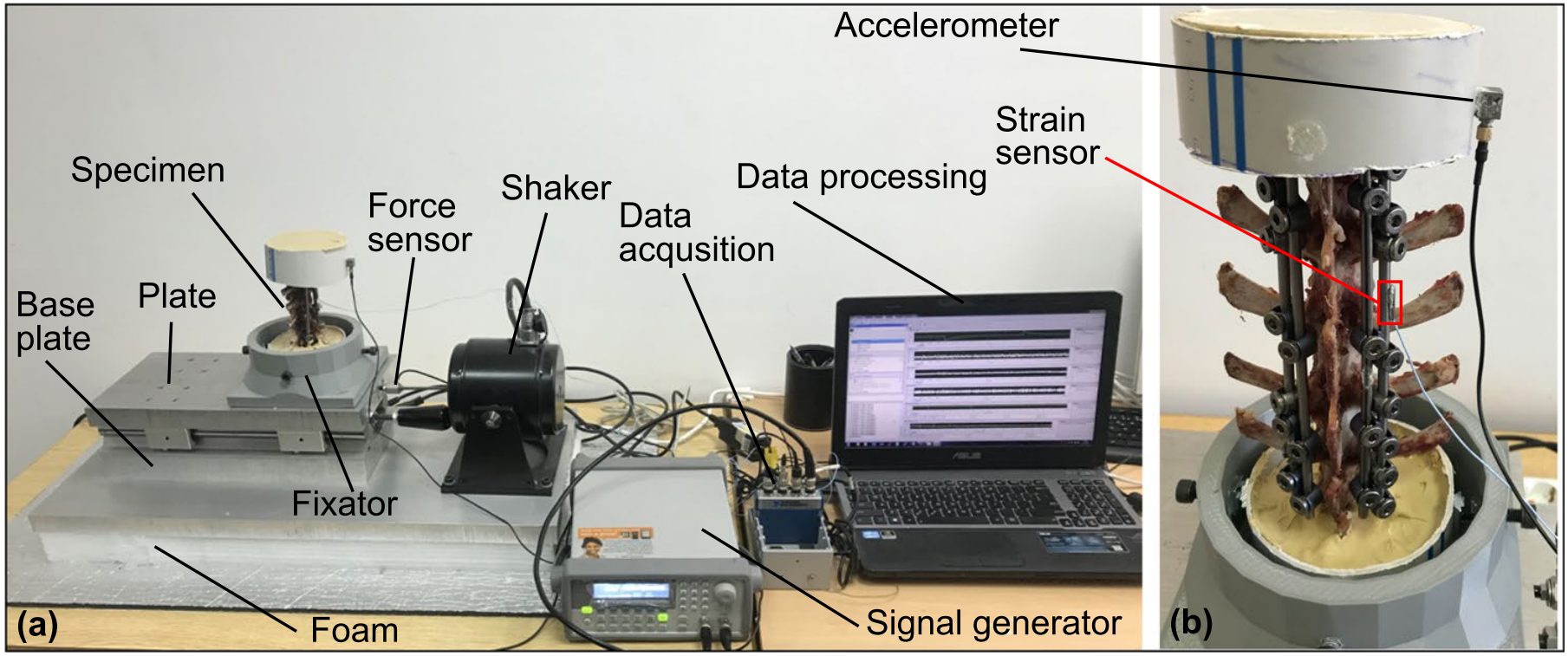

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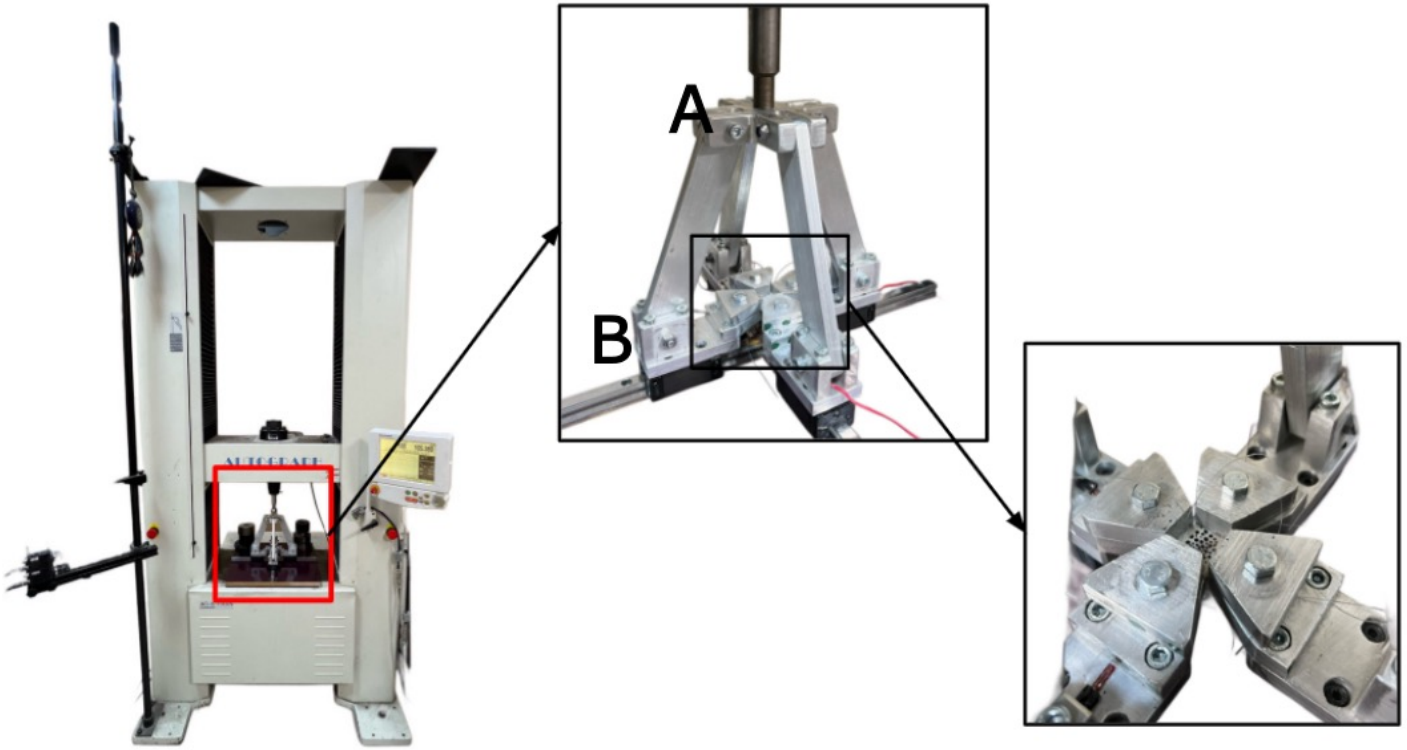

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TEŞEKKÜRLER