6. MEDNARODNI SIMPOZIJ O BIOMATERIALIH, 6 ISB

9. maj, 2025, UKC, Ortopedska klinika, Ljubljana, Slovenia

6th INTERNATIONAL SYMPOSIUM ON BIOMATERIALS, 6 ISB

9th May, 2025, UMC, Orthopaedic Clinic, Ljubljana, Slovenia

PROGRAM IN KNJIGA POVZETKOV

PROGRAM AND BOOK OF ABSTRACTS

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6th INTERNATIONAL SYMPOSIUM ON BIOMATERIALS,2025

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		Boštjan KOCJANČIČ, Veronika KRALJ IGLIČ
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Invited 9:56	Mojca Debeljak	TECHNOLOGIES FOR ASSESMENT AND TRAINING IN REHABILITATION
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Invited 10:20	Andrej Trampuž, Marina Maritati, Svetlana Karbysheva	IMPLANT ASSOCIATED INFECTION -DEVELOPMENT OF NOVEL DIAGNOSTIC AND TREATMENT METHODS
Invited 10:32	Andrej Coer, Katja Šuster	THE ROLE OF BACTERIOPHAGES IN ORTHOPEDIC AND DENTAL IMPLANTOLOGY
Invited 10:44	Armand Dominik Škapin, Miha Vodičar	BIOMECHANICAL GAIT ANALYSIS IN SPINAL DEFORMITY
Invited 10:56	Boštjan Kocjančič, Monika Jenko, Drago Dolinar	EVALUATION OF BIOMATERIALS SURFACES IN ORTHOPAEDICS
11:10 11:30	**Coffe break**	
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Invited 11:30	Carlo Dottino	WHY 3D PRINTING IS BECOMING SO IMPORTANT FOR CERTAIN ORTHOPAEDIC APPLICATIONS
Invited 11:45	Carlo Dotttino	THE PROCESS TO DEVELOP CUSTOM MADE IMPLANTS FROM THE CT-SCAN ACQUISITION TO THE SURGERY TOGETHER WITH POSSIBLE FUTURE ENHANCEMENTS (ES. AI IMPLEMENTATION)
Invited 12:00	Igor Belič, Boštjan Kocjančič	THE SONIC RESONANCE OF FEMORAL PART OF HIP ENDOPROSTHESIS – EXPERIMENTAL SETUP
Invited 12:12	Aleš Iglič, Veronika Kralj-Iglič	ON THE ROLE OF CURVED PROTEINS AND CYTOSKELETON FORCES IN ENCAPSULATION OF NANOPARTICLES
Invited 12:24	G. Zocco, I. Caravotta, F. Pegreffi, A. Russo	CINEMATIC ALIGNMENT BEYOND TRADITIONAL MECHANICAL CONCEPTS IN TKA
Invited 12:36	Ingrid Milošev P. Rodič, B. Kapun, D. Sačer, R. Trebše, K. Šuster, Č. Oblak, R. Gašperšič, K. Škulj, S. Horvat, A. Nair,	ADDITIVE MANUFACTURING OF TI6AL4V ALLOY AIMING FOR ANTIBACTERIAL PROPERTIES

	D. Kramar, A. Jeromen, E. Govekar A.Coer	
Invited 12:48	Samo Roškar, Rene Mihalič, Anže Mihelič, Jakob Trebše in Rihard Trebše	CHANGES OF PHYSICAL CHEMISTRY PROPERTIES OF SYNOVIAL FLUID RELATED TO SEPTIC AND ASEPTIC CONDITIONS - VISCOSITY AS A POTENTIAL MARKER FOR PJI DIAGNOSTICS
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	DENTAL MEDICINE SESSION	
		Čedomir OBLAK, Maja OVSENIK
Invited 14:45	Čedomir Oblak	MATERIALS IN PROSTHODONTICS LATEST ADVANCES AND RESEARCH
Invited 14:55	Maja Ovsenik	MATERIALS IN ORTHODONTICS NiTi AND SS
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Invited 15:22	Jan Oblak	BIOCOMPATIBILITY OF DENTAL MATERIALS – ORAL HEALTH EFFECTS
Invited 15:34	Rok Ovsenik	EFFECT OF LASER PHOTOBIOMODULATION ON SURFACE CHANGES OF NiTi ARCHWIRE IN FIXED APPPLIANCES
Invited 15:46	Domen Kanduti, Aleksandar Janev, Anton Sculean, Mateja Erdani Kreft, Peter Veranič, Rok Schara, Nataša Resnik, Boris Gašpirc	MAGNESIUM-BASED RESORBABLE MEMBRANES IN PERIODONTAL REGENERATION: IN VITRO EVALUATION OF OSTEOINDUCTIVE POTENTIAL
Invited 16:08	Urška Škof, Rok Schara	RECENT ADVANCES IN BIOMATERIALS FOR PERIODONTAL TISSUE REGENERATION
Invited 16:20	Janet Zimšek Mijovski, Milan Kuhar, Vojko Didanovič, Tadej Dovšak	SUBPERIOSTEAL IMPLANTS FOR SEVERE MAXILLARY BONE LOSS
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Invited 16:54	Maks Bitenc, Doroteja Hren, Monika Jenko, Maja Ovsenik	DIGITAL PLANNING OF RAPID PALATAL EXPANDER

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	Aljaž Merčun, Matej Drobnič, Elijan Mastnak, Jan Žumer, Srđan Đorđević	ANALYSIS OF MECHANICAL MUSCLE ACTIVITY WITH MUSCLE CONTRACTION (MC) SENSORS: A TIME SERIES AND DISCRETE VARIABLE APPROACH FOR THE VASTUS MEDIALIS MUSCLE
	Igor Potparić, Boštjan Kocjančič	TYPES OF MATERIALS USED IN KNEE IMPLANTS
	Igor Potparić, Boštjan Kocjančič	KNEE INJECTION THERAPY
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	Žiga Kristijan Žigon	PATENT FORAMEN OVALE
	Nina Knoll	VENO-VENOUS ECMO IN COVID-19 PATIENT
	Maja Kodra	CYTOSORB IN SEPSIS: A CASE PRESENTATION
	Aleksandra Kostić	DISLOCATION OF UHMWPE LINER AFTER TOTAL HIP REPLACEMENT, A CASE STUDY
	Tadej Mavčič	COMPRESSION NEUROPATHIES
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S2	Nika Svetina, Anja Sedej, Maja Ovsenik, Aljaž Golež	LLLT BIOSTIMULATION TECHNOLOGY AFFECTS THE CLINICAL STATE OF PERIODONTAL TISSUES DURING ORTHODONTIC LEVELLING PHASE
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S4	Olja Kolenc	ASSESSMENT OF THE INTERDENTAL PAPILLA DURING AND AFTER ORTHODONTIC TREATMENT WITH CLEAR ALIGNERS
	Concluding remarks	**Chair BOŠTJAN KOCJANČIČ**

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KNJIGA POVZETKOV

BOOK OF ABSTRACTS

Predsedujoči/Chair A/Prof.Dr.Boštjan Kocjančič, MD

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Overview of Biomaterials in Orthopaedics - Clinical Perspective

Drago Dolinar[1,2,3]
Department for Orthopaedic Surgery, University Medical Centre Ljujbljana, Slovenia
Medical Faculty, University of Ljubljana, Slovenia
MD-RI institute of Materials Research in Medicine, Ljubljana, Slovenoa

ABSTRACT
Orthopedic biomaterials play a pivotal role in contemporary medicine by significantly enhancing patients' quality of life. These materials are predominantly employed in procedures aimed at stabilizing fractures, replacing joints, and providing dynamic support.
Due to the demanding nature of orthopedic applications, the materials used must be capable of withstanding substantial mechanical loads. Although polymers and ceramics are utilized in certain orthopedic contexts, metals continue to be the primary choice. This is attributed to their unique combination of desirable properties, including high mechanical strength, ductility, fracture toughness, hardness, resistance to corrosion, ease of fabrication, and biocompatibility. These characteristics are essential for components subjected to wear and continuous loading, such as those used in fracture fixation and total joint replacement surgeries.
Orthopedic biomaterials are typically applied within three major anatomical areas: the upper limbs, the spine, and the lower limbs. Each of these is further categorized into subspecialties such as pediatric orthopedics, trauma-related interventions, and reconstructive procedures. Despite the wide range of clinical indications and techniques, a relatively small set of metals, ceramics, and polymers dominate the market for orthopedic implants.
A thorough understanding of the properties, applications, and limitations of these core materials is crucial for improving existing implant technologies and explaining the limited diversity of materials in clinical use. The primary constraint on the long-term success of orthopedic implants lies in the biological response to degradation products resulting from mechanical wear and electrochemical corrosion. A key concern is the release of particulate debris, which can lead to both localized tissue reactions and systemic complications, such as hypersensitivity to metal ions.
Advancing the field of orthopedic biomaterials will require deeper insights into the mechanisms of material degradation, their interactions with biological systems, and continued innovation in materials engineering to develop longer-lasting, more biocompatible implants.

KEYWORDS
orthopaedics, biomaterials, implants, longevity, TJA, wear particles, corrosion resistance, hypersensitivity

Optimization of Therapeutic Plasma Preparation

Veronika Kralj-Iglič[1]
[1]*University of Ljubljana, Faculty of Health Sciences, Ljubljana, Slovenia*

ABSTRACT
Sedimentation of erythrocytes and leukocytes in blood samples yields plasma rich with smaller particles (platelets, extracellular vesicles, lipoproteins, antibodies, etc.). Such material was found to have healing properties. Initially, the healing effect was attributed to platelets that release different growth and inflammation factors into the extracellular milieu. Later, other features were considered, e.g., the effects of platelet membrane receptors and of leukocytes on the immunomodulatory actions of the innate and adaptive immune system and mediating role of extracellular vesicles (EVs), indicating complex interactions between various cells in the healing process. Autologous plasma is prepared from the patient's own blood following procedures that are straightforward and easy to perform: the patient's peripheral blood is collected into anticoagulant-containing test tubes. Erythrocytes and leukocytes are sedimented by centrifugation while small particles travel in the opposite direction and become enriched in plasma. However, when erythrocytes are largely cleared from the plasma, centrifugal force sediments also smaller particles. It is therefore important to stop the centrifugation at the point when erythrocytes sediment to the bottom of the tube. A mathematical model was constructed to describe sedimentation of erythrocytes and counterflow of platelets and EVs. It was taken into account that the observed enrichment of plasma in platelets and EVs after centrifugation of blood depends on the erythrocyte sedimentation rate and is specific to an individual blood donor. EV enrichment depends on the average distance of the sample's top and bottom from the centrifuge rotor axis. Based on the agreement of the model predictions with observations, we propose the centrifugation protocol optimal for platelet and EV enrichment and recovery in an individual sample, adjusted to the dimensions of the centrifuge rotor, volume of blood and erythrocyte sedimentation rate.

KEYWORDS
Platelet-rich plasma, Extracellular vesicles, Centrifugation modeling

Anatomic Anterior Cruciate Ligament Reconstruction with Eccentric Femoral Footprint Positioning Using a Modified Transtibial Technique

Gaetano Spera [1], Ignazio Cravotta[1], Gianluca Giuseppe Costa[1,2], Francesco Pegreffi[1,3], Arcangelo Russo[1,2]

[1]Orthopaedic and Traumatology Unit, Umberto I Hospital, 94100 Enna, Italy
[2]Department of Medicine and Surgery, School of Medicine and Surgery University of Enna Kore, 94100 Enna, Italy
[3]Recovery and Functional Rehabilitation Unit, Umberto I Hospital, 94100 Enna, Italy

ABSTRACT

Accurate anatomical placement of the femoral and tibial tunnels is essential in anterior cruciate ligament (ACL) reconstruction to restore native knee kinematics and reduce graft failure risk. Recent studies suggest that eccentric positioning of the femoral tunnel within the anteromedial (AM) bundle center leads to lower revision rates without compromising joint stability.

This study introduces a modified transtibial technique that achieves anatomic femoral tunnel positioning while retaining the surgical simplicity and familiarity of the traditional transtibial approach. The procedure employs a quadrupled hamstring autograft, standard arthroscopic portals, and a medial tibial tunnel entry point to allow optimal trajectory to the femoral AM bundle footprint. Key technical elements include reshaping the intercondylar roof into a “roman arch” to facilitate guide rotation, orienting the femoral guide through the tibial tunnel at specific angles, and using a fixed-loop cortical suspension device for femoral fixation. Tibial fixation is achieved with an interference screw. Tunnel angulation and orientation are critical to ensure an anatomic graft trajectory while preserving structural integrity. This approach addresses traditional limitations of the transtibial method, particularly its perceived inability to reach the anatomic femoral footprint. The inclusion of roofplasty and strategic tibial entry point selection significantly enhances guide maneuverability and tunnel alignment. Benefits include reduced graft bending angles, which may promote biological integration and long-term graft viability. However, potential drawbacks such as shorter tunnel lengths, weakened tibial cortex, and guide pin breakage must be considered and managed intraoperatively.

Cadaveric and clinical literature support the feasibility of this technique, demonstrating that appropriate guide angulation can consistently reach the center of the AM bundle via the transtibial route. These findings affirm that with technical refinement, the transtibial approach can meet anatomic reconstruction standards.

In conclusion, the modified transtibial technique offers a reproducible and effective method for anatomic ACL reconstruction. By integrating specific adjustments, it maintains the biomechanical advantages of the transtibial pathway—such as graft isometry and tunnel co-alignment—while achieving precise femoral tunnel positioning. Future comparative clinical studies are needed to validate its efficacy against transportal and outside-in methods in terms of graft survival and patient functional outcomes.

KEYWORDS

Anterior cruciate ligament, transtibial technique, femoral footprint, anatomic reconstruction, AM bundle, roofplasty, tunnel angulation, graft trajectory, knee biomechanics, autograft fixation

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Implant-related risk of periprosthetic proximal femoral fracture after primary total hip arthroplasty in patients aged 65–80 years

Žan Kroflič[1], Blaž Mavčič[1,2*]
[1] *University of Ljubljana, Faculty of Medicine, Ljubljana, Slovenia*
[2] *University Medical Centre Ljubljana, Department of Orthopaedic Surgery, Ljubljana, Slovenia*

ABSTRACT

Background and Objective: The risk of long-term cemented femoral stem loosening in patients over 80 (fewer physical activities, shorter lifespan) is lower than the risk of periprosthetic proximal femoral fracture (PPFF) and vice-versa in young active patients below 65. However, arthroplasty registries do not provide direct data on implant-related subsequent risk of PPFF in patients who had their primary total hip arthroplasty (THA) implanted at the age between 65 and 80 years. The aim of our study was to determine the PPFF incidence of PPFF of three cementless femoral stem types (Zweymüller SL-Plus, Stryker ABG-II, Implantcast EcoFit) and one cemented femoral stem type (Link SP-II) in age groups 65.0-69.9 / 70.0-74.9 / 75.0-79.9 years after adjustment for femoral stem patient gender and surgeon's experience.
Methods: A retrospective cohort study was conducted on patients aged 65–80 years who underwent primary THA at the Department of Orthopaedic Surgery, University Medical Centre Ljubljana (Slovenia) between 2004 and 2023. Patients were stratified into three age groups: 65,0–69,9; 70,0–74,9 and 75,0–79,9 years. Patients in these age groups received implants based on surgeon preference and were thus pseudorandomized. Multivariate Cox regression and Kaplan-Meier survival analysis was used to evaluate the association between implant type, gender, surgeon experience and the risk of PPFFs.
Results: Among 3.188 patients aged 65–80 years who underwent primary THA, the overall incidence of periprosthetic femoral fractures (PPFFs) was 2.6%, increasing progressively with age. In patients aged 75.0–79.9 years, the Stryker ABG-II stem showed the highest risk (HR 37.3; 95% CI: 6.7–205.9), followed by Zweymüller-SL Plus (HR 26.0; 95% CI: 4.4–152.4) and Implantcast EcoFit (HR 19.7; 95% CI: 3.2–123.4). Similar trends were observed in the 70.0–74.9 and 65.0–69.9 age groups. Kaplan–Meier survival analysis confirmed significantly lower PPFF-free survival for cementless stems in all age subgroups (log-rank $p < 0,05$). Gender and surgeon's experience were not significantly associated with fracture risk.
Conclusions: This study demonstrates that cementless femoral stems are associated with a significantly higher risk of periprosthetic femoral fractures (PPFFs) in patients aged 65–80 years, with the highest hazard ratios observed in the oldest subgroup. The Stryker ABG-II stem posed the greatest risk across all age categories, while the cemented Link SP-II consistently showed a protective effect. These findings highlight the importance of careful implant selection in this age population.

KEYWORDS
Periprosthetic proximal femoral fractures, Total hip arthroplasty, Risk factors, Implant survival analysis

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Technologies for Assessment and Training in Rehabilitation

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ABSTRACT

Introduction: Recent advancements in rehabilitation technologies have transformed therapeutic strategies for individuals recovering from neurological and musculoskeletal disorders. These modern systems facilitate precise motor training and objective performance assessment, enhancing therapeutic efficiency and increasing patient motivation through interactive feedback and game-based elements. This review aims to provide an overview of current technologies employed in rehabilitation, highlighting their clinical applications and therapeutic potential.

Methods: A comprehensive review of rehabilitation technologies was conducted, focusing on devices designed for targeted assessment and motor training. The technologies were categorized based on therapeutic goals, including fine motor control of the fingers and hands, postural and balance control, gait training, and full-body coordination. Special attention is given to systems incorporating motivational exergames and somatosensory game platforms. These devices typically integrate robotics, sensor technologies, and adaptive software to deliver real-time feedback and modulate training intensity according to individual patient capabilities.

Results: Various technologies currently used in clinical settings are described, demonstrating their ability to increase patient engagement and enable objective, reproducible measurements of motor performance, strength, range of motion, gait, and balance. Several systems provide partial or full body-weight support, customizable range of motion, and virtual reality environments for enhanced user motivation. Examples include devices for upper limb rehabilitation (e.g., Amadeo, Tyromotion systems, Hocoma Armeo), gait training (e.g., Hocoma Lokomat, C-Mill, Ekso by EksoBionics), and robotic dynamometry (e.g., Biodex System). Some systems can be integrated with functional electrical stimulation (e.g., Hocoma Erigo). The quantitative data produced by these systems support clinicians and insurers in making evidence-based decisions regarding the continuation, adjustment, or termination of therapy.

Discussion: Game-based systems such as exergames have been shown to improve patient motivation and long-term adherence to rehabilitation programs. Robotic and sensor-based technologies offer structured, quantifiable, and adaptable interventions that outperform conventional methods in maintaining patient interest and fostering functional recovery. Nonetheless, contraindications such as severe pain, rigid contractures, and a history of epileptic seizures must be carefully considered. Patient safety remains a top priority.

Conclusions: Technology-assisted rehabilitation significantly improves both the assessment and delivery of therapy by making interventions more objective, personalized, and engaging. These tools contribute to improved clinical outcomes and provide essential data that inform healthcare providers and insurers on the optimal design and duration of rehabilitation programs.

KEYWORDS

rehabilitation, individualization of therapy, robotic, sensor based systems

Predictive value of neuron specific enolase (NSE) for good neurological outcome of patients after cardiac arrest

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ABSTRACT

Introduction

Cardiac arrest is the third leading cause of natural death in Europe, its annual incidence in Europe being 67-170 per 100 000 inhabitans. Survival rate is still low, 1-22%. In patients with out-of-hospital cardiac arrest (OHCA) we achieve return of spontaneous circulation (ROSC) in only 40-60%. These patients are admitted to the ICU. After ROSC patients may be conscious or comatose.

There is an increasing number of patients admitted to our ICU during the years – from 25-35/year from 1995 till 2002, then max 90/year till this day. There have been 1663 consecutive comatose patients with primary OHCA admitted from1995.

We asses their neurological outcome according to the Glasgow Pittsburgh scale – Cerebral Permormance Category (CPC) scale, ranging from CPC 1 (a return to normal cerebral function and normal living), CPC 2 (cerebral disability but sufficient function for independent activities of daily living) to CPC 3 (severe disability, limited cognition, inability to carry out independent existence), CPC 4 (coma) and CPC 5 (brain death).

Neuroprognostication

Neuroprognostication starts at 48-72 hours after cardiac arrest. We measue serum levels of neuron specific enolase (NSE), perform electroencephalogram, somatosensoric evoked potentials, computer tomography of the brain and clinical examination.

NSE is a biomarker for neurological injury, its level reflects neuronal cell damage and hypoxic-ishemic brain injury. We measure its level in the serum after 48 and 72 hours. More important than the absolute values is the trend – rising means bad prognosis.

We performed a study in Center for intensive internal medicine, which included 271 consecutive patients from 1st of November, 2017 till 31st of December, 2023. We wanted to compare NSE values in patients with CPC 1/2 to NSE values in patients with CPC 3/4. We also wanted to assess the cut-off value of NSE for poor neurological outcome. We found that the NSE concentration at 72 hours after cardiac arrest was significantly lower in patients with CPC 1/2 than in patients with CPC 3/4 (median 18,6 and 88,4; $p < 0,001$). We set a cut-off value of 75,9 µg/L (sensitivity 53,3 %, specificity 99,2 %).

Conclusion

Neuroprognostication makes the decision when to stop active treatment easier. There are still studies going on to find the most accurate neuroprognosticator to be used alone. Measuring serum NSE helps to predict neurological outcome, but there is another marker, neurofilament light chain (NFL), which according to our pilot study seems to be even more accurate.

Implant-Associated Infection: Development of Novel Diagnostic and Treatment Methods

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ABSTRACT
Implant-associated infections (IAIs) remain a major complication in orthopedic and trauma surgery due to the formation of biofilms on implant surfaces. These microbial communities are highly resistant to antibiotics and immune responses, leading to persistent infections, impaired function, and high treatment costs. This presentation highlights translational advances in the diagnosis and treatment of IAIs, integrating preclinical innovation with clinical application.
Rapid, non-culture-based diagnostic methods, particularly host biomarkers such as D-lactate, are emerging as effective tools for early infection detection. Electrochemical biosensors allow near-instant bedside measurements of D-lactate in synovial fluid, cerebrospinal fluid, and blood, improving diagnostic speed and accuracy (Karbysheva et al., 2022; Maritati et al., 2025). Additionally, telemetric multisensor implants are under development for continuous in vivo monitoring.
Treatment strategies increasingly emphasize local antimicrobial delivery through resorbable materials such as calcium phosphate, calcium sulphate, and bioactive glass. These carriers provide high local antibiotic concentrations, enhanced bone regeneration, and reduced systemic toxicity (Ferguson et al., 2019; Lindfors et al., 2017). New antiseptic agents, including trichloride-loaded polymers, offer broad-spectrum antimicrobial activity with both immediate and long-term effects (Richter et al., 2018).
Electrochemical and electrical therapies are also being explored as adjuncts for biofilm disruption through electrolysis and oxidative stress (Steadman et al., 2023). A standardized treatment algorithm supports clinical decision-making, guiding the selection of debridement, implant retention, or staged exchange procedures based on infection chronicity and pathogen profile (Renz et al., 2021).
Furthermore, digital tools such as an AI-based consultation platform developed by PRO-IMPLANT Foundation (www.pro-implant.org) enhance decision-making, data collection, physician training, and patient education. These innovations collectively support a more precise, efficient, and personalized approach to infection management.
This interdisciplinary framework—combining diagnostics, local therapies, surgery, and digital health—represents a significant step toward improving outcomes in patients with implant-associated infections.

KEYWORDS
Biofilm, Implant-associated infection, Diagnostics, Antimicrobial therapy, Bone substitutes

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Bacteriophages in Orthopedic and Dental Implantology: Challenges and Opportunities

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ABSTRACT

Bacteriophages are viruses that specifically infect bacteria. Although discovered over a century ago, interest in bacteriophage research has recently intensified in Western countries due to the escalating threat of antibiotic-resistant bacterial infections. This is particularly relevant for infections associated with orthopedic and dental implants, which are often caused by multidrug-resistant pathogens and are notoriously difficult to treat. Despite their potential, no regulatory agencies (FDA, EMA, JAZMP) have formally approved bacteriophage therapy, although it is occasionally used under compassionate-use provisions. A significant milestone was reached in 2024, when clinical data from the treatment of 100 European patients with bacteriophages were published, facilitated by a Belgian consortium, marking a key step toward clinical validation.

Nevertheless, several challenges must be addressed before bacteriophages can be widely adopted as therapeutic agents. Their high specificity demands precise pathogen identification for effective treatment. Moreover, although resistance to phages develops through different mechanisms than antibiotic resistance, it remains a concern. Regulatory, manufacturing, and standardization issues—such as producing high-purity, stable formulations—also present obstacles, and the host immune response may limit phage efficacy. Overcoming these hurdles is critical to realizing the full clinical potential of phage therapy.

Beyond infection control, bacteriophages hold immense potential in advancing orthopedic and dental implant technology, particularly through phage display technology. Phage display allows the identification of peptides and proteins that bind specifically to implant surfaces, enabling the design of novel biomaterials that promote enhanced osteoinductivity and biocompatibility. By incorporating these peptides, implant surfaces can be engineered to accelerate osseointegration, improve tissue integration, and reduce the risk of implant rejection. This technology not only enhances the functionality of implants but also paves the way for more personalized approaches in implant design and materials development.

In addition to their applications in infection control and surface functionalization, bacteriophages also show promise as nanocarriers for targeted delivery of therapeutic molecules in implantology. Due to their unique ability to be engineered for precise molecular interactions, bacteriophages can transport bioactive agents, such as growth factors or anti-inflammatory molecules, directly to implant sites. This can further enhance the healing process, reduce complications, and improve the overall performance of implants.

Bacteriophages represent a dual breakthrough in implantology: as an alternative to antibiotics for infection treatment and as a tool for advanced surface functionalization of implants. Their application could fundamentally reshape the future of orthopedic and dental implant design and therapy.

KEYWORDS
Bacteriophages, implant infection, phage therapy, phage display

Evaluation of Biomaterials Surfaces in Orthopaedics

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ABSTRACT
Due to the increasing use of orthopaedic implants, which is a consequence of the longer life expectancy of the population, the biocompatibility and suitability of materials are becoming more and more interesting. They are also key biomaterials used in orthopedics. The choice of materials used and the production of the surface are crucial for the lifespan of implants in orthopaedics, Literature data indicate different survival rates of hip endoprostheses, problems with the combination of materials for implants. One of the main challenges in ensuring the success and longevity of joint replacements is understanding the biological responses triggered by implant materials. These responses can activate the immune system and cause severe inflammation that leads to implant failure and malfunction, and to allergic reactions in patients. The main materials used for implants are metal, polyethylene and ceramics, with varying survival rates and problems with different materials and their combinations have been identified. We want to gain a deeper insight into the initial biological response of tissue to implants from selected conventional and newly developed materials according to additive manufacturing (AM), identifying both side effects and biocompatibility efficacy. There is an urgent need to develop and implement advanced techniques for the early detection of side effects and to propose measures to reduce their occurrence. This involves the study of physical and biological phenomena immediately after the interaction of biological matter with various newly functionalized materials. Our goal is to determine how to select and manufacture implant material in order to achieve optimal biocompatibility for the longest possible implant life.
The objectives of the research are (i) to better understand the biological response to implant material. We investigated the reactions of bone marrow stromal cells in contact with different implant materials; (ii) to better understand the immune response of the tissue around the hip prosthesis. We focus on studying the impact on M1 and M2 macrophages, key players in the immune system and response. We want to find an implant form that promotes an optimal response of M2 macrophages, which improves tissue integration and reduces inflammation. (iii) To study the complex effects of blood products on osseointegration. The effect of various blood products (plasma, platelet lysate and isolated extracellular vesicles) in combination with implant materials on cell cultures will be considered; (iv) To study the interaction of tissues with implant surfaces. Under physiological conditions, the dynamics of adhesion, growth and morphological changes of cells will be studied in real time. These investigations are carried out on different surfaces of materials with different grinding, which will result in different granulation of potential wear residues. We will focus on understanding the effect of residues on inflammation and possible change in phenotype.

KEYWORDS
Orthopaedic implants, biomaterials, additive manufacturing, longevity of implants, surface and interface evaluation

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Why 3D printing is becoming so important for certain Othopaedic applications

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ABSTRACT
3D printing of metal alloys represents an alternative means of production Vs traditional manufacturing systems such as Forging, Casting or Machining. This system also called “additive manufacturing” builds implants layer after layer employing metal powder which is melted and therefor solidified by means of an electron beam or a laser beam. In the former case the process is called Electron Beam Melting (EBM), while in the latter is called Selective Laser Sintering (SLS). These manufacturing systems allow for a very high degree of freedom and flexibility when compared to the traditional ones, and in fact are ideal for manufacturing prototypes or custom made devices. In the case of cementless orthopaedic implants 3D printing bring a distinctive advantage also in case of standard implants. Additive manufacturing in fact allows for the production of extra rough surfaces with high porosity (>50%), an average pore size of 700µm or more and fully interconnected pores. Those surfaces are monolithic being built together with their substrate and not added later as it’s the case when traditional manufacturing means are used. In this way it’s possible to maximize implants primary stability thanks to the surface extra roughness, while osteo-integration is as well enhanced. At the same time the surface being monolithic can withstand high stresses without any delamination risks. Clinical results and survival rates at 13 years follow-up gathered from joint registries demonstrate that 3D printed technology is especially effective to reduce the percentage of mobilizations due to aseptic loosening, which is one of the main causes for failure of orthopaedic implants on the long term.

KEYWORDS
3D Printing; Additive Manufacturing; Cementless Cups; Cementless Stems; Aseptic Loosening

Custom Made Orthopaedic implants Design and Manufacturing Process and future improvements

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ABSTRACT
The raise of metal 3D printing technologies had made possible the production in a relatively easy and fast way of very complex monolithic orthopaedic implants with surface features ranging from full solid walls to interconnected nets. Custom Orthopaedic implants are normally used for two main indications: Oncology, where the anatomical segment affected by the tumour should be resected and replaced by a metal device, and Reconstruction where patient's anatomy should be reconstructed due to severe bone loss due to previous implants failure and/or infection. The manufacturing process is divided in several steps: 1) Patient anatomy reconstruction, which is made using mainly CT-Scans and sometimes MRI. 2) Implant design. 3) Manufacturing and finishing. 4) packaging and sterilization. 3D printing has made the manufacturing step the easiest part, while today's process burden is mainly on the anatomy reconstruction and implant design side. Those steps today are still performed manually by an engineer and therefore the more Custom made implants are produced, the more human resources are needed. Furthermore one engineer can effectively handle only one project per time, therefore limiting the full process efficiency. A way to improve efficiency in terms of implants production output and time would be to apply Artificial Intelligence (AI) to the early steps of the product design. Recognitive AI can be used to reconstruct patient's anatomy out of the CT-Scns / MRI data, while Generative AI can be used for implant design automation. While the former process has been already applied, the latter is still in the making as there are too many parameters to deal with. Once, in a matter of 2 years or so the process will be fully automated, then one engineer will be able to follow multiple projects and the process lead time will be cut by minimum one week.

KEYWORDS
3D Printing; Generative AI; Recognitive AI; Custom Implants

The Sonic Resonance of Femoral Part of Hip Endoprosthesis – Experimental Setup

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ABSTRACT

Mechanical resonance is the response of a mechanical system to the oscillations coming from inside or outside of the observed system. It is well known that the mechanical (sonic) resonance may cause swaying motions and even catastrophic failure in improperly constructed structures. The phenomenon is known as resonance disaster. Sonic energy enters the system through excitation and is dissipated through damping. Damping can be internal (within the material) or external (mounting of an object). The results of our previous research clearly indicate that, due to the geometry and the used material, the observed endoprostheses exhibit a very distinctive sonic resonance characteristic. The resonance is excited by the sound coming from outside (or inside) of the human body. The energy of resonance movement of the endoprosthesis is dissipated through the endoprosthesis – bone interface. A long-term exposure to the resonance oscillations might contribute to other causes of aseptic loosening of endoprostheses. The experimental setup is being assembled. There is one goal of the setup – to prove that the initially tight fitting of endoprosthesis and artificial bone becomes loose due to the acoustic resonance of the endoprosthesis. The experimental setup as well as the procedural part of the experiment is explained in detail.

KEYWORDS

Femoral part of hip endoprosthesis, vibration analysis, resonance, aseptic loosening.

On the Role of Curved Proteins and Cytoskeleton Forces in Encapsulation of Nanoparticles

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ABSTRACT

Encapsulation of nanoparticles by biological membrane is an important stage of their transfer across the membrane. In this work MC simulations are employed to investigate the ability of the membrane to encapsulate nanoparticles. Our theoretical model describes the membrane leading-edge that are produced by curved membrane-attached proteins that recruit the protrusive forces of actin polymerization, and identifies the role of bending and adhesion energies. Among others we found that non-spherical nanoparticles are more difficult to encapsulate than spherical ones. For non-spherical nanoparticles encapsulation time depends on the initial orientation of the nanoparticles. The proposed mechanism for the spontaneous self-organization of the actin cytoskeleton at the encapsulation cup is in good agreement with recent high-resolution experimental observations.

KEYWORDS
Nanoparticle encapsulation, Membrane dynamics, Monte Carlo simulations

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Impact of Alignment Strategy on Knee Function: Early Results from a Prospective Comparison Between Kinematic and Mechanical Alignment in TKA

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ABSTRACT
Introduction
The primary objective of knee arthroplasty is to restore proper joint kinematics, which in turn requires reestablishing anatomical axes and ligament stability. Therefore, correct component alignment is critical for surgical success. While mechanical alignment (MA) aims to maintain the implant in a neutral position, kinematic alignment (KA) seeks to restore the patient-specific joint motion. The purpose of this preliminary prospective observational study is to evaluate clinical outcomes—including range of motion (ROM), functional performance, and patient satisfaction, at a two-year follow-up in patients who underwent total knee arthroplasty (TKA) using either MA or KA.
Materials and Methods
Twenty patients were enrolled between June 2021 and March 2022 and divided into two groups: Group 1 (MA, 10 patients) and Group 2 (KA, 10 patients). Inclusion criteria were: age between 55 and 90 years, Kellgren-Lawrence grade III-IV osteoarthritis, absence of severe varus or valgus deformity, and ability to comply with the study protocol (i.e., providing informed consent). Measured outcomes included ROM, Visual Analog Scale (VAS) for pain, Knee Society Score (KSS) Functional Score, plantar contact point (ACP) assessed via video-capturing, and patient satisfaction.
Results
At the two-year follow-up, mean ROM was 110°±3° in Group 1 and 123°±2° in Group 2 ($p < 0.05$). Some patients reported occasional pain, typically following strenuous activity or changes in weather conditions. KSS values were excellent in both groups (ranging from 80 to 100 points), with no statistically significant difference. ACP values were 5°±3 in Group 1 and 26°±3 in Group 2 ($p < 0.05$).
Discussion
This preliminary study suggests that the use of KA is associated with improved knee flexion at two years postoperatively. Additionally, the KA approach appears to better preserve a near-normal gait pattern, as reflected by ACP values close to physiological cut-off thresholds.
Conclusion
Further studies are warranted to determine whether KA significantly improves knee function without compromising long-term prosthesis survival.
Nevertheless, our preliminary findings indicate that KA represents a personalized alignment technique capable of achieving promising clinical and functional outcomes.

KEYWORDS
Total knee arthroplasty, kinematic alignment, mechanical alignment, joint kinematics, range of motion, Knee Society Score, patient satisfaction, osteoarthritis, gait analysis, anterior contact point.

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Additive manufacturing of Ti6Al4V alloy aiming for antibacterial properties

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ABSTRACT

Additive manufacturing (AM) uses CAD data or 3D scanning to guide machines in building objects layer by layer. Emerging in the 1990s, AM meets the demand for more complex designs and efficient material use, in contrast to traditional methods that remove material.

In orthopaedic implants, AM allows custom-fit devices and materials tailored to specific patient needs. Titanium implants are favoured for their osseointegration properties, but enhancing their resistance to bacterial adhesion could reduce implant-related infections (IRIs).

IRIs, primarily caused by S. aureus and coagulase-negative staphylococci, are difficult to treat due to biofilm formation on implant surfaces. To address this, we used a commercially available Ti-6Al-4V alloy produced via AM and incorporated copper particles to introduce antibacterial properties. The multidisciplinary approach to studying new material was explored, including materials production, characterization and in vitro and in vivo biological properties. Materials analysis (SEM/EDS, AFM, TEM) and electrochemical testing in simulated physiological solutions showed that while the AM and wrought Ti-based alloys have similar compositions, their microstructures and antibacterial activity differ.

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Changes of Physical Chemistry Properties of Synovial Fluid Related to Septic and Aseptic Conditions - Viscosity as a Potential Marker for PJI Diagnostics

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ABSTRACT
Prosthetic joint infection (PJI) represents the second most frequent complication of total joint arthroplasty with up to 20% of low-grade PJI treated as aseptic failure. The most sensitive diagnostic criteria have been provided by European Bone and Joint Infection Society (EBJIS). However, to date there is no single test to reliably diagnose all PJIs. Synovial fluid (SF) viscosity could be considered as marker for PJI, however, its diagnostic value of PJI remains unknown. Our study aimed to analyze the physicochemical properties of synovial fluid under septic and aseptic conditions in vitro. Furthermore, we aimed to analyse the SF viscosity in revision surgeries and compare it to SF cell count with differential (CCD).

For the in vitro testing, the SF was obtained from the patients with end stage osteoarthritis at time of primary implantation of the endoprosthesis. To replicate septic conditions, we used in vitro grown biofilms of different Staphylococcus epidermidis strains. After the SF was incubated with the biofilms it was tested for changes in its viscosity and compared to control conditions, where the SF was not exposed to any bacterial biofilms. For evaluation of SF viscosity in revision total hip and knee arthroplasty, the intraoperative SF sample was collected at all revision procedures in Valdoltra Orthopaedic Hospital between December 2020 and January 2023. In total, 123 SF samples were analysed. During each surgery at least 5 microbiological and multiple histopathological samples were harvested, and explant sonication was performed. The diagnosis was based on EBJIS definition.

In vitro analysis showed that neither of the used S. epidermidis strains caused a decrease in viscosity of treated SF.in these conditions. Among 123 SF samples collected at the arthroplasty revision procedures, 65 knee and 47 hip SF samples were analysed that corresponded with 55 septic and 57 aseptic diagnoses. The mean SF viscosity in the PJI group was 8.5 ± 0.4 mPas and 103.2 ± 18.8 mPas in the aseptic group ($p < 0.05$). SF viscosity achieved 100% sensitivity and 85.3% specificity, with AUC 0.832 (95%CI 0.739, 0.925). Combination of SF viscosity and CCD achieved AUC 0.951 (95%CI 0.919, 0.987).

The study demonstrates diagnostic value of combining SF viscosity with CCD in decision making in hip and knee revision surgery.

KEYWORDS
synovial fluid, viscosity, synovial fluid cell count, revision joint arthroplasty, prosthetic joint infections, aseptic revision joint arthroplasty procedures

Analysis of Taper Corrosion in Ti6Al7Nb Femoral Components of Cementless Hip Endoprostheses

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ABSTRACT

Taper corrosion of femoral components in total hip endoprostheses has re-emerged as a clinically relevant issue, particularly due to mechanical and electrochemical interactions at the taper-head interface. This study investigates the corrosion behavior of Ti6Al7Nb taper surfaces through surface roughness measurements and potentiodynamic electrochemical testing. Five tapers were analyzed: two from new implants and three from explanted endoprostheses with varied in vivo durations (3–239 months).
Roughness profiles were evaluated using Alicona Infinite Focus G4 profilometry, and electrochemical behavior was tested in Hank's solution using a three-electrode cell configuration. Results showed similar surface roughness and profile parameters (Ra, Rz, peak spacing, profile depth) among four tapers, with one new taper exhibiting distinct deviations, likely due to different manufacturing parameters. Potentiodynamic measurements revealed low corrosion rates for both new tapers and the long-term explant (239 months), while tapers from short-term infected cases showed slightly higher corrosion rates. However, the differences were minimal, and taper corrosion did not correlate with the mode of implant failure. Corrosion appeared more influenced by external factors such as infection rather than taper design or wear alone.
In conclusion, corrosion of the Ti6Al7Nb taper in cementless hip implants does not significantly contribute to prosthesis failure, particularly when ceramic heads are used. These findings align with recent studies suggesting that taper corrosion is a minor contributor in modern ceramic-head implants.

KEYWORDS

Taper corrosion, Ti6Al7Nb, hip endoprosthesis, potentiodynamic testing, surface roughness, ceramic heads, modular taper, implant failure, electrochemistry, Hank's solution

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Additive Manufacturing for Biodegradable Medical Implants: Key Advantages

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ABSTRACT
The global demand for bone implants is escalating rapidly, primarily driven by the ageing population and the associated rise in musculoskeletal conditions such as trauma, bone tumours, congenital or acquired skeletal deformities, and other critical bone defects that require surgical intervention. Addressing such defects remains a significant challenge in both orthopaedic surgery and biomaterials science, which continues to seek optimal bone replacement materials.
Biodegradable metals have emerged as promising candidates for temporary bone scaffolds due to their bioactivity and capacity to degrade in vivo without eliciting harmful biological responses. Beyond fulfilling mechanical requirements, an ideal bone substitute should exhibit a sophisticated biomimetic architecture—encompassing optimised pore morphology, size, and overall porosity—to facilitate tissue integration and vascularisation.
Conventional fabrication methods such as casting, sintering, foaming, and chemical vapour deposition lack the precision to tailor complex geometries and mechanical characteristics with the required fidelity. In contrast, the advent of additive manufacturing (AM) technologies offers transformative potential, particularly due to their capacity for free-form fabrication and precise architectural control. Among these, the Laser Powder Bed Fusion (LPBF) technique stands out for its ability to produce biodegradable metallic structures with tunable degradation behaviour and controlled microstructural and mechanical properties.
This study explores the application of LPBF in fabricating biodegradable metal scaffolds, specifically focusing on Fe-Mn and Zn-Mg-based alloy systems. The work presents detailed insights into the processing parameters, degradation kinetics, microstructural evolution, and resultant mechanical performance of these novel materials, highlighting their potential for future clinical use in bone tissue engineering.

KEYWORDS
Biodegradable metal scaffolds, Additive manufacturing, Bone tissue engineering

Multifunctional surfaces for advanced wound healing

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ABSTRACT
Chronic wounds represent a significant global health issue, affecting more than 344 million people worldwide. They are associated with high healthcare costs and extensive use of antibiotics, which also poses a serious environmental concern, as antibiotics are found in rivers and drinking water, contributing to the development of resistant bacterial strains. The problem is further complicated by the fact that current wound care solutions often fail to address key needs such as effective exudate management, gas exchange, and the reduction of biofilm formation, leading to prolonged healing times and increased antibiotic resistance. Additionally, environmental dimension should also be considered, such as reducing usage of antibiotics as well considering use of wasted materials, such as sugarcane, which presents industrial by-product that remains largely unutilized and significantly contributes to greenhouse gas emissions and environmental pollution. This presents a dual challenge: the need for innovative wound care solutions and sustainable approaches to waste management.

In our study use of cellulose extracted from the sugarcane waste was used to create biocompatible ink which is infused with different natural antibacterial agents to prevent bacterial infections and improve wound healing. The combination of 3D printing technologies and gaseous plasma treatment enabled surface optimization (functionalization and nanostructuring), which has been shown to enhance cell proliferation while simultaneously inhibiting bacterial infections. Thus, fine tuning of surfaces properties by gaseous plasma can further improve biological response.

DENTAL MEDICINE SESSION

Advances in Research on Prosthetic and Implant Dental Materials

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ABSTRACT
In recent decades, prosthetic and implant dentistry has advanced significantly, largely due to innovations in dental materials science. The continuous evolution of materials used for dental restorations, prostheses, and implants has significantly improved clinical outcomes, patient satisfaction, and treatment longevity. This review provides a comprehensive overview of recent advances in prosthetic and implant dental materials, with particular emphasis on the development and application of ceramics, polymers, metals, and bioactive composites.

Ceramic materials, especially zirconia and lithium disilicate, have emerged as key components in modern dental practice due to their exceptional aesthetic properties, biocompatibility, and mechanical strength. Innovations in ceramic fabrication techniques, including CAD/CAM processing, hot isostatic pressing, and advanced sintering methods, have enabled the production of high-precision, durable restorations. Furthermore, surface modifications and the integration of nanostructures are enhancing the bioactivity and osseointegration potential of ceramic-based implant components.

In addition to ceramics, advancements in high-performance polymers, such as PEEK and PMMA composites, offer improved flexibility, shock absorption, and wear resistance, making them suitable for provisional prosthetics and alternative frameworks. Metallic materials, particularly titanium and its alloys, continue to be the gold standard for implants, with recent improvements in surface treatments and coatings aiming to enhance tissue integration and antimicrobial resistance.

The incorporation of additive manufacturing, or 3D printing, into dental material production has further expanded the possibilities for customized, patient-specific solutions. Bioactive materials and coatings—capable of releasing therapeutic agents or promoting bone regeneration—represent another promising frontier, combining restorative and regenerative capabilities in a single application.

Through the integration of materials science, bioengineering, and digital technology, modern dental research is pushing the boundaries of what is achievable in prosthetic and implant therapy. This review synthesizes current findings and trends, highlighting the interdisciplinary efforts that are shaping the future of restorative dentistry and improving the prosthetic rehabilitation.

Materials in Orthodontics – Nickel Titanium and Stainless Steel

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ABSTRACT

In orthodontics and dentofacial orthopaedics new biomaterials are being constantly developed to respond the need for better mechanical properties and biocompatibility to improve quality of treatment of our patients. Since the beginning of our profession "the biophysical characteristics of materials in fixed orthodontic appliances" have significantly improved. The most commonly used orthodontic arch wires are nickel titanium (NiTi) alloys, because of their excellent biocompatibility, super elasticity and shape memory capacity, which allows these materials to return to their original configuration or shape after being submitted to a low-force stress at minimal patient discomfort. These properties, that are not observed in the traditionally used stainless steel (SS) wires, permit the orthodontist to apply continuous forces on teeth, without causing discomfort to the patient. This positive aspect stimulated the use of titanium alloys wires instead of stainless steel ones, mainly during the beginning of treatment, when the teeth are in their improper position in the dental arch, are rotated or inclined.

In clinical orthodontics, the importance of friction due to mechanical and biological factors has received much attention. Mechanical factors include surface roughness due to material type, in particular arch wire material, which is related to the coefficient of friction and type of ligatures ligating the wire into the slot of the bracket. Biological factors include saliva, corrosion and debris. The surface properties of arch wires and their possible intraoral degradation might affect the friction force and hence the effectiveness of orthodontic treatment.

Until recently, studies on friction have been performed on as-received arch wires and brackets, and either in vitro or in vivo aged ones. Some investigations reported that stainless steel rectangular wires, when exposed to the intraoral environment, showed a significant increase in the amount of debris accumulation and observed a significant correlation between the number of debris and friction. However, the assessment of debris accumulation was performed mainly using semi quantitative methods on short-term in vivo exposed material. Brackets and arch wires are usually exposed intraorally to corrosion and debris accumulation for several months or even years, which might influence their surface characteristics and affect friction. Surface chemistry of new NiTi and in vivo exposed NiTi arch wires which were exposed to the conditions in patients' mouths for two months were evaluated using scanning electron microscopy (SEM) together with energy dispersive X-ray spectrometry (EDS) will be presented. The morphology and chemical composition of the new and in vivo exposed NiTi arch wires showed surface chemical analysis of the passive film on the NiTi arch wires were performed by Auger Electron Spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS).

The AES and XPS results of new and in vivo exposed NiTi archwires showed that the thin oxide films on new NiTi are mainly TiO_2, of thickness 4-8 nm. For the in vivo exposed NiTi arch wire, an 80nm thick organic film was formed containing O, Ca, P and Cl besides C, with Ni and Ti increasing beneath the C layer. This layer growth during in vivo exposure is of organic origin and is dental plaque.

The most important finding of this study from the clinical point of view is the estimated thickness (80 nm) of organic deposits on the surface of in vivo-exposed NiTi arch wires. It is obvious that we need to prevent the formation and growth of dental plaque–organic layer on the surface of NiTi archwires and to investigate in detail the dental plaque, a multi-species biofilm whose development is initiated by adherence of pioneer species to the salivary proteins and glycoproteins adsorbed on tooth enamel in detail.

KEYWORDS
NiTi alloys, Stainless steel, materials in orthodontics, arch wires, fixed orthodontic appliance

Clinical Safety and Adverse Effects of Clear Orthodontic Aligners: A Systematic Review of Allergic and Mucosal Reactions

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ABSTRACT
The increasing use of clear aligners in orthodontics has raised questions about their long-term biocompatibility and safety, particularly due to prolonged mucosal contact and potential systemic exposure. This presentation synthesizes findings from clinical studies, case reports, and reviews published between 2015 and 2025, excluding in vitro data, to evaluate the clinical safety profile, adverse effects, and allergic reactions associated with clear aligners, including Invisalign®.
Overall, clear aligners are well-tolerated by most patients. In a prospective study by Antonio-Zancajo et al., patients reported significantly lower pain and better oral health-related quality of life with aligners compared to traditional fixed appliances. Similarly, Nota et al. observed lower masticatory muscle activity and pain during aligner therapy, confirming improved comfort. Further, aligners have been associated with mild periodontal changes. Madariaga et al. found that, compared to fixed appliances, aligners caused less gingival inflammation and better plaque control over a six-month period. Conversely, Wu et al. found minimal difference in periodontal status between removable and fixed devices, highlighting variability depending on patient compliance and hygiene. However, some adverse clinical events have been documented. Several studies report transient discomfort, mucosal irritation, and pain during the initial stages of treatment. Allareddy et al. analyzed the MAUDE database and identified over 100 cases of adverse effects linked to Invisalign use, including oral ulcers, stomatitis, systemic reactions, and rare cases of anaphylaxis. Awosika et al. detailed a case of angioedema, urticaria, and stomatitis in a patient with a confirmed acrylate allergy triggered by Invisalign use. These rare but significant hypersensitivity reactions emphasize the importance of allergological testing in susceptible individuals.
Chemical exposure through monomer release, particularly bisphenol A (BPA), is another concern vastly explored in in vitro studies. There is however a discrepancy between in vitro studies reporting levels below toxic thresholds and the only found clinical study by Kotyk & Wiltshire and Raghavan et al. Reporting on more significant levels of BPA present in patient saliva post-therapy, suggesting in vivo release under oral conditions. Whether such exposure has systemic hormonal effects remains inconclusive, though repeated and prolonged exposure may warrant further investigation.
In conclusion, clear aligners demonstrate a favorable safety profile in clinical settings, with most side effects being mild and reversible. Nevertheless, isolated reports of allergic reactions and mucosal lesions highlight the need for vigilance, especially in sensitized individuals. Future studies should prioritize long-term surveillance, biomonitoring, and inclusion of immune-related endpoints to comprehensively assess biocompatibility.

KEYWORDS
Clear aligners, Invisalign, adverse effects, allergic reaction, contact dermatitis, pain, oral mucosa, periodontal health, BPA, orthodontics

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Biocompatibility of dental materials – oral health effects Systematic In Vitro Review (2015–2025)

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ABSTRACT

The widespread clinical use of clear aligners and vacuum-formed thermoplastic retainers has prompted increasing scrutiny of their biological safety. These devices are typically worn intraorally for extended durations up to 22 hours per day making material biocompatibility a key concern. This systematic in vitro review aims to assess the cytotoxicity, chemical leachability, and potential endocrine-disrupting effects of commonly used materials, including polyurethanes, PETG (polyethylene terephthalate glycol), and emerging 3D-printed resins.

Following PRISMA 2020 guidelines, we screened five major databases (PubMed, Scopus, Web of Science, Cochrane Library, Google Scholar) and identified 17 eligible studies published between 2015 and 2025. These studies employed standard ISO 10993-5 protocols to evaluate cell viability (via MTT, AlamarBlue, and CCK-8 assays), hormonal activity (MCF-7 E-Screen), and chemical leachate profiling (LC-MS/MS, GC-MS). Most used human gingival fibroblasts (HGF) and keratinocytes as model cell lines, with a few studies exploring inflammatory responses (e.g., IL-6/IL-8 expression) or reactive oxygen species.

Across materials, results consistently showed no severe cytotoxicity. Cell viability typically exceeded 80%, with mild cytotoxicity (65–75%) noted in certain scenarios such as thermoformed PETG, suboptimal UV curing of 3D resins, or nanoparticle-modified surfaces. Endocrine activity assays demonstrated no significant estrogenic effects, and BPA (bisphenol A) release was minimal, ranging from 3–9 ng/mL, well below recognized safety thresholds. However, chemical leach profiles revealed the presence of minor monomers and additives, especially under aggressive extraction conditions. Importantly, variability in extraction protocols, durations (24 h to 30 days), media (culture medium, artificial saliva, ethanol), and cell types limits direct comparison between studies. Moreover, most experiments were performed under static conditions without simulating the mechanical, enzymatic, and microbiological environment of the oral cavity.

In conclusion, this review supports the general in vitro biocompatibility of current clear aligner and retainer materials, with no evidence of significant cytotoxic or endocrine-disruptive effects under standardized test conditions. Nonetheless, certain material modifications (e.g., nanoparticle coatings) may subtly alter biological responses, warranting further investigation. Future studies should adopt dynamic, multi-cellular models such as co-cultures with immune cells and 3D gingival equivalents and standardized chemical analysis to enhance clinical relevance and regulatory rigor. Such efforts are essential to ensuring the long-term safety of next-generation orthodontic devices, particularly those involving complex formulations and novel fabrication techniques like 3D printing.

KEYWORDS

Biocompatibility, clear aligners, orthodontics, cytotoxicity, BPA, thermoplastic materials, 3D printing, nanoparticle coatings, leaching, in vitro testing

Effect of laser Photo biomodulation on surface changes of NiTi Archwire in fixed appliances

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ABSTRACT

Gingival enlargement is a common complication of treatment with fixed orthodontic appliance, biocompatible stainless steel archwires (SS). Due to the retention areas, dental plaque accumulation is increased, which results in anaerobic conditions, favourable for periodontopathogenic bacteria. Therefore, it is reasonable to assume that periodontopathogenic bacteria can be found in patients with fixed orthodontic appliances. Organic deposits on the surface of archiweres were analyzed. 21 patients with fixed orthodontic appliances and gingival enlargement in the upper dental arch were included in the study.

For determination of periodontopathogenic bacteria Aggregatibacter actinomycetemcomitans Porphyromonas gingivalis, Prevotella intermedia, Tannerella forsythia and Treponema denticola the molecular microbiological method,GenoType Test System, was used. For surface analysis of new and in vivo exposed SS archwires, X-ray Photoelectron Spectroscopy was used. The average probing depth at the baseline was 3.76 ± 0.85 mm. Three types of periodontopathogenic bacteria, A. actinomycetemcomitans, T. forsythia and T. denticola, were found to be present. The thickeness of the oxide film on new SS archwires was 12 nm consisting of a double oxide layer of the Fe-oxide grown on the Fe-/Cr-oxide layer. During in vivo exposure, an organic film of plaque was grown on the SS archwires of thickness about 40 nm. Anaerobic periodontopathogenic bacteria can be found in patients with fixed orthodontic appliances. Therefore, special care is recommended during this kind of treatment.

KEYWORDS: biocompatible SS archwires, periodontopathogenic bacteria; gingival enlargement; fixed orthodontic appliance, X-ray photoelectron spectroscopy (XPS)

Magnesium-based resorbable membranes in periodontal regeneration: In vitro evaluation of osteoinductive potential

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ABSTRACT

Periodontitis is among the most prevalent chronic diseases globally, with severe forms affecting over one billion individuals. Contemporary periodontal therapy focuses not only on preventing the inflammatory and immune responses and tissue breakdown associated with the disease but also on the regeneration of lost periodontal tissues [1,2]. The field of periodontal and alveolar bone regeneration continues to be of significant scientific and clinical interest, particularly when considering an aging and increasingly health-conscious population. The preservation of natural dentition has consequently become a primary objective of modern, prevention-oriented dentistry.

Advances in the understanding of wound healing biology have catalysed the development of regenerative periodontology, which aims to enhance the long-term clinical outcomes of periodontal treatment [1,2]. Periodontal wound healing generally progresses through the classical phases: the inflammatory phase, granulation tissue formation, extracellular matrix deposition, and tissue remodelling. Successful regeneration requires the establishment of a conducive microenvironment that supports the proliferation and differentiation of mesenchymal progenitor cells originating from the periodontal ligament and alveolar bone [3].

The foundational cell theory proposed by Melcher in 1976 postulates that the nature and quality of regenerated periodontal tissues are determined by the specific cell types that initially colonize the root surface. This principle is the foundation of the concept of Guided Tissue Regeneration (GTR) [1,4]. For complete tissue regeneration, barrier membranes are an important element in regenerative treatment as they allow separation of bone and soft tissue components of periodontal or bone defect. Depending on the anatomical characteristics of the defect, these membranes may be applied with or without bone graft materials [1,4].

In efforts to improve volumetric stability of bone grafts during healing, first resorbable metallic membranes composed of magnesium have been introduced. Magnesium and its alloys are well known for their favourable mechanical properties, biocompatibility, and biodegradability, and are extensively used in various industries including aerospace, automotive, sports, and biomedical engineering [5,6]. Although magnesium-based materials were initially explored in biomedical applications in the early 20th century, their clinical use declined due to challenges such as rapid degradation, hydrogen gas release, and compromised mechanical integrity [5,7]. However, recent developments in magnesium bio-alloy technology have yielded materials with controlled degradation rates, improved biocompatibility, and enhanced osteoconductive properties [5,6,8].

The present study aims to evaluate biochemical and cell-biological performance of magnesium-based barrier membranes. Analyses of magnesium membrane biocompatibility, cell proliferation, and differentiation was performed on murine osteoblasts MC3T3-E1 in vitro. To our knowledge, no systematic in vitro or clinical research comparing magnesium membranes with established regenerative materials has been reported in the literature.

Our research shows favourable osteoinductive and osteogenic differentiation properties of magnesium membranes in comparison to standard collagen membranes, without exhibiting cytotoxic effects. These results highlight the potential of magnesium membranes for guided bone and tissue regeneration.

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Innovative Biomaterials for Periodontal Tissue Regeneration

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ABSTRACT

In the past ten years, a number of new biomaterials have been developed in the field of periodontal regenerative treatment.

Much interest has been directed towards the production of various polymer composite barrier membranes and multilayer barrier membranes. These membranes have also been used as growth factor and drug delivery systems. In addition, multiphase scaffolds for integrated periodontal regeneration have been developed (1,2). Cells (PDLSc, BMMSc) seeded directly into such a scaffold are a viable option to further increase the success of regeneration (2,3). In recent years, periodontal regeneration therapy has also focused on promising cell sheet technology and gene therapy. Hydrogels, complex 3D tissue constructs, shape memory smart materials, and immunomodulatory injectable microspheres are the latest engineering solutions (4). Since periodontal tissue is composed of different tissue layers, delivery of multiple bioactive agents is desirable. There are several methods to achieve temporal control of multidrug release (2).

Although some of these biomaterials have successfully demonstrated the formation of all periodontal tissues in vitro and in animal models, their efficacy needs to be further evaluated in human clinical trials. Despite the new technology, some issues of periodontal tissue regeneration remain unresolved.

KEYWORDS

Biomaterials, regeneration, barrier membrane, scaffold, cell sheet, hydrogel, temporal control

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Subperiosteal implants for severe maxillary bone loss

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ABSTRACT

The renewed application of subperiosteal implants, enhanced by digital technologies and advanced biomaterials, offers a promising solution for patients with severe maxillary ridge atrophy, who are unsuitable for conventional endosseous implants. This work presents a comprehensive workflow that integrates patient-specific design, 3D imaging, and additive manufacturing in developing patient-specific subperiosteal implants, emphasizing the critical role of biocompatible materials in enhancing osseointegration and clinical success.

A detailed digital model is created using high-resolution cone-beam computed tomography (CBCT) of the patient's midface, intraoral soft tissues, and complete denture. This provides the foundation for computer-assisted design and manufacturing of a subperiosteal implant tailored to the patient's anatomical and prosthodontic needs. The implant design is guided by the future prosthetic rehabilitation plan, ensuring optimal function and aesthetics. Titanium alloys, recognized for their biocompatibility and mechanical strength, are employed in the fabrication process. Following surgical placement, a temporary fixed prosthesis is fitted to the implant abutments. After the healing period, a definitive fixed or removable denture is fabricated to complete the rehabilitation process. Early clinical outcomes demonstrate enhanced functional and aesthetic results, shortened surgical time, and reduced postoperative complications.

This patient-specific, prosthodontically guided approach represents a fundamental shift in oral rehabilitation, particularly in cases of advanced jaw atrophy. It offers patients improved comfort, stability, and satisfaction where traditional options are limited.

KEYWORDS
Subperiosteal implants, titanium, severe maxillary atrophy, digital workflow, prosthodontic rehabilitation, patient-specific design, biocompatible materials.

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Clinical and laboratory evaluation of translucent zirconium oxide ceramics for dental prosthetic rehabilitation

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ABSTRACT

Translucent zirconium oxide ceramics stabilized with yttrium oxide (Y-TZP) have revolutionized dental prosthetic restorations due to their excellent mechanical properties, biocompatibility, and esthetic potential. Three interconnected studies evaluated the clinical and laboratory performance of monolithic translucent zirconia ceramics.

Clinically, 33 monolithic fixed dental prostheses (FDPs) fabricated from second-generation translucent zirconia (3Y-TZP) were placed in the posterior dental arches of 20 patients. After an average clinical follow-up of 112.6 months (range 85–137 months), the overall survival rate was 76%. Biologic complications, such as periodontal inflammation, caries, and pulpitis, were the primary reasons for prosthetic failure, while technical complications were minimal, with only one fracture observed in a connector area.

Four-unit self-glazed monolithic bridges produced via 3D gel-deposition technology were tested in laboratory investigations. After mechanical fatigue and accelerated aging, the average fracture forces ranged from 701.1 N to 763.4 N, without statistically significant differences compared to controls. These findings indicate that mechanical fatigue and accelerated aging do not significantly compromise fracture resistance, highlighting the durability of four-unit self-glazed monolithic bridges fabricated using 3D gel-deposition technology under simulated oral conditions

Further laboratory assessments were conducted on three different microstructures of translucent zirconia (3Y-TZP CC ZrInterdent, Katana Zirconia ML, IPS e.max ZirCAD Prime). Specimens underwent static and dynamic fatigue testing to evaluate the effects of polishing versus glazing. Polished specimens consistently exhibited higher flexural strength and fatigue resistance than glazed counterparts, particularly notable in the 3Y-TZP group, where glazing resulted in a statistically significant 25% reduction in strength compared to controls.

These collective findings underline the superior mechanical reliability of polished zirconia ceramics and the significant role of biological factors in long-term clinical outcomes. Laboratory simulations highlighted the limitations of glazing, emphasizing polishing as the preferable surface treatment to enhance long-term performance. Despite the promising mechanical properties demonstrated in vitro, biological factors influence clinical success, indicating that future research and clinical protocols must emphasize comprehensive patient management and material selection.

KEYWORDS

Translucent zirconia, Y-TZP, prosthodontics, monolithic FDPs, mechanical fatigue, accelerated aging, surface treatment, glazing, and polishing.

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Tissue vs. Bone-Level Zirconia Implants: 2.5-Year Outcomes from an RCCT

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ABSTRACT

Aim: This pilot study compares two-piece zirconia implants with bone-level (BL) and tissue-level (TL) platforms over two years following restoration, as part of an ongoing randomized clinical trial. No studies have directly compared different two-piece zirconia implant designs or evaluated their stability using resonance frequency analysis (RFA). The study includes seven patients missing maxillary premolars, forming part of a larger randomized controlled clinical investigation.

Materials and Methods: Ten zirconia implants featuring a BL or TL platform (Z5-BL/Z5-TL, Z-Systems) were placed according to the Type 4 protocol. Implant stability was measured using implant stability quotient (ISQ) values immediately after placement and again following prosthetic loading. Four months after implantation, lithium disilicate crowns were cemented onto ceramic abutments.

Results: All ten zirconia implants successfully osseointegrated and were prosthetically restored, with a mean follow-up of 35.11 months. Initial ISQ values ranged from 73 to 79, rising to 76 and 84 after 3–4 months, indicating strong implant stability. Marginal bone loss (MBL) was slightly greater around BL implants, averaging 0.46 mm (range: 0.15–0.77 mm), compared to 0.2 mm (range: 0–0.38 mm) for TL implants. Despite this, probing depths remained stable at 2–3 mm for both implant types, with minimal bleeding on probing observed.

Conclusions:Two-piece zirconia implants with a TL platform demonstrated favorable outcomes regarding osseointegration, stability, and marginal bone preservation, comparable to those of titanium implants. In contrast, BL zirconia implants showed slightly higher MBL and occasional fixation screw fractures, suggesting potential mechanical limitations with this design.

KEYWORDS: zirconia implants; ceramic; two-piece; bone-level; tissue-level; implant stability; ISQ;

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Stereophotogrammetry – the clinical use

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ABSTRACT

Introduction: Our aim is to demonstrate the application of the stereophotogrammetry imaging system in clinical settings by assessing the effectiveness of orthodontic-orthopaedic treatment of Class III malocclusion as early as in the early mixed dentition phase. When initiated during the prepubertal period, orthodontic-orthopaedic therapy can influence jaw positioning, which is accompanied by corresponding changes in the surrounding soft tissues.

Methods: Study aimed to assess the effectiveness of rapid maxillary expander combined with face mask therapy by analyzing three-dimensional soft tissue facial features in prepubertal children with Class III malocclusion (Mandall et al., 2010). The study included 64 white children aged 6 to 8 years, divided into two groups: 32 with Class III malocclusion (CLIII) and 32 without (non-CLIII).

Results: We used the 3D stereophotogrammetry technique (3dMD) to capture three-dimensional facial surface images. This technology is based on the principle of triangulation, employing multiple cameras and various light sources with specific wavelengths for enhanced accuracy. The cameras simultaneously capture images from different angles, forming a triangle between the object and the cameras. The 3dMD setup includes three synchronized digital cameras on each side of the face (one in colour, two in infrared). A computer system processes and calibrates the 3D coordinates of both facial sides. A key advantage is the extremely fast scan time of 1.5 milliseconds, making it highly suitable for paediatric patients, with an accuracy of 0.5 mm (Kau et al., 2010).3D facial surface scans were captured at two time points—before treatment (T0) and after treatment (T1). The captured 3D images were resized in the Rapidform software, aligned using the best-fit algorithm, and then rescaled for analysis. Results: We generated both qualitative and quantitative outputs displayed as colour maps. At T0, the CLIII group displayed less pronounced midface features and a more prominent mandible compared to the control group. By T1, no statistically significant differences remained between the groups, suggesting effective treatment outcomes. After the treatment, noticeable changes were observed. Surface-based comparisons post-treatment indicated forward movement in the midface and upper lip regions. In contrast, the lower lip and chin moved backward in the CLIII group but slightly forward in the non-CLIII group.

Discussion: Orthodontists can influence facial appearance and soft tissue positioning by modifying the underlying skeletal structures and dentition. Enhancing facial aesthetics and achieving balanced facial proportions are key factors in evaluating the success and long-term stability of orthodontic interventions.By applying the 3dMD imaging system, we were able to assess the outcomes of an orthodontic treatment approach. The method's non-invasive nature, precision, simplicity, and child-friendly design make it ideal for routine clinical use—for both diagnosis and treatment—across all age groups, including young children.

Conclusions: Following rapid maxillary expander and face mask therapy, there was an anterior displacement of the maxilla, and posterior movement of the mandible. These changes brought the facial proportions of CLIII patients in line with those of non-CLIII peers, contributing to a more balanced and harmonious facial appearance. The findings were achieved using a non-invasive stereophotogrammetry 3D imaging method.

KEYWORDS

3D Stereophotogravimetry, face mask therapy

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LLLT biostimulation technology affects the clinical state of periodontal tissues during orthodontic levelling phase

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ABSTRACT
Photobiomodulation (PBM) is a therapeutic technique that uses low-energy red and near-infrared light to stimulate cellular regeneration and function. Its effects are primarily mediated through absorption by cytochrome-c oxidase, followed by nitric oxide (NO) release, gene transcription, and indirect signaling via bioactive molecules.
In this clinical cross-sectional study, 32 subjects (10 males, 22 females; mean age 14.6 ± 2.0 years) undergoing fixed orthodontic treatment for dental crowding were included. The experimental group (N = 14) received PBM using the Ortholumm ML5/1 lamp (wavelengths: 625, 660, and 850 nm; energy density: 1.0 J/cm²/min), administered twice weekly for four weeks, 10 minutes per session. The control group (N = 18) received a sham treatment using a standard incandescent bulb following the same protocol.
Inflammation of soft tissues was assessed using the dichotomous Plaque Index (PI), Sulcus Bleeding Index (SBI), and the presence of gingival hypertrophy (defined as a free gingival margin ≥1 mm occlusal to the enamel–cement junction).
No significant differences were found in PI or SBI between groups at any time point. Gingival hypertrophy after one month was significantly more frequent in the control group (t-test, $p = 0.041$). Partial Least Squares regression ($R^2 = 0.068$) showed that neither treatment group nor gender significantly predicted hypertrophy count.
These findings confirm a lower incidence of gingival hypertrophy following PBM therapy, although no differences were observed in plaque or bleeding indices.

KEYWORDS
Photobiomodulation (PBM); Orthodontic treatment; Gingival hypertrophy; Plaque Index (PI); Sulcus Bleeding Index (SBI); Near-infrared light; Inflammation

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Digital Planning of Rapid Palatal Expander

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ABSTRACT

Biocompatibility is a key concept in medicine, referring to the ability of a material to not cause harmful effects when in contact with a biological environment. In dental medicine, biocompatibility is defined as the ability of a material to elicit an appropriate biological response in the oral cavity. This means that the material must function in a way that does not harm the patient's health, does not cause toxic reactions, allergies, or inflammation, and is stable and durable (resilient).

In dental medicine, these materials are constantly exposed to the complex environment of the oral cavity, which includes mechanical stress, pH changes, and the presence of bacteria and saliva.and cobalt-chromium (CoCr) alloys. These alloys are used due to their excellent mechanical properties, such as high strength, corrosion resistance, and suitable elastic characteristics. Numerous studies have shown surface changes in both new and used metal alloys due to corrosion processes. Modern laboratory dental prosthetics is a key part of dental medicine, enabling a high-level approach and the production of quality dental prosthetic replacements that improve both functionality and aesthetics for the patient.
In maxillofacial and dental orthopedics, new technologies have enabled the digital fabrication of devices for rapid maxillary expansion using CrCo alloys and stainless steel. A maxillofacial orthopedic device for rapid maxillary expansion is placed in the oral cavity during the active expansion phase, followed by a retention period lasting up to six months. The purpose of this work is to present cobalt-chromium alloys, stainless steel 304L, and stainless steel 316L, which are used in maxillofacial orthopedic devices for rapid maxillary expansion made by digital methods. The study include a used rapid maxillary expansion device made by digital method from CoCrMoW material and stainless steel 304L. The surface properties were analyzed using scanning electron microscopy (SEM), energy-dispersive spectroscopy (EDS), and XRD for chemical analysis and X-ray Photoelectron Spectroscopy (XPS)

The results of our study confirmed that both cobalt-chromium alloy (CoCrMoW) and 304L stainless steel are suitable materials for use in orthodontic appliances. Using the XPS method, the chemical composition of the surface and the oxide layer below the surface was analyzed to a depth of 50 nm. We found that there is an oxide layer of Cr2O3 oxide on the surface of the orthodontic appliance, which is about 20 nm thick. The presence of Cr2O3 oxide indicates a biocompatible layer that covers the apparatus for the rapid palatal expander.

KEYWORDS
Rapid palatal expander, biomaterials, CoCrMo, SS 304L, Additive manufacturing, CAD/CAM

Young Surgent Session

Repeatability analysis of mechanical muscle activity with muscle contraction (MC) sensors: a time series and discrete variable approach for the vastus medialis muscle

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ABSTRACT

Background

The aim of this study is to investigate the repeatability of measurements of mechanical muscle activity with a muscle contraction sensor (MC) on the vastus medialis muscle. By comparing time series and discrete variables, we aim to validate the reliability of the MC sensor signals under controlled dynamic conditions.

Methods

Seventeen subjects aged 19-40 years participated. The MC sensor, positioned on the vastus medialis muscle, recorded muscle activity during electrical stimuli. Immediate, intermediate, and delayed repeatability were assessed. Time series analysis examined temporal variations, while discrete analysis evaluated standard parameters from twitch contraction studies. Cross-correlation coefficients and intraclass correlation coefficients (ICC) were calculated.

Results

Cross-correlation analysis showed a strong similarity between the sensor signals (0.995, 0.992, 0.975) with minimal time delays (0.39ms, 0.79ms, 0.78ms). High ICC values for magnitude of amplitude (0.999, 0.998, 0.994), delay time (0.995, 0.994, 0.969) and time to reach maximum amplitude (0.973, 0.953, 0.963) indicated consistent measurements. Despite a slight decrease from immediate to delayed repeatability, ICC values remained high.

Conclusion

The MC sensor demonstrates reliable and repeatable measurements of mechanical muscle activity. This technology offers potential advantages over traditional methods such as EMG and MMG as it provides direct insights into muscle tension and activation dynamics.

Keywords:

MC sensor, muscle activity, repeatability, intraclass correlation, cross-correlation.

Types of materials used in knee implants

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ABSTRACT
Knee endoprosthesis require materials that replicate the complex biomechanics of the knee joint while ensuring durability, biocompatibility, and functional longevity. The knee's anatomy, comprising the tibiofemoral and patellofemoral joints, exhibits intricate motions such as the screw-home mechanism, which stabilizes the joint during extension through rotational locking. These dynamic biomechanical demands necessitate implant materials with high mechanical strength, wear resistance, corrosion resistance, and biological compatibility.
Cobalt-chromium (CoCr) alloys, including cast CoCrMo and wrought CoNiCrMo, have long been employed in knee implants for their exceptional stiffness (200–300 GPa), fatigue resistance, and structural integrity. Cast CoCrMo's coarse dendritic microstructure, reinforced with molybdenum carbides, offers wear resistance suitable for bearing surfaces, while wrought CoNiCrMo, with finer grains, provides superior tensile and fatigue properties for implant stems. Despite excellent corrosion resistance, CoCr alloys are susceptible to galvanic corrosion when in contact with dissimilar metals.
Titanium and its alloys, notably commercially pure titanium and Ti-6Al-4V, are favored for their excellent biocompatibility, lower elastic modulus (~110 GPa), and natural corrosion resistance via a self-forming TiO_2 oxide layer. Cementless fixation enabled by porous coatings promotes bone ingrowth, reducing osteolysis and implant loosening. However, titanium's relatively lower wear resistance and susceptibility to crevice corrosion require ongoing material improvements.
Ceramic materials such as alumina and zirconia are employed primarily for bearing surfaces due to their extreme hardness, chemical inertness, and minimal wear debris generation, which lowers osteolysis risk. Their brittleness, however, poses fracture risks, limiting their applications.
Ultra-high molecular weight polyethylene (UHMWPE) remains the gold standard for bearing surfaces due to its abrasion resistance and biocompatibility, though wear particles can induce inflammation and implant failure. Highly cross-linked polyethylene (HXLPE), especially vitamin E-stabilized variants, enhances wear and oxidative resistance.
Emerging materials like polyether ether ketone (PEEK) and carbon fiber-reinforced PEEK (CFR-PEEK) offer promising alternatives, combining biocompatibility, radiolucency, and mechanical properties closer to bone. CFR-PEEK demonstrates wear performance comparable or superior to UHMWPE when articulating against metallic or ceramic surfaces.
Overall, material selection in knee endoprosthesis balances mechanical demands, wear resistance, and biological responses to optimize implant success and patient outcomes.

KEYWORDS
Knee endoprosthesis, biomaterials, cobalt-chromium alloys, titanium alloys, ultra-high molecular weight polyethylene, ceramic materials, polyether ether ketone.

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Knee injection therapy

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ABSTRACT
Knee pain is a prevalent musculoskeletal complaint, accounting for approximately 5% of primary care visits. Common etiologies include osteoarthritis (OA), patellofemoral pain, and meniscal or ligament injuries. Intra-articular injection therapy serves as a non-surgical, conservative modality for symptom relief and, at times, diagnostic clarification. Four primary types of knee injection therapies are currently in use: corticosteroids, hyaluronic acid (HA), platelet-rich plasma (PRP), and mesenchymal stromal cells (MSCs), each with distinct mechanisms, efficacy profiles, and indications.
Corticosteroid injections, the most established form of intra-articular therapy since the 1950s, are especially effective in early-to-moderate OA (Kellgren-Lawrence grades 1–3), with analgesic effects lasting up to 24 weeks, by some reports. Their anti-inflammatory action derives from reduced vascular permeability, immune cell infiltration, and prostaglandin synthesis. Despite their safety profile, risks such as transient hyperglycemia and rare cases of septic arthritis exist. HA injections, employed for over three decades, are preferred when first-line conservative treatments fail or surgery is contraindicated. HA restores the viscoelastic properties of synovial fluid, offering lubrication, shock absorption, and chondroprotection. While generally safe, HA is costlier than corticosteroids but may provide symptomatic relief for up to six months. PRP therapy, involving autologous platelet rich plasma, demonstrates potential in promoting joint homeostasis. Evidence supports its effectiveness for up to 12–24 months, particularly when administered in multiple doses. However, standardization issues in PRP preparation limit reproducibility across studies. MSCs, derived from autologous bone marrow or adipose tissue, exhibit immunomodulatory and regenerative capabilities. Although promising in early OA, their chondrogenic efficacy remains under investigation. The use of MSCs in combination with PRP or HA may enhance therapeutic outcomes. Safety concerns are minimal, though optimal dosing and protocols remain to be determined. Proper injection technique is critical for success, with the inferolateral quadrant frequently utilized. While these therapies do not reverse joint degeneration, they offer viable symptom management and may delay surgical intervention.

KEYWORDS
Osteoarthritis, intra-articular injections, corticosteroids, hyaluronic acid, platelet-rich plasma (PRP), mesenchymal stem cells (MSCs), knee pain management.

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Biomimetic osteochondral scaffold with MSCs augmentation for the treatment of knee joint surface lesions.

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ABSTRACT
Introduction: Multilayer osteochondral scaffold are increasingly being used in the treatment of knee joint surface lesions (KJSLs), both self-contained and biologically enriched by cells. However, despite its increasing use in clinical practice, the literature on this type of treatment is quite limited. Purpose: 1) To analyze the performance and safety of a biomimetic osteochondral scaffold with the addition of enriched bone marrow aspirate (fBMA) for the treatment of KJSLs; 2) Identify predictive factors that potentially affect treatment outcomes and safety.
Methods: Patients who were treated for KJSLs (size over 1.5 cm2, ICRS grade III-IV) in the years 2014 to 2020 at the Orthopaedic Clinic in Ljubljana with this approach were included in the registry. Treatment outcomes were monitored using standardized questionnaires (PROMs) on knee function (KOOS), general quality of life (EQ-5D), and activity (TAS), as well as recording serious adverse events (SAEs) and implant failure (GF). We compared their pre- and post-operative values. We used regression analysis to examine the impact of potential predictive factors on treatment outcomes and safety.
Results: With a mean follow-up time of 54.2 (19.4) months, 78 (87%) of the enrolled patients completed the control PROMs questionnaires. All categories of PROMs improved significantly according to Bonferroni correction ($p < 0.00625$) compared to preoperative values: KOOS category Pain 62 (17) to 79 (18), KOOS Total 57 (16) to 70 (20), EQ-VAS 61 (21) to 76 (16), EQ-5D-3L 0.57 (0.20) to 0.80 (0.21) and TAS 2.8 (1.5) to 3.9 (1.9). The GF rate was 4 %. Previous interventions, duration of preoperative symptomatics, KJSL size, age, gender, as well as newly assumed CSS scores and CFU-F colony count have been shown to be predictive factors with a significant impact on treatment outcomes.
Conclusion: The approach of treating KJSLs with CHAS and fBMA supplement has been shown to be an effective and safe procedure up to the medium-term follow-up period. Based on the analysis of potential prognostic factors, it is recommended to perform the procedure in a timely and accurate manner in order to prevent an increase in KJSLs, worsen the general condition of the treated knee joint and avoid revision procedures, which is especially true for elderly patients and women. When biological enrichment with cells is available, the principle of "more is better" is more successful.

Multilayered biomimetic scaffolds in the osteochondral treatment of the talus.

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ABSTRACT
Introduction: The daily incidence of ankle injuries is 1 per 10,000 active people. A certain degree of involvement of the articular surface of the upper ankle joint is present in as many as 70% of acute ankle sprains. Osteochondral lesions of the thallus (OLTs) thus represent a relatively prevalent pathology with a significant impact on the patient's functionality and quality of life, and if inadequately treated, they inevitably lead to the development of a degenerative form of articular disease. Replacement of the damaged articular surface with the same type of hyaline cartilage represents one of the major challenges of advanced orthopaedic surgery, and the range of techniques that potentially lead to the formation of biochemically and biomechanically equivalent tissue is very limited. Biomimetic multilayer carriers are among the most promising in this area, but the literature is very limited, which prompted us to systematically review the available studies of this type of treatment.
Methods: We performed a systematic review in three databases to identify studies that addressed the treatment of OLTs with multilayer biomimetic carriers. In doing so, we have taken into account the PRISMA guidelines for conducting this type of research. In the search, we used the following string: (cartilage OR chondral OR osteochondral) AND (scaffold OR matrix OR implant) AND (ankle OR talus). Relevant data from the included studies (year of publication, type of study, number of patients, demographics, characteristics of OLTs, type of vehicle used, length of follow-up time, results and complications) were recorded and included in the qualitative analysis. We used the Coleman Methodology Score (CMS) to assess the methodological quality of the studies.
Results: The search string yielded 1258 results. Taking into account the PRISMA guidelines, 10 studies with a total of 87 patients were eligible for inclusion in the study after the search, review and selection process. In the field of OLTs treatment, only three multiple osteochondral replacements have been tested in clinical use. Among them, the carrier TruFit (Smith & Nephew, Andover, MA, USA) has already been withdrawn from the market due to unfavorable results. Significantly different results were recorded by the other two holders (MaioRegen, Finceramica, Italy; Agili-C, Cartiheal, Israel), which achieved significant clinical improvement in more than 80% of studies. The radiological results are less consistent, especially in terms of the filling of the lesions and the structure of the resulting tissue.
Conclusion: The results, especially clinical, indicate the promising potential of some multilayer biomimetic carriers for the treatment of even the most complex OLTs. Nevertheless, the number of studies and patients enrolled is extremely limited, so further well-designed studies are crucial in developing this promising field.

Guidelines for the treatment of osteoporotic vertebral fractures

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ABSTRACT
Osteoporotic vertebral fractures commonly occur in elderly patients with reduced bone mineral density, typically resulting from low-energy trauma. These fractures significantly affect mobility, quality of life, and overall health, presenting with acute, localized pain exacerbated by movement, height loss, and progressive kyphosis, although some cases may remain asymptomatic. Accurate differentiation from pathological and high-energy fractures requires careful radiological assessment, including computed tomography (CT) and magnetic resonance imaging (MRI).
The AO Spine–DGOU Osteoporotic Fracture (OF) Classification System, combined with treatment recommendations from the Spine Section of the German Society for Orthopaedics and Trauma (DGOU), provides clear guidelines for managing these fractures. The classification divides fractures into five types (OF 1–5) based on vertebral body deformity, posterior wall involvement, and structural integrity. Conservative treatment with analgesics and physiotherapy is typically recommended for fractures OF 1 and OF 2, which involve minimal vertebral deformation. In contrast, more severe fracture types (OF 3–5), indicating substantial structural damage and possible instability, usually require surgical intervention, including spinal fixation and/or cement augmentation, to restore stability and alignment. Spinal orthoses remain a supportive option in fractures classified as OF 2–5 when nonsurgical management is chosen.
These guidelines provide a reliable basis for selecting appropriate treatment strategies for osteoporotic vertebral fractures, taking into account fracture severity, patient condition, and clinical symptoms.

KEYWORDS
Osteoporotic vertebral fractures; Osteoporosis; Fracture classification; Conservative treatment; Surgery; Fixation; Cement augmentation; Orthoses

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YOUNG STUDENT SESSION

3D printed Titanium Porous Endosteal Collar for Tumor Megaendoprostheses

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ABSTRACT
Large endoprosthetic implants are widely used in skeletal reconstruction surgery, including orthopaedic oncology and complex revision arthroplasty with severe bone loss (Haider et al., 2023). Reconstruction with tumor megaendoprostheses prevents the need for amputation and allows for immediate mechanical stability and functional recovery of patients. The most common locations for tumor endoprosthetic replacements are distal and proximal femur, proximal tibia and proximal humerus (Kim, 2015).

The reported complication rate for reconstruction with megaendoprostheses is 5-10 times higher than in routine total joint arthroplasties (Shehadeh et al., 2010). This may be due to the difference in functional demand between active young patients with bone sarcomas compared to elderly patients who require joint arthroplasty due to osteoarthritis. Additionally, longer survival rates of patients allow for them to outlive the expected functional life of megaendoprosthesis. This significantly increases the number of patients requiring revision surgery (Shehadeh et al., 2010). Complications following endoprosthetic reconstruction include mechanical and biological problems. Aseptic loosening accounts for approximately 25% of revisions (Jeys et al., 2008) and is often associated with the loss of cortical bone at the point of contact between the bone and the stem of endoprosthesis (Mumith et al., 2017).

There have been several attempts to improve endoprosthetic designs in order to improve ingrowth and osseointegration at the collar-bone interface and thereby reduce the risk of aseptic loosening. Several in vitro studies were conducted using novel porous endoprosthetic technologies (Guo et al., 2019; Li et al., 2016; Xu et al., 2013). Using the newer porous materials they found favourable cytocompatibility and bone growth (Li et al., 2016), superior cell adhesion and proliferation (Guo et al., 2019), and comparable compressive strength to that of the cortical bone (Xu et al., 2013).

AdlerOrtho's Pantheon limb salvage system has been on the market for 5 years and features one of novel endoprosthesis collar designs. It consists of a fully porous (1000 microns pore size) 3D printed titanium bridging collar with an endosteal porous sleeve. The porous titanium collar off-loads the stem and redistributes the load into surrounding bone to promote bony integration (Li et al., 2016; Stevenson et al., 2024; Xu et al., 2013). Some recent in vivo studies compared novel porous endoprosthesis collars and traditional, non-porous collars; they found consistently better and faster bone ingrowth in porous design. In traditional, non-porous collars, bone resorption occurred more often while there were no radiographic signs of implant loosening in porous prostheses (Haider et al., 2023; Rajasekaran et al., 2021; Stevenson et al., 2024).

From March 2024 until April 2025, 7 patients received megaendoprostheses with the new 3D-printed porous titanium collars at the University Medical Centre Ljubljana, Department of Orthopaedic Surgery. So far, the implants have shown stable fixation with no signs of loosening. Nevertheless, long-term follow-up in arthroplasty registries will be required to confirm favourable findings in clinical practice.

KEYWORDS
Limb reconstruction surgery, porous design, 3D-printed titanium collar, aseptic loosening.

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Infection risk analysis in silver-coated endoprosthesis

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ABSTRACT
Because of bone defects due to resection of bone tumors or following several arthroplasty procedures in the same joint, tumor endoprostheses or megaendoprostheses have become one of the most important ways of retaining the function of the primary bone structure. However, the introduction of foreign materials into the body increases the risk of infection, as well as biofilm formation on the surface of artificial materials (Pala et al., 2022). Bacterial biofilm is a complex community of bacteria attached to the implant surface and encased in a self-produced matrix; this matrix, composed of substances like proteins, polysaccharides, and DNA, protects the bacteria from external threats like antibiotics and the immune system. In recent years, researchers have focused on preventing biofilm and infections rather than removing the prosthesis altogether, as is often the case once biofilm is formed (Veerachamy et al., 2014). One of the promising materials in recent studies is silver (Bulut et al., 2025). Silver can ionise in body fluids with low pH, such as the environment of metabolising bacteria. In its ionised form, silver can bind to transmembrane proteins, ribosomes, or even bacteria DNA, which makes them unable to function properly (Lansdown, 2006).

The Department of Orthopaedic Surgery, University Medical Centre Ljubljana performed one of the first independent study of silver-covered endoprosthesis, of the type MUTARS® (Modular Universal Tumor And Revision System). The study was following 101 patients with silver-coated endoprostheses and monitoring their infection rate and implant survival. Secondarily followed parameters were also the factors of age, gender, preoperative diagnosis and anatomical localisation of reconstruction. They took note of the number of surgical revisions, partial or total implant removal (assessed after 1, 2 and 5 years), infection free implant survival rate, and presented them with the COX regression model with a statistical significance of $P \leq 0,05$. Of 101 patients, 30 required at least one surgical revision (median 1.1 years after initial implantation), 18 endoprostheses had to be partially replaced or removed. There were 5 local tumor relapses. 33 patients died of oncological disease. Infection rate was 15% (of which 5 were recurring infections, 10 were newly acquired deep infections). 9 implants had to be explanted due to infection. Replacement incidences were 4% after 1 year; 15% after 2 years and 25% after 5 or more years (Mavčič et al., 2019).

The results of our institution were comparable to similar studies from other bone tumor centres. There was a high variability between patients with different anatomical localisation of the implant and different anatomical diagnosis. Age was identified as an independent risk factor of infection in spite of silver coating. In recent meta-analyses, silver-coated implants showed consistently lower infection rates (Bulut et al., 2025; Clinger et al., 2021; Diez-Escudero and Hailer, 2021; Fiore et al., 2023, 2021), although the difference in comparison to conventional non-coated implants was not as dramatic as expected initially. It seems that silver-coating is just one out of multiple factors that can decrease the risk of infection or enhance infection treatment with implant retention, in combination with other crucial cofactors (general patients' immune status, comorbidities, length of surgical procedure, soft-tissue coverage and antibiotic prophylaxis).

KEYWORDS
Endoprosthesis, biofilm, infection, silver, silver-coated, implant survival, revision surgery.

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Patent foramen ovale

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ABSTRACT
A CASE REPORT
A 58-year-old active male with hypercholesterolemia, treated with simvastatin, experienced a sudden onset of motor aphasia. He had no risk factors for cardioembolic complications (e.g. paroxysmal atrial fibrillation, carotid artery atherosclerosis, or abnormal findings on transthoracic echocardiogram), and brain MRI showed no pathological findings. The patient fully recovered without any neurological deficits. However, transcranial Doppler (TCD) revealed a highly positive result, indicating a significant right-to-left shunt, most commonly associated with a patent foramen ovale (PFO).
The patient underwent successful PFO closure using an Amplatzer PFO occluder - a transcatheter device designed to close a PFO in a minimally invasive manner.
PATENT FORMANE OVALE
A PFO is a flap-like opening between the left and right atria of the heart. It is physiologically open during fetal life but normally closes after birth. In approximately 25% of the population, it remains open, potentially leading to a cryptogenic stroke.
Treatment options include anticoagulant therapy or a percutaneous PFO closure procedure. Randomised trials have shown that PFO closure significantly reduces the risk of recurrent stroke compared to antiplatelet or anticoagulant therapy alone.
Structurally, the device consists of two self-expanding discs made of nitinol, connected by a short central waist that anchors the device within the PFO. A thin polyester fabric is sewn into each disc to encourage tissue growth and promote long-term closure. The device also includes a proximal screw for precise positioning and deployment. Radiopaque markers at both ends enhance fluoroscopic visualization during the procedure.
The device is indicated for use in patients aged 18 to 60 years who have experienced a cryptogenic stroke likely caused by paradoxical embolism through a PFO. It is important to note that patients with a nickel allergy may experience an allergic reaction due to potential nickel release from the device, which can continue for at least 60 days post-implantation.

KEYWORDS
Patent foramen ovale, cryptogenic stroke, PFO closure, Amplatzer PFO occluder, nitinol, polyester fabric, percutaneous cardiac procedure.

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Veno-venous ECMO in COVID-19 patient

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ABSTRACT
VV ECMO (veno-venous extracorporeal membrane oxygenation) is a temporary mechanical assistance device used in patients with life-threatening respiratory failure (1).

CASE REPORT
To illustrate the utility of VV ECMO devices, we present a case of a 59-year old male patient who suffered from critical respiratory insufficiency caused by a COVID-19 infection. The patient had a complicated medical history with a heart transplant and consequent immunosuppressive therapy. He also presented with Pseudomonas pneumonia and invasive pulmonary aspergillosis. the patient was mechanically ventilated with 100% oxygen, inhaled NO and pronation were also added as a rescue measure. The interventions proved to be insufficient in providing desired oxygenation, therefore a VV ECMO was inserted. After 3 days patient's lungs improved and ECMO was removed.

ECMO
VV ECMO was developed in 1970 but its use became widely popularised during the H1N1 influenza epidemic in 2009. The primary goal of the device is blood oxygenation and removal of carbon dioxide (2). Besides the veno-venous ECMO, veno-arterial ECMO also exists and is used for cardiac failure. VV ECMO is used strictly for respiratory insufficiency, which can be hypoxemic and/or hypercapnic but cannot be managed with standard invasive mechanical ventilation (1).
VV ECMO can supply all metabolic oxygen requirements. Blood is taken from a central vein and ran through a membrane oxygenator where oxygen is added and carbon dioxide is removed. Blood is then returned to the right atrium. In this way we can bypass the lungs which do not provide the patient with sufficient gas exchange (3). The two cannulas are inserted percutaneously, ultrasound guided. The first cannula is usually put in the femoral vein, but can also be inserted in the jugular. The second cannula goes in the right atrium where oxygenated blood is returned (1).
The cannulas are made with reinforced stainless steel wire. Since preventing blood clotting is mandatory in ECMO, a surface coating such as heparin or bivalirudin is applied. Haemorrhage, venous spasm, arrhythmia, pneumothorax and ruptured vessels are examples of cannula insertion complications. The membrane is made of a gas exchange material such as solid silicone rubber, a microporous hollow-fibre (polypropylene) or a solid hollow-fibre membrane (polymethyl pentane) (1). Again, coagulation control is crucial so the membrane also has an anticoagulant coating (most commonly heparin). To increase biocompatibility a coat of phosphoryl choline for example can also be added, although different manufacturers use a variety of coating combinations (4). Production of ECMO membranes is a complicated process, currently the TIPS (thermally induced phase separation) method is preferred due to less variation in porosity and pore size (5).

CONCLUSION
VV ECMO is used as a "bridge" measure and can provide a temporary alternative to the patient's lungs. While it doesn't provide a long-term solution, it can save lives of people with respiratory failure where we can expect a good quality of life after rehabilitation (3).

KEYWORDS
VV ECMO, COVID-19, respiratory insufficiency, membrane.

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Use of CytoSorb Therapy in a Patient with Septic Shock: A Clinical Case Report

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ABSTRACT

CASE REPORT

This clinical case report presents the use of CytoSorb therapy in a 41-year-old male patient admitted to the intensive care unit with septic shock caused by cellulitis of the right lower extremity.

The patient's past medical history included lung transplantation due to pulmonary arterial hypertension, hypothyroidism, primary hypogonadism, stage 3 chronic kidney disease, chronic atrial fibrillation, and a subarachnoid hemorrhage in 2017.

Upon admission, the patient was confused, poorly responsive, and hemodynamically unstable, requiring vasopressor support. Initial treatment involved broad-spectrum antibiotics, vasopressors (norepinephrine, vasopressin), inotropic support (dobutamine), and hydrocortisone. Streptococcus pyogenes was isolated from the wound swab. He developed multiple organ failure, including kidney and liver dysfunction, and septic cardiomyopathy with right ventricular dysfunction. Laboratory findings revealed elevated inflammatory markers and lactate levels, with interleukin-6 reaching 31,699 pg/mL. Due to the extremely high levels of inflammatory mediators, CytoSorb therapy was indicated. Following CytoSorb therapy initiation, the patient underwent hemodialysis due to acute kidney injury. Clinical improvement was observed: hemodynamic stability was restored, inflammatory markers decreased, and vasopressor requirements diminished. The patient eventually recovered and was successfully discharged from the hospital.

CYTOSORB

CytoSorb is a widely used blood purification device for non-selective cytokine removal (Cytosorbents, 2016; Becker et al., 2023). It utilizes a hemoadsorption cartridge containing biocompatible polymer beads with a large surface area (Cytosorbents, 2016). The device removes hydrophobic molecules up to 55 kDa, including pro- and anti-inflammatory cytokines (e.g., IL-1β, IL-6, TNFα, IL-10), free hemoglobin, bilirubin, and myoglobin (Cytosorbents, 2016; Becker et al., 2023). It is employed in conditions with cytokine storms, such as sepsis, ARDS, COVID-19, cardiac surgery, and various critical illnesses (Cytosorbents, 2016; Becker et al. 2023).

CONCLUSION

Systemic inflammatory response syndrome (SIRS) exacerbates patient outcome by uncontrollable cytokine release (Jaffer et al., 2010). In this case, CytoSorb therapy significantly contributed to the stabilization and recovery of an immunocompromised patient after lung transplantation suffering from septic shock.

KEYWORDS

CytoSorb, septic shock, cytokine removal, blood purification, immunosuppression, SIRS, sepsis treatment, critical care, intensive care, clinical case report.

ACKNOWLEDGEMENT

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Dislocation of UHMWPE liner after total hip replacement, A case study

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ABSTRACT
Dislocation of the Polyethylene liner (UHMWPE) from the Ti6Al4V metal alloy cup was accompanied by severe metallosis and represents a rare complication after total hip arthroplasty (THA) in the first months after surgery. Understanding the risk factors for liner dislocation has great clinical relevance for every hip surgeon as to consider different surgical options for effective planning and treatment. Liner placement, liner locking mechanism, impingement, surgical technique all plays a crucial roll in keeping the liner within he acetabular cup. We present a case study of a 61-year-old female patient who was admitted to our clinic for revision surgery after THA due to pain, limited range of motion, audible crepitus, and radiographic signs of acetabular polyethylene inlay wear. The initial THA was performed 18 months prior. There were no signs of aseptic loosening or infection. Based on these findings and the clinical presentation, revision surgery was deemed necessary.
Scientific databases were accessed to identify research papers dealing with prevention and treatment of liner dislocation after THA. We performed a search using the keywords 'revision hip arthroplasty' and 'dislocation', 'instability', 'outcome', 'failure', 'treatment'.
The retrieved implant parts, ceramic acetabular head, UHMWPE liner and Ti6Al4V alloy acetabular head were the object of a detailed tribological investigation. Digital stereo light microscopy was used for large parts and surfaces, Field Emission Scanning Electron Microscopy with integrated EDS technique and low vacuum Scanning Electron Microscopy were used to investigate the detailed surface chemistry of the metal alloy, ceramics and the thin film of titanium alloy on the surface of the ceramic head. It was found that the thin metallic layer is formed due to tribological transfer of metal from the taper stem and the inner of the acetabular cup.
Risk factors were analysed to establish the most relevant and evidence-based treatments available in the current literature.
This case highlights early-onset of metallosis following polyethylene liner dislocation in total hip arthroplasty, leading to a ceramic-on-metal contact and acetabular cup wear. The likely cause was excessive torsional force from a fall, overcoming the liner's locking mechanism. The risk of dislocation after THA can be reduced using some precautions inferred from the literature. The use of a larger femoral and acetabular component, elevated rim liner and dual mobility implants can significantly reduce the risk of dislocation after THA. However, care must be taken regarding patient-related risk factors since these cannot be addressed and modified. Hence, a complete evaluation of risk factors should be performed for each patient and procedure before starting THA.

KEYWORDS: Revision, Dislocation, Metallosis, Hip arthroplasty, Failure, Risk factors, Surgical treatment

Compressive Neuropathies

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ABSTRACT
Compressive neuropathies are a group of disorders involving compression or entrapment of peripheral nerves, leading to sensory and motor deficits. They are due to anatomical narrowing or extrinsic pressure on nerves as they pass through limited pathways. Ischemia, inflammation, demyelination, and ultimately fibrosis follow the resultant compression, disrupting nerve conduction and gliding movement.
The most prevalent type of median nerve entrapment is carpal tunnel syndrome, which causes numbness, tingling, and muscle weakness. Proximal entrapments such as pronator syndrome can either present in a similar manner or accompany distal compression. Clinical examination and electrodiagnostic studies are the foundation for diagnosis and everything from conservative management such as splinting and physical therapy to surgical decompression in refractory cases is employed for treatment. Ulnar nerve entrapment, the most frequent at the elbow in the course of the cubital tunnel, is characterized by ring and little finger sensory symptoms and weakness of the intrinsic hand muscles. Clinical examination and nerve conduction studies help diagnosis. Management involves activity modification, anti-inflammatory medication, and surgery such as in situ decompression or nerve transposition in severe situations. Radial nerve entrapment is uncommon but typically occurs at the arcade of Frohse, affecting the posterior interosseous nerve. Patients present with pain, tingling, and weakness of finger and wrist extension. History, examination, and electrodiagnostic testing confirm the diagnosis. Conservative therapy and decompression surgery are among the treatments. Thoracic Outlet Syndrome involves compression of the subclavian vessels and/or brachial plexus through the space between clavicle and first rib. It presents as pain, weakness, and risk of vascular symptoms like swelling or color changes. Diagnosis is difficult, requiring imaging and provocative testing. Treatment begins with physical therapy and progresses to surgical decompression as necessary.
Early diagnosis with multidisciplinary treatment, including orthoses and surgery, are essential in successfully treating compressive neuropathies. Understanding the pathophysiology of the lesion is helpful to guide appropriate therapeutic measures in order to prevent permanent nerve injury and promote nerve healing.

KEYWORDS
Nerve entrapment, Carpal tunnel syndrome, Ulnar nerve, Radial nerve, Decompression surgery

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POSTER SESSION

Effect of dilution on number density and size of extracellular particles in blood preparations

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ABSTRACT
The preparation of autologous platelet and extracellular vesicle-rich plasma (PVRP) has been explored in many medical fields with the aim to benefit from its healing potential. In parallel, efforts are being invested to understand the function and dynamics of PVRP that is complex in its composition and interactions. To achieve this, the quality of plasma should be assessed. While the cells are large enough to be observed by an optical microscope and there are also batch methods to assess the average number density of cells (e.g. flow cytometry), assessment of sub-micron sized extracellular vesicles presents a challenge. Extracellular vesicles are dynamic entities and undergo changes during the sample processing. It is therefore of advantage to develop the methods that cause minimal perturbation of the samples. A recent study involving many blood and plasma samples showed feasibility of assessment of the number density and size of extracellular particles directly in diluted blood and plasma. In the presented work we elaborated preparation of samples by studying the the number density, hydrodynamic diameter and the ratio between the absorbances at 208 nm and 260 nm that reflects the protein/nucleic acid content at different dilutions of the samples and different centripetal accelerations of the centrifuge rotor. We measured the number density and hydrodynamic diameter with the instrument Videodrop (Myriadelab, Paris, France) and absorbance with the instrument Nanodrop (Thermo Fisher Scientific Inc., Waltham, MA, USA). We found that the centripetal acceleration of the centrifuge rotor had no effect on the average number density and the hydrodynamic diameter of the extracellular vesicles up to 1000g (where $g=10m/s^2$). Dilution affected the number density and the hydrodynamic diameter but not the ratio between the absorbances at 280 nm and 260 nm. The optimal centrifuge setting for the human plasma at room temperature was estimated at 500g for 10 minutes.

LLLT biostimulation technology affects the clinical state of periodontal tissues during orthodontic levelling phase

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ABSTRACT
Photobiomodulation (PBM) is a therapeutic technique that uses low-energy red and near-infrared light to stimulate cellular regeneration and function. Its effects are primarily mediated through absorption by cytochrome-c oxidase, followed by nitric oxide (NO) release, gene transcription, and indirect signaling via bioactive molecules.
In this clinical cross-sectional study, 32 subjects (10 males, 22 females; mean age 14.6 ± 2.0 years) undergoing fixed orthodontic treatment for dental crowding were included. The experimental group (N = 14) received PBM using the Ortholumm ML5/1 lamp (wavelengths: 625, 660, and 850 nm; energy density: 1.0 J/cm²/min), administered twice weekly for four weeks, 10 minutes per session. The control group (N = 18) received a sham treatment using a standard incandescent bulb following the same protocol.
Inflammation of soft tissues was assessed using the dichotomous Plaque Index (PI), Sulcus Bleeding Index (SBI), and the presence of gingival hypertrophy (defined as a free gingival margin ≥1 mm occlusal to the enamel–cement junction).
No significant differences were found in PI or SBI between groups at any time point. Gingival hypertrophy after one month was significantly more frequent in the control group (t-test, $p = 0.041$). Partial Least Squares regression ($R^2 = 0.068$) showed that neither treatment group nor gender significantly predicted hypertrophy count.
These findings confirm a lower incidence of gingival hypertrophy following PBM therapy, although no differences were observed in plaque or bleeding indices.

KEYWORDS
Photobiomodulation (PBM); Orthodontic treatment; Gingival hypertrophy; Plaque Index (PI); Sulcus Bleeding Index (SBI); Near-infrared light; Inflammation

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Biocompatibility Evaluation of Hip Endoprosthesis Biomaterials

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ABSTRACT

Background One of the main challenges in ensuring the success and longevity of joint replacement and osseointegration is understanding the biological responses triggered by implant materials. These responses can activate the immune system, leading to severe inflammation that leads to implant malfunction and failure.
The main objective of the research is to gain a deeper insight into the initial biological response of tissue to implants from selected conventional and additive manufacturing (AM or 3D printed materials), which are newly developed materials according to EBM (Electron Beam Melting) and SLA (selective laser melting) and adhesion of primary stem cells derived from the human bone marrow (BMSC).
The biggest challenge in the development of bone replacements is the possibility of ensuring good mechanical stability (mechanical or structural compatibility) at first, and later, after implantation, rapid osseointegration and resorption (biocompatibility). The properties that cause the toxicity of materials are the structure, chemical composition and products formed during degradation, which in turn leads to oxidative stress, inflammation and immune response. This includes the examination of physical and biological phenomena immediately after the interaction of biological matter with various newly functionalized materials. Our goal is to find out how to select and manufacture the implant material to achieve optimal osseointegration for maximum implant life.
Materials and Methods: Evaluation of implant surface roughness, cytotoxicity studies of classically manufactured materials and study and definition of BMSC adhesion. Methods for investigating surface micromorphology, a scanning electron microscope with integrated FIB and SIMS techniques, XPS, X-ray photoelectron spectroscopy, and a 2D laser microscope that allows the study of the behavior of living BMSCs.
Results and conclusions: new basic knowledge about surface nano/micromorphology and surface properties of AM materials and about the adhesion of BMSC on differently rough surfaces and consequently about osseointegration.

KEYWORDS
Biomaterials, hip endoprostheses, biocompatibility, citotoxicity, BMSC, adhesion,

Assessment of the interdental papilla during and after orthodontic treatment with clear aligners

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ABSTRACT

Invisible removable dental appliances were developed to overcome the limitations of fixed braces, offering improved aesthetics and hygiene due to their transparency and removability. This is reflected in lower plaque and gingival index values during treatment compared to fixed appliances. However, concerns remain, as these aligners cover a large portion of the soft tissues for much of the day, potentially affecting the shape and presence of interdental papillae. Orthodontic forces from these appliances as said influence surrounding tissues—such as the periodontal ligament, alveolar bone, cementum, and gingiva—by stimulating the release of biological factors that activate osteoclasts and osteoblasts. This leads to bone remodeling: osteoclasts resorb bone in the direction of movement, while osteoblasts form new bone on the opposite side, ensuring stable tooth repositioning.
In this clinical case, the patient received orthodontic treatment with a clear aligner with a juxta-gingival rim. The patient was instructed to wear the aligner for at least 22 hours a day, to remove it before eating and drinking, and to rinse them every time it is removed from the mouth. The patient was told to maintain good oral hygiene by brushing twice a day and flossing regularly.

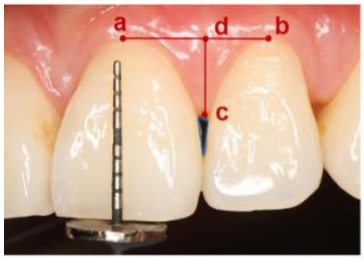

Figure 1: Description of the methodology used to measure the papilla height and papilla triangle areas. [1]

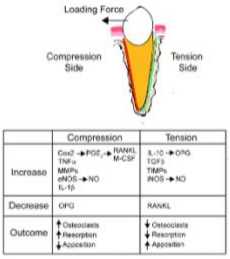

Figure 2: Signaling pathways associated with compression and tension due to orthodontic loading. Distinct signaling factors are upregulated and downregulated associated with compressive and tensile strain, as summarized in the table, with the net outcome of resorption in compression and bone apposition in tension. [2]

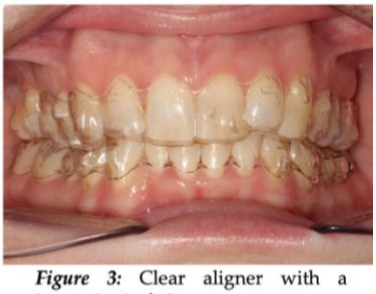

Figure 3: Clear aligner with a juxta-gingival rim.

The height of the interdental papilla was assessed on the intraoral images. Points A and B were marked at the highest points on the adject teeth, and point C was marked at the tip of the interdental papilla. A perpendicular line was then drawn from point C to the line connecting points A and B. This measurement represented the height of the interdental papilla and was compared during and after treatment with a clear aligner. Our results showed a slight difference between the height of the interdental papilla during and after orthodontic treatment, with an increase of the papilla during orthodontic treatment as well as after orthodontic treatment.

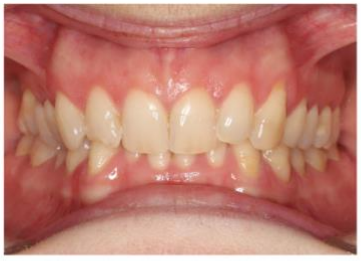

Figure 4: Before orthodontic treatment with a clear aligner

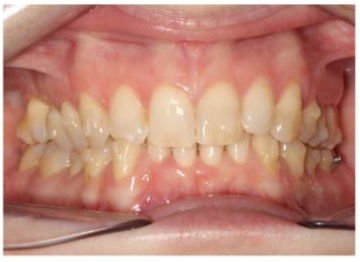

Figure 5: During orthodontic treatment with a clear aligner

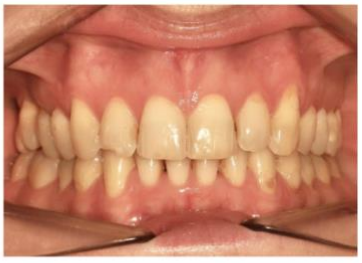

Figure 6: After orthodontic treatment with a clear aligner

The changes observed in the papilla are most likely due to inflammation of the surrounding tissue, which can lead to an increase in volume. These alterations may be associated with the use of a removable dental appliance. However, further research is necessary to confirm this connection, as the current observations are based on a single patient and therefore cannot be generalized. Additionally, it's important to incorporate other diagnostic methods, since relying solely on intraoral examination may not

provide the most accurate assessment. A combination of techniques is recommended for a more reliable diagnosis.

KEYWORDS
Clear aligners, Interdental papilla, Orthodontic soft tissue response

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