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Review of the Role of Biomechanical Research in Developing Rehabilitation Physiotherapy Programs for Patients with Coxarthrosis

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Abstract: modern biomechanical research has introduced innovative possibilities for crafting rehabilitation physiotherapy programs. These investigations are transforming conventional approaches in designing rehabilitation physiotherapy programs for coxarthrosis treatment, leading to enhanced patient outcomes through pain reduction and improved quality of life. The objective of this study is to emphasize the contemporary application of biomechanical research in shaping rehabilitation physiotherapy programs for individuals with coxarthrosis. The following hypothesis is put forward within the framework of the raised issue: «Integration of biomechanical studies in the development of rehabilitation physiotherapy programs for patients with coxarthrosis will have a positive effect in the development of rehabilitation personal software techniques». The article anticipates the application of synthesis and analysis methods aimed at a comprehensive study of the role of biomechanical research in the development of effective physiotherapy rehabilitation programs for patients. The analysis and synthesis of scientific literature in the review article serve not only to summarize existing data but also to form a new level of understanding of the problem, which is an important step in improving clinical practice and developing new physiotherapy methods. Based on the specified methods, an analysis is being conducted to identify challenges in the implementation of biomechanical research methods and explore potential solutions within the framework of monitoring the outcomes of physical therapy in the treatment of coxarthrosis. Conclusion – examining the role of biomechanical research in rehabilitating patients with coxarthrosis is justified in terms of addressing the relevance of the issue and outlining the contemporary need for effective treatment methods, increased objectivity and quality of rehabilitation, and the search for ways to improve the quality of life for patients. During this review, it was established that biomechanical research of rehabilitation physiotherapy programs for coxarthrosis is an important method for evaluating the effectiveness of these programs.

Keywords: [Osteoarthritis](#), [Joints](#), [Physical Therapy Modalities](#), [Rehabilitation](#), [Program](#).

Introduction

Coxarthrosis (hip osteoarthritis) is a serious degenerative joint disease accompanied by damage to cartilage tissue and the development of inflammatory processes (Afanasiev et al., 2021). This disease leads to significant pain, restricted movement, and poor quality of life in patients (Latoguz et al., 2022).

Accordingly (Strafun et al. (2018), biomechanical research has opened up new possibilities for the development of rehabilitation physiotherapy programs. The research revolutionizes the general approaches applied in the development of rehabilitation physiotherapy programs for the treatment of coxarthrosis, contributing to better patient outcomes by reducing pain and improving their quality of life.

Since the treatment of coxarthrosis has long been an urgent problem, the relevance of using biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis is emphasized through several key aspects:

- Individualization of treatment: each patient has unique characteristics that affect the mechanics of movement and function of a hip joint. Biomechanical research allows us to develop individualized rehabilitation programs that take into account the patient's personal characteristics;

- Minimizing the risk of complications: a correct assessment of the biomechanical aspects of movement helps to avoid loads that can lead to further joint wear and deterioration of the patient's condition;

- Improving the effectiveness of rehabilitation: the use of biomechanical data helps specialists to accurately identify problematic aspects of joint function and focus on them during treatment;

- Ensuring maximum results: an individual approach developed on the basis of biomechanical data helps to achieve the best rehabilitation results and improve the patient's quality of life;

- Surgery preparation capabilities: In patients who require surgical intervention, biomechanical testing allows us to prepare the joint for surgery and optimize the surgical plan.

- Progress monitoring: Biomechanical analyses allow us to continuously monitor a patient's progress during rehabilitation and adjust the treatment program if necessary.

All these factors emphasize the relevance of the need for a comprehensive examination to determine the role of biomechanical research in developing rehabilitation programs for coxarthrosis, contributing to optimal treatment and improvement of patients' lives.

Aim

The aim of this study is to highlight the contemporary use of biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis.

Materials and methods

The article anticipates the application of synthesis and analysis methods aimed at a comprehensive study of the role of biomechanical research in the development of effective physiotherapy rehabilitation programs for patients. The analysis and synthesis of scientific literature in the review article serve not only to summarize existing data but also to form a new level of understanding of the problem, which is an important step in improving clinical practice and developing new physiotherapy methods. Based on the specified methods, an analysis is being conducted to identify challenges in the implementation of biomechanical research methods and explore potential solutions within the framework of monitoring the outcomes of physical therapy in the treatment of coxarthrosis.

Review and Discussion

Accordingly, over the last 10 years, there has been a significant increase in research aimed at understanding the mechanisms of coxarthrosis and developing effective treatment methods. The paper (Strafun et al., 2018) notes that biomechanical research of rehabilitation physical therapy programs for coxarthrosis is aimed at evaluating the effectiveness of these programs in restoring the mobility, strength, and function of the hip joint. The paper (Shavkatovich, 2023) emphasizes the importance of finding optimal therapeutic and rehabilitation strategies for developing modern physical therapy programs in the treatment of coxarthrosis. According to (Fishchenko et al., 2018) the methodological

importance of using biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis is to develop a scientific and systematic approach to the treatment and rehabilitation of this disease. According to (Moldovan, & Mindrescu, 2019) the overall methodological importance of using biomechanical research is to improve the quality and outcomes of treatment for patients with coxarthrosis and other joint diseases by providing evidence-based, individualized, and effective rehabilitation approaches. Studies have shown that the integration of biomechanical aspects into rehabilitation programs can significantly improve outcomes for patients with coxarthrosis by reducing pain, improving function, and slowing disease progression.

Table 1 analyzes the role of biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis and shows the main aspects of this role.

Table 1 demonstrates how biomechanical research affects various aspects of the rehabilitation of patients with coxarthrosis and highlights their importance in improving treatment and

outcomes for this category of patients. It is also worth noting that the aspects mentioned in Table 1 strengthen the role of biomechanical research as an important tool in improving the rehabilitation of patients with coxarthrosis and other joint diseases, contributing to more effective and individualized treatment and improving their condition and quality of life. Table 2 considers the issues of methodological importance of biomechanical research in the development of rehabilitation physiotherapeutic programs for patients with coxarthrosis.

According to Table 2, biomechanical research is important for the scientifically based, individualized, and effective development and use of rehabilitation programs for patients with coxarthrosis, helping to improve their quality of life and minimize the risk of complications. Table 3 considers the issue of expanding the use of biomechanical studies in the rehabilitation of patients with coxarthrosis.

Accordingly, Table 3 emphasizes the importance of addressing these issues in expanding the use of biomechanical research in the rehabilitation of patients with coxarthrosis and ensuring access to more effective and individualized

Table 1. The role of biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis and the main aspects of this role

Literature	Aspect	The role of biomechanical research
(Afanasiev et al., 2021).	Individualization of treatment	Development of individual rehabilitation programs based on biomechanical data, taking into account the unique characteristics of the patient.
(Karpinska et al., 2018).	Objectivity and accuracy	Measurement and analysis of joint movement parameters and functions for an objective assessment of the condition and effectiveness of treatment.
(Latopuz et al., 2022).	Progress monitoring	Continuous monitoring of the patient's progress during rehabilitation and adjustment of the treatment program according to the results.
(Kostiuchok and Luchyshyn, 2019)	Prevention of complications	Identification of loads and movements that could lead to further joint wear and worsen the patient's condition.
(Roi et al., 2018).	Scientific validity	Providing a scientific basis for rehabilitation programs and developing scientific evidence in physical therapy and rehabilitation.
(Kraydjikova et al., 2015).	Preparation for surgery	Preparation of the joint for surgical intervention based on biomechanical research.
(Balik et al., 2017)	Improvement of the quality of life	Improvement of the physical function and comfort for patients, resulting in improved quality of life.

Table 2. Methodological importance of biomechanical research in the development of rehabilitation physiotherapeutic programs for patients with coxarthrosis

Literature	Aspect	Methodological importance
(Mirzamurodov et al., 2020).	Scientific validity	Provides a scientific basis for the development and use of rehabilitation programs.
(Savchenko et al. 2020).	Individualization of treatment	Helps to create individualized programs, taking into account the personal characteristics of the patient.
(Moldovan, & Mindrescu, 2019).	Objectivity and accuracy	Provides objectivity and accuracy in measurements and assessments of joint condition.
(Nevedomska, E. et al., 2018).	Progress monitoring	Allows constant monitoring and evaluation of the patient’s progress during treatment.
(Kraydjikova et al., 2015).	Prevention of complications	Helps to identify and avoid possible complications during rehabilitation.
(Akhmedov, 2022).	Improvement of the quality of life	It helps to improve physical function and quality of life of patients.
(Afanasiev et al., 2021)	Preparation for surgery	Preparation of the joint for surgery using objective data.
(Karpinska et al., 2018).	Ethical aspects	Taking into account ethical issues and ensuring data confidentiality.
(Balik et al., 2017).	Development of standards	Development of standards and protocols for biomechanical research and rehabilitation.
(Roi et al., 2018).	Financing	Development of funding mechanisms for research and rehabilitation programs.

Table 3. Expanding the use of biomechanical research in the rehabilitation of patients with coxarthrosis

Literature	Aspect	Importance	Possible solutions
(Karpinska et al., 2018).	Availability of equipment and experts	Limited availability of biomechanical equipment and qualified specialists in many locations.	1. Development of training programs for specialists in the field of biomechanics. 2. Attracting donor and grant resources for the purchase of equipment.
(Mirzamurodov et al., 2020).	Difficulty in interpreting the results	Biomechanical data can be difficult to analyze and interpret.	1. Development of special programs and algorithms for automatic data processing and analysis. 2. Preparation of specialists for a more detailed analysis of the results.
(Roi et al., 2018).	High research costs	Performing biomechanical research can be a financially costly process.	1. Development of general projects with medical centers and research institutions. 2. Involvement of insurance companies in financing rehabilitation programs based on biomechanical research.
(Latopuz et al., 2022).	Lack of widespread access to individualized programs	Unavailability of individualized rehabilitation programs for most patients.	1. Development of programs for remote monitoring and consultation. 2. Implementation of information technologies to develop individualized programs.

Table 3. (continued).

Literature	Aspect	Importance	Possible solutions
(Savchenko et al. 2020).	Ethical aspects	Privacy and ethics issues in the collection and use of biomechanical data.	1. Development of ethical standards and rules for data collection and processing. 2. Involvement of ethics commissions to monitor compliance with the rules.
(Afanasiev et al., 2021)	Development of standards	Lack of standards and protocols for biomechanical research and rehabilitation.	1. Development of national and international standards for biomechanical research. 2. Training and certification of specialists in the field of biomechanics.
(Moldovan, & Mindrescu, 2019).	Financing	Lack of funding for research and rehabilitation programs.	1. Active involvement of the public in fundraising for the purposes of special funds. 2. Involvement of the business sector in sponsorship of rehabilitation programs.

treatment programs. Table 4 – shows the results of the analysis of various aspects of the role of biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis.

According to Table 4, biomechanical research plays an important role in determining the individual needs of patients during physical therapy rehabilitation of patients with coxarthrosis. Thus, biomechanical research is an integral part of the successful physical rehabilitation of patients with coxarthrosis, providing an individual and effective approach to treatment.

According to Table 5, biomechanical research plays an important role in the physical therapy of patients with coxarthrosis, contributing to an objective assessment of their progress and rehabilitation. In general, the use of biomechanical research helps to provide an objective assessment and optimal monitoring of rehabilitation of patients with coxarthrosis.

According to Table 6, biomechanical research plays a key role in preventing complications during physical therapy in patients with coxarthrosis. In general, biomechanical research helps to individualize and optimize approaches to physical therapy, helping to prevent complications and improve treatment outcomes in patients with coxarthrosis. Table 7 considers methods of biomechanical research and their feasibility in monitoring the results of physical therapy in the treatment of coxarthrosis.

Table 7 shows that the use of the methods in the framework of studying coxarthrosis is appropriate since they allow obtaining objective data on the condition of the joint, motor function, and effectiveness of treatment. Each method has its own advantages and a specific area of application, and their combination can provide a more complete picture of the condition of a patient with coxarthrosis. Table 8 considers methods of biomechanical research,

Table 4. The role of biomechanical research in determining the individual needs of the patient in the implementation of physical therapy rehabilitation of patients with coxarthrosis

Literature	Aspect	Role
(Savchenko et al. 2020).	Analysis of physical parameters	It helps to determine the condition of the joint and its functional capabilities.
(Mirzamurodov et al., 2020).	Biomechanical load assessment	It determines the optimal load for the patient, which helps to avoid overloading or underloading.
(Roi et al., 2018).	Determination of objective goals	It makes it possible to create a rehabilitation program aimed at achieving specific objective goals for each patient.

i.e. contraindications and possible problems in monitoring the results of physical therapy in the treatment of coxarthrosis.

According to Table 8, the use of the methods indicated in it requires careful attention to possible limitations and contraindications for

each patient with coxarthrosis, in order to ensure safety and provide the best possible monitoring of the results of physical therapy. Table 9 presents the results of the analysis of problematic issues in the implementation of biomechanical research methods and possible solutions within the

Table 5. Use of biomechanical research to objectively assess the progress of physical therapy rehabilitation of patients with coxarthrosis

Literature	Aspect	Role
Kraydjikova et al., 2015).	Physical condition monitoring	It provides the ability to constantly monitor the condition of the joint and physical parameters of the patient.
(Fishchenko et al., 2018).	Correction of the treatment program	It allows making changes to the rehabilitation program based on objective data on progress or complications.
(Latopuz et al., 2022).	Stimulation of motivation	It shows specific improvements to patients that can increase their motivation for treatment.

Table 6. Aspects of the application of biomechanical research for the prevention of complications in realization monitoring of physical therapy in the treatment of coxarthrosis

Literature	Aspect	Role
(Fishchenko et al., 2018).	Determination of optimal loads	It helps to avoid overloading the joint and prevents wear of cartilage tissue.
(Moroz and Zarudna, 2015)	Development of individual constraints	It allows creating restrictions on certain movements or loads for patients at risk of complications.

Table 7. Methods of biomechanical research and their feasibility in monitoring the results of physical therapy in the treatment of coxarthrosis

Research method	Description	Application in coxarthrosis research	Feasibility
Radiography	Image of joints using X-rays.	Assessment of the degree of joint degeneration and structural changes.	It is advisable for the determination of joint damage extent.
Computed tomography scan	Detailed tomographic images of joints.	Study of the internal structure of joints and their changes.	It is advisable for detailed tissue analysis.
Magnetic resonance imaging (MRI)	Images of soft tissues and joint structures.	For the assessment of inflammation, muscle tissue, and soft tissue.	It is advisable for detailed tissue analysis.
Dynamic motion analysis	Measurement of patient movement parameters.	Assessment of biomechanical changes during movement and physical activity.	It is advisable for the monitoring of motor function and response to exercise.
Strength metering	Measurement of muscle and joint strength.	Determination of muscle strength and joint load capacity.	It is advisable for identifying muscle weakness and monitoring its changes.
Electromyography (EMG)	Registration of electrical activity of muscles.	Assessment of muscle activity and functionality during movement.	It is advisable for analyzing and monitoring muscle activity.

Table 8. Methods of biomechanical research, i.e. contraindications and possible problems in monitoring the results of physical therapy in the treatment of coxarthrosis

Research method	Contraindication	Possible problems
Radiography	Lack of maturity for radiation exposure.	Maturity for radiation exposure, possible allergic reactions to contrast material.
Computed tomography scan	Allergy to contrast material, pregnancy (especially in the first trimester).	Maturity for radiation exposure, allergies.
Magnetic resonance imaging (MRI)	Patients with claustrophobia (fear of confined spaces), severe cases of obesity, metal implants or clips in the body (in non-contact areas).	Maturity for radiation exposure, claustrophobia, possible allergic reactions to contrast material.
Dynamic motion analysis	Severity of movement disorders, old age, severe obesity.	Deterioration of biomechanical parameters during the examination, possible discomfort.
Strength metering	A severe form of obesity, active phase of inflammation, and old age.	The need to follow the instructions during measurements, and possible discomfort.
Electromyography (EMG)	Implanted metal devices or prostheses in the electromyography area, allergy to electrodes.	Possible discomfort from the electrodes, and restriction of movement during the electromyography.

Table 9. The results of the analysis of problematic issues in the implementation of biomechanical research methods and possible solutions within the framework of monitoring the results of physical therapy in the treatment of coxarthrosis

Problematic issues	Possible solutions	Research methods
Effectiveness of physical therapy	– Use of biomechanical modeling for objective assessment of improvements.	Dynamic motion analysis, EMG, assessment of biomechanical parameters using sensors
	– Clinical trials to determine the results of physical therapy.	
Biomechanical aspects of movement	– Professional development of specialists and improvement of treatment protocols.	Radiography, CT, MRI
	– Use of computer programs for detailed analysis of biomechanical parameters of movement.	Biomechanical modeling
Determination of optimal exercises	– Collaboration with biomechanics specialists and other experts to understand the impact on joint movement.	Dynamic motion analysis
	– Study of the effectiveness of various exercises and methods of physical therapy in a clinical setting.	
Progress monitoring	– Development of individual therapy plans based on the biomechanical characteristics of patients.	Dynamic motion analysis, assessment of biomechanical parameters using sensors
	– Use of biomechanical parameters for an objective assessment of progress.	Strength metering, assessment of biomechanical parameters using sensors
	– Regular review and correction of therapy plans based on monitoring results.	Dynamic motion analysis

Table 9. (continued).

Problematic issues	Possible solutions	Research methods
Individual approach	– Assessment of the biomechanical characteristics of each patient.	Radiography, CT, MRI, magnetic resonance spectroscopy
	– Development of individual physical therapy plans and their correction during treatment.	
Patient support	– Conducting informational sessions and educating patients about the importance of therapy.	
	– Psychological support and motivation to ensure adherence to recommendations.	

framework of monitoring the results of physical therapy in the treatment of coxarthrosis.

Table 9 provides a structured view of problems, research methods, and ways to solve them in biomechanical research of coxarthrosis. If the problematic issues outlined in Table 9 are combined into a comprehensive approach to biomechanical research in coxarthrosis and possible solutions are considered, the following results and benefits can be expected:

- Increased research objectivity: The integration of objective measurement methods and wider monitoring will allow for more accurate and reliable data on joint health and treatment effectiveness;

- Expanded sample of patients: Collaboration and pooling of data from different research will allow for more data from different regions and approaches to rehabilitation;

- Long-term monitoring: Long-term research will help determine the long-term impact of rehabilitation on patients and find optimal long-term care strategies;

- Ethical approach: Taking into account the ethical aspects of research will guarantee the rights and safety of patients during research;

- Increased availability of equipment and specialists: The development of educational and training programs will help to increase the number of specialists in the field of biomechanics and the availability of the necessary equipment.

- Effective financing: The involvement of insurance companies and other financial resources

in supporting rehabilitation programs based on biomechanical research will help to provide financial resources for the implementation of these programs.

In general, this background research found that:

- Biomechanical research in the context of physical therapy for the treatment of coxarthrosis plays an important role in improving the quality of life of patients, helping them restore functionality and reduce pain and discomfort;

- Taking into account the various aspects of the role of biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis;

- Biomechanical research plays an important role in the choice of coxarthrosis treatment option, contributing to the optimization of treatment strategies and providing an individualized approach to patient treatment.

In forming the substantiation of the hypothesis raised in this article about the role of biomechanical research in the development of rehabilitation physiotherapy programs for patients with coxarthrosis, it is advisable to note the following scientific and positional grounds:

- Scientific basis: There is a lot of research showing that coxarthrosis (hip osteoarthritis) is a serious and common disease that significantly limits physical activity and impairs patients' quality of life. Biomechanical aspects, such as joint mechanics, joint loading, and motion analysis, can play a key role in understanding this disease;

– Individualization of the approach: Given that each patient may have unique features and problems in hip joint function, biomechanical research can help develop individual approaches to rehabilitation and physiotherapy;

– Accuracy in determining progress: The inclusion of biomechanical aspects to rehabilitation programs will allow for a more accurate determination of the degree of progression of coxarthrosis and the impact of physiotherapy on this process;

– Reduced pain and improved functionality: Hip pain and limited functionality are the main problems for patients with coxarthrosis. Consideration of biomechanical aspects in the rehabilitation program can help reduce pain and improve motor activity;

– Scientific achievements in other fields: The use of biomechanical approaches in rehabilitation and physiotherapy has already proven to be effective in other areas of medicine and sports. This suggests that the use of biomechanical research may also be useful in the context of coxarthrosis.

According to the analysis, the scientific validity of physical therapy rehabilitation programs in the treatment of coxarthrosis, supported by biomechanical research, is a key factor in the development and implementation of rehabilitation programs for the treatment of coxarthrosis, helping to ensure the effectiveness

and evidence-based approach to the treatment of this pathology.

Conclusion

Examining the role of biomechanical research in rehabilitating patients with coxarthrosis is justified in terms of addressing the relevance of the issue and outlining the contemporary need for effective treatment methods, increased objectivity and quality of rehabilitation, and the search for ways to improve the quality of life of patients. During this review, it was established that biomechanical research of rehabilitation physiotherapy programs for coxarthrosis is an important method for evaluating the effectiveness of these programs.

Financing

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Conflict of interest

There is no potential conflict of interests.

Consent to publication

Patients gives consent to publication.

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Огляд ролі біомеханічних досліджень у побудові реабілітаційних фізіотерапевтичних програм для пацієнтів з коксартрозом 2-3 ступеню

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Анотація: Станом на 2023 р. біомеханічні дослідження стали ключовим інструментом у сфері реабілітації пацієнтів з коксартрозом 2-3 ступеню та інших захворювань суглобів. Завдяки сучасним біомеханічним дослідженням, розкриваються нові перспективи у побудові реабілітаційних фізіотерапевтичних програм. Ці дослідження революціонізують загальні підходи, які застосовуються у побудові реабілітаційних фізіотерапевтичних програм лікування коксартрозу 2-3 ступеню та допомагають досягти кращих результатів в процесі відновлення пацієнтів, сприяючи зменшенню в них відчуття болю та поліпшенню якості їхнього життя. Метою дослідження є висвітлення аспектів сучасного використання біомеханічних досліджень у процесі побудови реабілітаційних фізіотерапевтичних програм для пацієнтів

з коксартрозом 2-3 ступеню. Дослідження проводилися на основі аналізу наукових праць та інформативних джерел, охоплюючих дані реабілітаційних центрів міста Києва впродовж 2021-2023 років. Участь у дослідженні взяло 120 хворих (60 чоловіків, 60 жінок) з коксартрозом 2-3 ступеня. Розгляд ролі біомеханічних досліджень у реабілітації пацієнтів з коксартрозом 2-3 ступеню є обґрунтованим з точки зору висвітлення актуальності проблеми та окреслення сучасної потреби в ефективних методах лікування, підвищення об'єктивності та якості реабілітації, а також пошуку шляхів, щодо поліпшення якості життя пацієнтів. В ході оглядового дослідження було встановлено, що біомеханічне дослідження реабілітаційних фізіотерапевтичних програм при коксартрозі 2-3 ступеню є важливим методом оцінки ефективності цих програм. На основі результатів біомеханічних досліджень можна коригувати програми реабілітації, щоб підвищити їх ефективність.

Ключові слова: коксартроз 2-3 ступеню, суглоби, фізична терапія, біомеханічні дослідження, реабілітаційні фізіотерапевтичні програми.



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