

**INVESTIGATION OF ANTERIOR CRUCIATE
LIGAMENT RELATED RESEARCH: ANIMAL
MODELS, BIOMATERIALS, AND BIBLIOMETRIC
PARAMETERS**

Kamila Akhinzhanova, Bachelor of Arts

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**School of Engineering and Digital Sciences
Department of Chemical and Materials Engineering
Nazarbayev University**

53 Kabanbay Batyr Avenue,
Astana, Kazakhstan, 010000

Supervisors:

Lead Supervisor Name: Associate Professor Cevat Erisken

Co-supervisor Name: Associate Professor Dhawal Shah

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Declaration

I hereby declare that this manuscript, entitled “Investigation of anterior cruciate ligament related research: animal models, biomaterials, and bibliometric parameters” is the result of my work except for quotations, citations, and publications data, which have been duly acknowledged. I also declare that to the best of my knowledge and belief, it has not been previously or concurrently submitted, in whole or in part, for any other degree or diploma at Nazarbayev University or any other national or international institution.

Name: Kamila Akhinzhanova

Date: May 12, 2025

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List of Abbreviations

ACL	Anterior cruciate ligament
MSCs	Mesenchymal stem cells
PRP	Platelet-rich plasma
BEAR	Bridge-enhanced ACL repair
WSCC	Web of Science Core Collection
HA	Hyaluronic acid
PLLA	Poly-L-lactic acid
PCL	Polycaprolactone
ECM	extracellular matrix
PU	Polyurethane
PET	Polyethylene terephthalate

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ABSTRACT

The anterior cruciate ligament (ACL) injuries are a common clinical phenomena, which makes an ACL repair a hot research topic. This study analyzes bibliometric trends on ACL regeneration and publications with high citations. To gather the data, an online search for articles on ACL regeneration and engineering published between 2000 and 2025 was performed on the Web of Science Core Collection (WSCC). The data on animal models, biomaterials used, the publication year, countries, institutions, journals, and citation count were obtained and analyzed using VOSviewer and Excel. In total, after applying keyword search and exclusion criteria and filtering out irrelevant publications, 284 articles on ACL regeneration were considered. The top 100 most-cited articles were further analyzed. The results revealed that the number of published articles increased throughout the years, indicating a growing research interest on the topic. Rabbits were found to be the most frequently used animals (29%) for in-vivo studies. Collagen appeared as the most frequently used biomaterial (39%). The USA was found to publish the most articles (n=99) and the top publishing journal on ACL regeneration was *Frontiers in Bioengineering and Biotechnology*. This study was conducted to serve as a helpful tool for researchers and clinicians in the field of ACL repair.

Keywords: bibliometric, anterior cruciate ligament, regeneration, tissue engineering, biomaterial, animal model, VOSviewer

CHAPTER 1- (INTRODUCTION)

1.1 Ligament Tissue and Anterior Cruciate Ligament (ACL)

Ligaments are strong bands of fibrous connective tissue, which connect the bones and maintain joint stability. The anterior cruciate ligament, located inside the joint and spanning from the femur to the tibia, is one of the four main ligaments in the knee (Duthon et. al., 2006). Physiologically, the ACL acts as a primary restraint against excessive anterior movement of the tibia in relation to the femur, as well as regulating knee rotation and preventing hyperextension (Bascuñán et. al., 2019). This tissue has a complex hierarchical structure, which mainly consists of parallel bundles of type I collagen fibers and smaller quantities of elastin and proteoglycans (Duthon et. al., 2006). The ACL is made up of two fiber bundles, anteromedial and posterolateral, which tighten at different knee angles to ensure the stability of the knee during movements (Duthon et. al., 2006). The unique structure and the avascular composition of the ACL provide the strength and flexibility necessary for normal knee function, but at the same time create challenges in healing and regeneration of an injured ligament (Nau & Teuschl, 2015).

1.2 ACL Injury - Mechanisms and Consequences

The ACL injuries most commonly occur in sports and high-impact activities involving sudden pivoting, deceleration, or landing (Nau & Teuschl, 2015). Often, ACL tears are the result of sudden changes in direction or twisting of the knee, which makes it unstable and causes swelling and pain. If left untreated, this tear can cause further damage to other structures of the knee like meniscus or cartilage. This creates a risk of developing secondary meniscus injuries and cartilage degeneration (Nau & Teuschl, 2015). In the long term, there can be significant consequences, as most people with ACL tears experience constant knee instability and abnormal joint function, and

about 50% develop knee osteoarthritis within 10-20 years, even after surgical ligament reconstruction (Nau & Teuschl, 2015). This shows that ACL rupture is not just an acute injury but a long-lasting issue, which underlines the need for effective treatment and prevention. Moreover, ACL's intra-articular location and synovial fluid exposure interfere with formation of scaffold or clot for natural healing (Leong et. al., 2014). This means that the ACL has poor spontaneous healing capacity, which creates demand for surgical interventions and research and development of regenerative treatments.

1.3 ACL Regeneration - Biological and Clinical Importance

Restoring a torn ACL is important to restore knee stability and function, as well as to avoid joint degradation. These injuries are very common, as in the United States alone, about 350,000 ACL reconstructive surgeries are done each year (Nau & Teuschl, 2015), and more than 2 million worldwide (Renström, 2013). Currently, the most common treatment for a complete ACL rupture is surgical reconstruction utilizing tendon grafts (Nau & Teuschl, 2015). This method can help restore stability, however, it presents some limitations. In cases of using autografts, the patient's own tissue, there could be complications at the sites from where the tissue is taken from, such as pain, inflammation, or muscle weakness. In cases of using allografts, donor tissue, there could be an immune reaction or disease transmission (Nau & Teuschl, 2015). Even after a successful surgery, there could still be knee looseness or stiffness and high possibility of developing osteoarthritis (Lohmander et. al., 2007). All these clearly point out that the ACL tissue does not heal itself and that the currently available procedures are unable completely restore the functions of ACL. Therefore, ACL regeneration remains as significant clinical problem and further research is needed for advancements of ACL regeneration and treatment.

1.4 Tissue Engineering Strategies for ACL Regeneration

Tissue engineering aims to regenerate an ACL tissue by combining scaffold, cells, and growth factors, the so-called “tissue engineering triad” principle (Langer & Vacanti, 1993). The goal of this method is to overcome donor site morbidity, limited biological integration, and other limitations posed by traditional ACL reconstruction techniques (Nau & Teuschl, 2015).

Scaffolds act as biodegradable structures, which support attachment of cells and formation of matrix (Altman et. al., 2002). Collagen and silk fibroin are some of the natural materials often used, as they offer controlled degradation and strength (Altman et. al., 2002). On the other hand, poly-L-lactic acid (PLLA) is a synthetic polymer, which offers tunable mechanical properties (Laurencin et. al., 2006). Other biomaterials are also used in the ACL regeneration to optimize the biomechanical properties, degradation kinetics as well as biocompatibility (He et. Al., 2021).

Cell sources such as mesenchymal stem cells (MSCs), which are derived from bone marrow and adipose tissue, provide great regenerative potential and are accessible (Zhang et. al., 2013). Another great example would be ligament fibroblasts, but these are tissue-specific and less accessible (Jackson et al., 2013).

Growth factors include PDGF, TGF- β , and VEGF, which stimulate cell proliferation and collagen synthesis (Morton et al., 2007). A combination of these factors, called platelet-rich plasma, has been used to promote the ACL scaffold healing process (Morton et al., 2007). Integrating multiple factors together has shown to give synergistic effects (Leong et. al., 2014).

There are also mechanical stimulations that are performed using bioreactors and controlled loading, which can help improve collagen alignment and ligament-like properties (Hohlrieder et. al., 2013). Together, all of these can be utilized to recreate the original ACL structure and function.

1.5 Animal Models in ACL Engineering Research

Animal models are used in order to test safety, integration, biomechanical performance of engineered ACL constructs prior to human trials (Bascuñán et. al., 2019). This approach gives an opportunity to evaluate the healing process in vivo under physiological conditions, i.e., normal body movement and stress conditions.

Small models, such as rats and rabbits, are used in early-stage biomaterial testing and are advantageous because of their low cost and ease of handling (Nau & Teuschl, 2015). Rabbits are a good model for ACL studies as the size of their knees more easily allows for surgical intervention (Nau & Teuschl, 2015).

Large animal models, such as dogs, goats, sheep, and pigs are often used since their knee anatomy and loading patterns better resemble those of humans (Proffen et. al., 2012). Canine models have been widely used in ACL research but can create bias, as they are often prone to spontaneous joint regeneration (Pond & Nuki, 1973). Goats and sheep are a great model choice because of their consistent knee size and stability (Proffen et. al., 2012). Meanwhile, pigs offer anatomical similarities to the ACL of a human (Proffen et. al., 2012).

The use of these models enables researchers to develop bio-enhanced repair methods, an example of which would be the bridge-enhanced ACL repair (BEAR) scaffold (Murray et al., 2016). BEAR scaffold was first tested in pigs before moving to clinical trials (Murray et al., 2016). Selecting the appropriate animal model is crucial for successful application of ACL regeneration techniques to human use (Leong et. al., 2014).

1.6 Biomaterials in ACL Engineering Research

Collagen is the main extracellular matrix (ECM) protein in the native ligament tissue, which provides great biocompatibility and cell support, however, has limited mechanical strength when used alone (Murray et. al., 2007). Therefore it is often combined with cells and growth factors to improve in vivo performance (Zhu et. al., 2022). The BEAR technique, which uses a collagen sponge implant, has shown good results as compared to autografts in restoring knee stability (Murray et al., 2020). Silk fibroin, a natural biomaterial, provides great tensile strength, slow degradation, and facilitation of cell adhesion and tissue ingrowth and has shown to be effective in tissue regeneration (Lyu et. al., 2023). Chitosan is another natural biomaterial, providing biocompatibility, biodegradability, and antimicrobial activity, adhesion, and matrix formation in ligament repair (Ning et. al., 2023). Hyaluronic acid's (HA) biocompatibility, hygroscopicity, and anti-inflammatory signaling help to regulate cell adhesion, migration, and angiogenesis during the repair process (Ning et. al., 2023).

Synthetic polymers such as poly-L-lactic acid (PLLA) and polycaprolactone (PCL) allow to tune mechanical properties and control degradation, making them a great biomaterial for scaffolds, however, they often require biological augmentation to promote cellular integration (Yilgor et. al., 2012). Polyurethane (PU), a biodegradable synthetic polymer that is resilient and easy to process, can be tailored to exhibit low stiffness, high elasticity, and controllable degradation (Mi et. al., 2017). Another synthetic polymer, polyethylene terephthalate (PET), provides great mechanical properties, however, there are some side effects such as inflammation reported in literature (Xie et. al., 2024).

1.7 The Scope of the Project

The goal of this study is to perform an analysis of the scientific publications on ACL tissue engineering using bibliometric methods in order to identify most used animal models, biomaterials, cited publications as well as the research trends in this area.

The analysis would evaluate the bibliometric data based on the following parameters:

- animal model
- biomaterial type
- annual publication trends
- institutional collaboration trends
- geographic distribution
- journal of publication trends
- citations leaders
- keyword and research clusters

In this study it is anticipated that the number of animal models and types are increasing with time as researchers seek new ways to test their biomaterials, and that large animal models are more frequently used as part of the requirements of translational medical research for a successful market presence.

CHAPTER 2- (METHODS)

2.1 Literature Search

This study analyzes various publications, which include research articles related to ACL tissue regeneration, published between 2000 and 2024. Web of Science Core Collection (WSCC) was the resource chosen for the literature search for its comprehensive coverage of high-quality academic publications, standardized metadata, reliability, and accessibility (Birkle et. al., 2020).

The articles were selected based on their relevance to the topic of ACL tissue regenerative engineering. The information on animal models used, biomaterial used, citation trends, institutional affiliations, geographic affiliations, publisher countries, years of publication, authors, and keywords was analyzed. The top 100 most cited articles were identified based on their total citation count in the WSCC database.

When selecting the publications to be included in the analysis, the filters were applied and exclusion criteria were set. For instance, non-English articles were excluded from the list. Additionally, publications were filtered out according to the document type. Book chapters, retracted publications, early access, and preceding papers were excluded. Thus, this analysis only includes articles. Articles published before the year 2000 were excluded as well. Only articles that fit into the “Engineering Biomedical” and the “Materials Science Biomaterials” WSCC categories were considered, excluding the works on ACL that are not related to tissue engineering.

The data was generated by retrieving the articles and their bibliometric data on ACL tissue regeneration from the WSCC on May 4, 2025. The search was designed as follows: ((anterior cruciate ligament [Title]) OR ((ACL [Title]) OR ((anterior cruciate ligament regeneration) [Title]) OR ((anterior cruciate ligament engineering [Title]) OR ((anterior cruciate ligament regenerative

engineering [Title]) OR ((ACL regeneration [Title]) OR ((ACL engineering [Title]) OR ((ACL regenerative engineering [Title]) AND Document type (article) AND Period (2000 to 2025)).

2.2 Analysis Tools

This bibliometric analysis was performed using VOSviewer and Microsoft Excel 2016. VOSviewer enabled the visualization and analysis of bibliometric data, including authors, countries, institutions, reference citations, and keyword co-occurrence. Excel 2016 was utilized to organize the extracted data, generate tables, and create figures and graphs to illustrate the results of the analysis.

2.3 Data Extraction

Data extraction was performed. The data set was first retrieved from the WSCC. Then it was analyzed using VOSviewer and Microsoft Excel 2016. The analysis focused on the following key parameters: author names, journal titles, institutional affiliations, country distributions, reference citations amount, and keywords associated with animal model usage.

CHAPTER 3- (RESULTS AND DISCUSSION)

3.1 Publication Trend

The total number of articles included in this analysis was 284. They were selected through keyword search focusing on the topic of ACL tissue regeneration from the database between the years 2000 and 2025. The number of articles on ACL published from 2000 through 2010 was 51, while 129 were published from 2011 through 2020. In the years after 2020, 104 articles related to ACL were published, as shown in Figure 1. The results represent an expected bibliometric trend with older publications having more citations, as they had more time to accumulate them, and an increase in the research interest on the topic. A rise in the articles published over the last five years shows a strong current interest on the topic of ACL tissue engineering. The peak citation count was in the years from 2001 through 2005, which may indicate that the earlier foundational work paves the way and still has a strong influence on recent research.

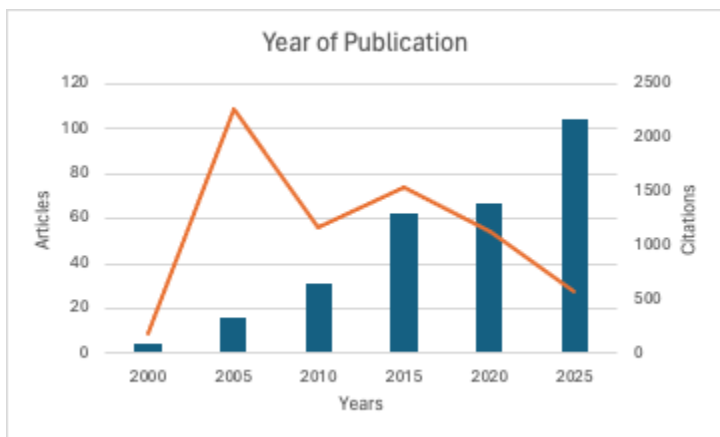


Figure 1: Years of Publication and Citation Distribution

3.2 Country Distribution

The 284 articles were analyzed for the publisher country distribution and for the international collaboration patterns. The USA published the most articles (n=99), followed by the UK (n=83), Switzerland (n=45), and the Netherlands (n=27). These and the other contributors are shown in Figure 2. The VOSviewer map, Figure 3, reveals that the United States and China are the leading contributors to the ACL tissue regeneration research, with the UK, Canada, and Japan also playing key roles. This map illustrates how often researchers from different countries publish together. There was a bibliometric review on publication trends and global productivity on the topic of ACL reviewing publications between 1980 and 2021, which identified USA, Japan, and Germany as major contributors (İpek & Dündar, 2023). Another bibliometric review specifically looking into the trends on the research on the topic of ACL repair, which reviewed the period between 1960 and 2022, concluded that USA, Germany, and UK were top sources of publications (Li et. al., 2022). It also revealed that China is increasingly collaborating with Western researchers on ACL engineering studies (Li et. al., 2022).

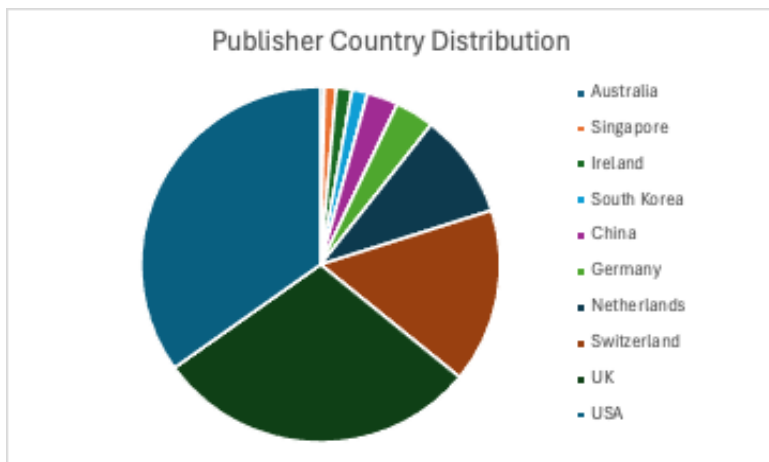


Figure 2: Publisher Country Distribution

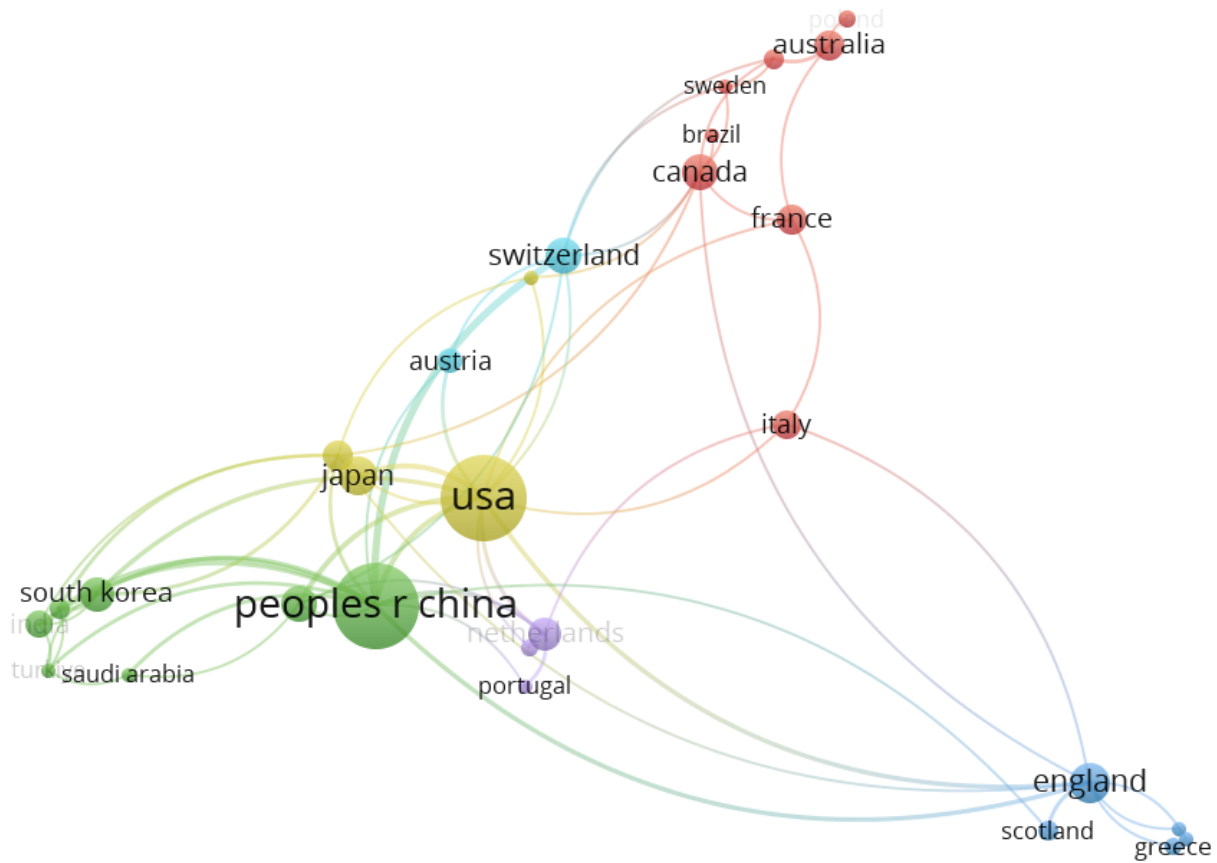


Figure 3: Network Visualization Map of International Collaborations on ACL

3.3 Institutional Collaborations

The institutional co-authorship analysis revealed that Chinese universities, especially Shanghai Jiao Tong University, Peking University, and Xi’an Jiao Tong University, are the leading collaborators contributing to the ACL tissue regenerative engineering research and work closely with one another, illustrated in Figure 4. Overall, this map shows that there is a strong regional collaboration within China and more limited international collaborations between other countries on the ACL repair research. The earlier mentioned bibliometric study confirms that ACL research

collaborations usually cluster regionally, with Chinese institutions establishing strong international networks (İpek & Dündar, 2023).

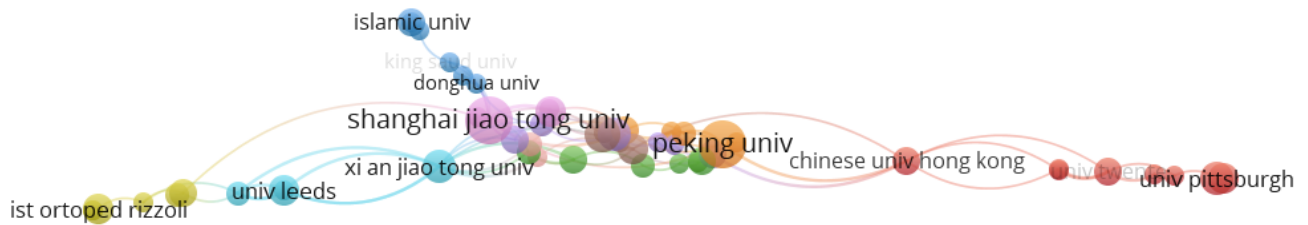


Figure 4: Network Visualization Map of Institutional Collaborations on ACL

3.4 Journal of Publication Trends

The 284 articles were published in 54 different journals. The top 30 journals, shown in Table 1 (see Appendix A), published 246 articles, which is 86.62% of all the publications. The impact factor from 2023 was found on the WSCC database for each journal. The list only included the journals which have published at least three articles included in this analysis. The top five journals were as follows: *Frontiers in Bioengineering and Biotechnology*, *Annals of Biomedical Engineering*, *Biomaterials*, *Tissue Engineering Part A*, *Bioengineering-Basel*. *Biomaterials*, with the impact factor of 12.8, had the highest total citations (n=3230), with the mean citations per article number being 170. The *Frontiers in Bioengineering and Biotechnology* journal was the most publishing journal on ACL engineering in this analysis. It is ranked in the top quartile (Q1) for Biotechnology/Bioengineering journals and has remarkably grown in influence (SCImago Journal & Country Rank, 2024).

3.5 Keywords and Cluster Analysis

The keyword co-occurrence analysis was performed using VOSviewer and revealed that “anterior cruciate ligament”, "reconstruction", “anterior cruciate ligament rec”, “model”, and “knee” were the largest and most central nodes, as shown in Figure 5, where each color represents a different cluster and the node size reflects the keyword frequency. The central placement and high connectivity identifies these words as core themes that tie together the subfields in the ACL engineering research. The overlay map shows the progression from biomechanics to scaffold design, and then further into advanced biomaterials and computational tools.

For co-occurrence network analysis the number of minimum occurrences was set at 20. The total of 16 keywords were identified within three clusters. The first cluster included terms like “anterior cruciate ligament reconstruction”, “tendon”, “in vivo”. This cluster represents ACL reconstruction techniques and experimental testing. These keywords suggest frequent co-occurrence in studies on evaluation of surgical reconstruction using tendons in in vivo models. The second cluster included terms like “knee”, “injury”, “biomechanics”, “kinematics”, and “osteoarthritis”. This cluster represents clinical and biomechanical assessment focus in research. These keywords suggest studies on mechanical effects of ACL injury, performance, stability, and function evaluations, and long-term risks such as osteoarthritis. The third cluster includes terms like “graft”, “patellar tendon”, “acl reconstruction”, “in vitro”, “anterior cruciate ligament rec”. This cluster represents graft materials and tissue engineering strategies. These keywords suggest studies on biomaterials, scaffold development, and cellular responses. This structure composed of three different clusters suggests a multidisciplinary approach, in which surgical techniques, functional performance analysis, and tissue engineering solutions all actively contribute to the research on ACL repair.

Keywords such as “rabbit model”, “ovine”, “dogs”, and “animal models” form visible but smaller sized clusters. These terms form links with “in vivo”, “scaffold”, and “regeneration”, which suggests that animal models are used for preclinical testing of biomaterials to evaluate the repair strategies. The analysis indicates that rabbits and sheep (ovine) are the most frequently used models, which is probably due to their anatomy and ease of handling. The overlay map revealed that model-related keywords are in green to yellow colors, indicating that they mostly appear in publications between 2015 and 2018.

Keywords such as “collagen”, “silk”, “chitosan”, “scaffold”, “matrix”, “electrospun”, and “artificial ligament” form a large, well-connected cluster. Biomaterial terms nodes are relatively large in size, meaning they often appear in publications on ACL regeneration and have co-occurrence links with terms “in vitro”, “graft”, “tissue engineering”, and “regeneration”. In the overlay map, Figure 6, “collagen” appears in blue to green (2010-2016), identifying it as a more traditional and foundational biomaterial. Meanwhile, newer concepts like “electrospun fibers” appear in yellow (2018-2020). This suggests a progression from basic biocompatible materials towards advanced engineered scaffold technologies in research.

In addition to the VOSviewer map, a manual search for animal model and biomaterial terms was performed in the article titles, author keywords, and keywords plus for each publication. Tables 2 and 3 (see Appendices B and C) summarize the results of the search. The keyword search also considered terms like “canine”, “ovine”, “caprine”, and “porcine”, which were classified under their corresponding animal categories.

Figure 7 shows how many times cumulatively each animal model keyword appeared in publications between 2000 and 2025. The keyword “rabbit” appeared in 21 articles, suggesting that it was the most frequently used animal model for ACL regeneration research. This can be

explained by its cost-effectiveness and manageable size. “Sheep” was the most common large animal keyword, appearing in 17 articles. “Pig” was mentioned 12 times, and appeared in later publications, after 2009. This frequency may be due to sheep’s and pig’s anatomical similarity to the human knee. “Rat” was mentioned less frequently, 8 times. This might be explained by its small size, which does not make it a good animal model for biomechanical properties evaluation, however, it may still be suitable for biocompatibility testing. “Dog”, “goat”, “cow”, and “deer” appeared the least amount of times. The reasons might be high maintenance and cost since these are all relatively large animals. The most variety of species was seen in the years 2013-2017, which might suggest a broadening of comparative models. The appearance of rabbits and sheep in research stayed pretty consistent throughout the years.

Figure 8 shows how many times cumulatively each biomaterial keyword appeared in publications between 2000 and 2025. The keyword “collagen” appeared in 39 studies consistently throughout the years, suggesting that it is the most commonly utilized biomaterial. This may be due to its high biocompatibility. “Silk” appeared 26 times, peaking in the years 2013-2019. This might suggest a growing interest in strong and biodegradable natural materials. Other natural biomaterials like “chitosan”, “gelatin”, and “HA” start appearing later in time and less frequently when compared to collagen and silk. “PCL” and “PET” were the most commonly mentioned synthetic biomaterials, showing popularity in more recent years. On the other hand, synthetic “PLLA” and “PU” appeared the least out of all the biomaterials analyzed.

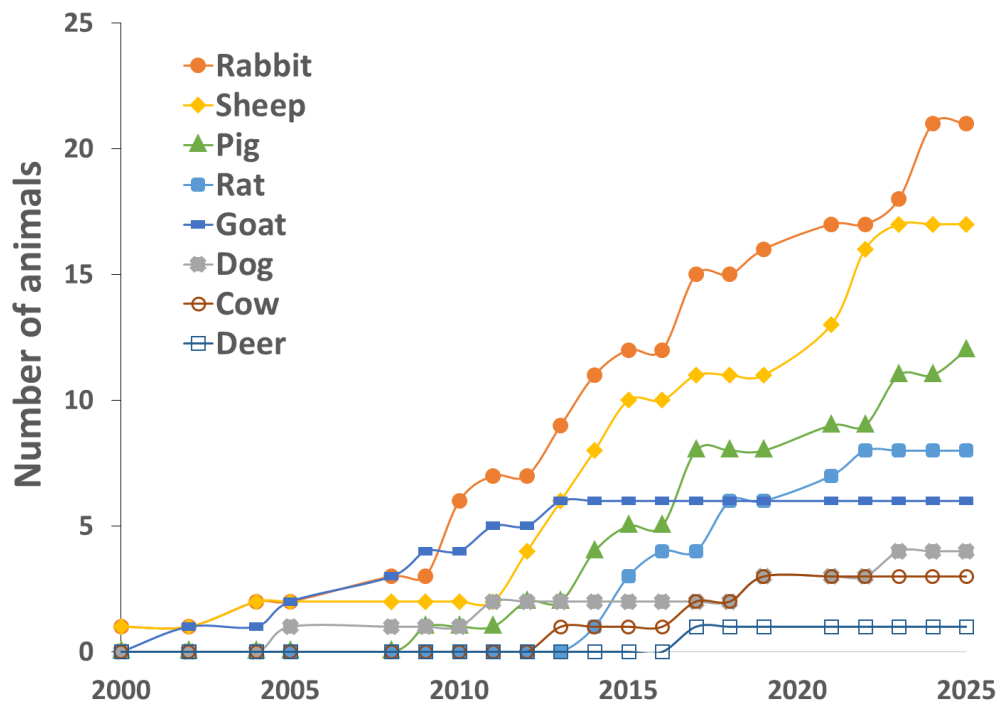


Figure 7: Cumulative Appearance of Animal Model Keywords

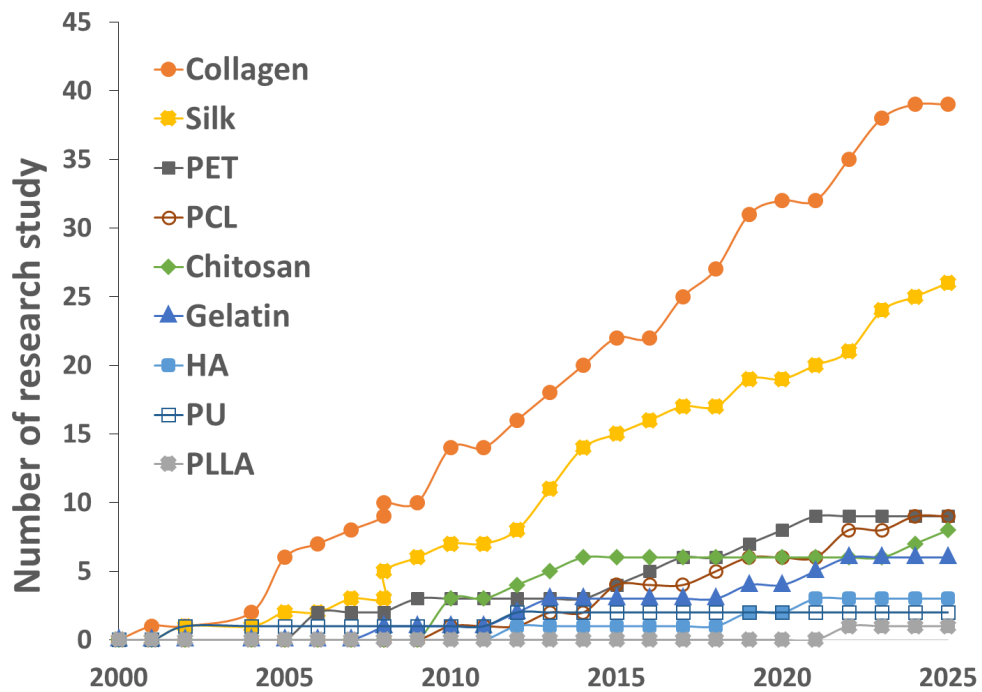


Figure 8: Cumulative Appearance of Biomaterial Keywords

3.6 The Most-Cited 100 Publications

The 100 top-cited publications were published between the years 2000 and 2024, as illustrated in Table 4 (see Appendix D). 32 articles on ACL that made it into the 100 most-cited list were published from 2000 through 2010, while 61 were published from 2011 through 2020. In the years after 2020, 7 articles from the list were published, as shown in Figure 9. Overall, the article count increased steadily from 2000 to 2015, indicating a growing research interest in ACL engineering, with the peak period for top publications being from 2011 through 2015. After 2015, the number of highly cited papers declined, which may be because they are more recent and had less time to accumulate citations, therefore, the decline is not necessarily due to the reduced relevance. The highest cited articles were published from 2001 through 2005, suggesting that they had more time to accumulate citations. This may also be because earlier publications reflect more foundational work, which is often referenced when conducting a background literature review for various studies.

The top 100 articles were published in seven different countries, with the USA having the most articles (n=50), followed by the UK (n=34), and the Netherlands (n=9), shown in Figure 10.

The top 100 articles were published in 29 different journals. The top 9 journals, shown in Table 5 (see Appendix E), published 72 articles. The impact factor from 2023 was found on the WSCC database for each journal. The list only included the journals which have published at least three articles included in this analysis. The top five journals were as follows: *Biomaterials*, *Tissue Engineering Part A*, *Annals of Biomedical Engineering*, *Computer Methods in Biomechanics and Biomedical Engineering*, and *Acta Biomaterialia*. *Biomaterials*, with the impact factor of 12.8, had the most publications and the highest total citations.

The top authors are listed in Table 6 (see Appendix F). Only the authors contributing to at least 3 publications, either as the primary researcher or a co-author, were included in the list. The top author was Murray M. M. with 6 publications, followed by Jiang J. with 5, and Dunn M. G. and Arruda E .M. with 4 publications each.



Figure 9: Years of Publication and Citation Distribution for the 100 Most-Cited Articles

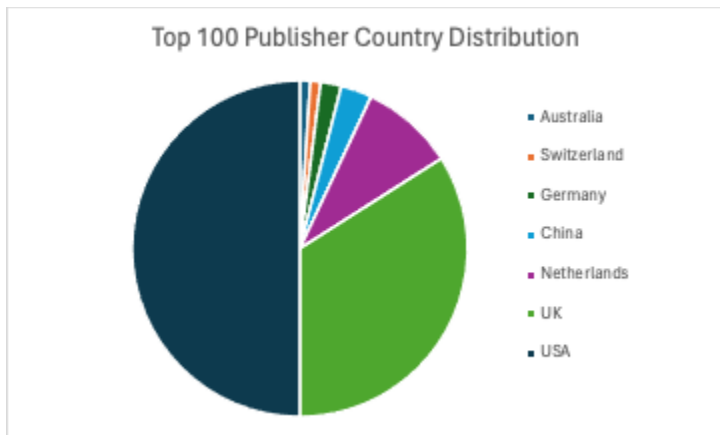


Figure 10: Publisher Country Distribution for the 100 Most-Cited Articles

CHAPTER 4- (CONCLUSION)

This analysis demonstrated that 284 articles have been published on this topic in the field of “Engineering Biomedical” and the “Materials Science Biomaterials” categories of WSCC database between 2000 and 2025. This work underscores the significance of the ACL related research, regenerative attempts, animal models and biomaterials used. The analysis revealed that, as expected, there was an increase in the research interest on the topic, rabbits and sheep appeared more frequently in the research studies, and that collagen and silk were the most abundantly used biomaterials. It is anticipated that the findings of this will guide the researchers and the clinicians in the field for selecting appropriate biomaterials and animal models for the regeneration of ACL injuries to help more than two million people worldwide.

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APPENDICES

Appendix A

Table 3: Journals Publishing Most on ACL

	Source	Documents	Citations	Mean citation	Impact factor
1	FRONTIERS IN BIOENGINEERING AND BIOTECHNOLOGY	26	104	4.0	4.3 (2023)
2	ANNALS OF BIOMEDICAL ENGINEERING	23	454	19.7	3.0 (2023)
3	BIOMATERIALS	19	3230	170.0	12.8 (2023)
4	TISSUE ENGINEERING PART A	18	576	32.0	3.5 (2023)
5	BIOENGINEERING-BASEL	18	36	2.0	3.8 (2023)
6	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	17	235	13.8	1.7 (2023)
7	JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS	14	210	15.0	3.3 (2023)
8	MEDICAL ENGINEERING & PHYSICS	12	91	7.6	1.7 (2023)
9	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	11	244	22.2	3.9 (2023)
10	PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART H-JOURNAL OF ENGINEERING IN MEDICINE	10	137	13.7	1.7 (2023)
11	ACTA BIOMATERIALIA	8	216	27.0	9.4 (2023)
12	BIOMEDICAL SIGNAL PROCESSING AND CONTROL	6	26	4.3	4.9 (2023)
13	COMPUTERS IN BIOLOGY AND MEDICINE	5	59	11.8	7.0 (2023)
14	TISSUE ENGINEERING PART C-METHODS	4	106	26.5	2.7 (2023)
15	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS	4	80	20.0	3.2 (2023)
16	BIOACTIVE MATERIALS	4	95	23.8	18.0 (2023)
17	CELL AND TISSUE BANKING	4	78	19.5	1.4 (2023)
18	COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE	4	147	36.8	4.9 (2023)
19	JOURNAL OF TISSUE ENGINEERING AND REGENERATIVE MEDICINE	4	52	13.0	3.1 (2023)
20	MEDICAL & BIOLOGICAL ENGINEERING & COMPUTING	4	66	16.5	2.6 (2023)
21	TISSUE ENGINEERING AND REGENERATIVE MEDICINE	4	24	6.0	4.4 (2023)
22	ARTIFICIAL ORGANS	3	31	10.3	2.2 (2023)
23	BIOMEDICAL ENGINEERING ONLINE	3	20	6.7	2.9 (2023)
24	BIOMEDICAL ENGINEERING-APPLICATIONS BASIS COMMUNICATIONS	3	14	4.7	0.6 (2023)
25	BIOMEDICAL MATERIALS	3	38	12.7	3.9 (2023)
26	COMPUTERIZED MEDICAL IMAGING AND GRAPHICS	3	28	9.3	5.4 (2023)
27	JOURNAL OF BIOMATERIALS APPLICATIONS	3	20	6.7	2.3 (2023)
28	JOURNAL OF MEDICAL DEVICES-TRANSACTIONS OF THE ASME	3	11	3.7	0.8 (2023)
29	JOURNAL OF NEUROENGINEERING AND REHABILITATION	3	64	21.3	5.2 (2023)
30	TECHNOLOGY AND HEALTH CARE	3	3	1.0	1.4 (2023)

Appendix B

Table 1: Animal Model Keywords

	rat	rabbit	dog	sheep	goat	pig	deer	cow
2000		1		1				
2002					1			
2004		1		1				
2005			1		1			
2008		1			1			
2009					1	1		
2010		3						
2011		1	1		1			
2012				2		1		
2013		2		2	1			1
2014	1	2		2		2		
2015	2	1		2		1		
2016	1							
2017		3		1		3	1	1
2018	2							
2019		1	1					1
2021	1	1		2		1		
2022	1			3				
2023		1	1	1		2		
2024		3						
2025						1		
TOTAL	8	21	4	17	6	12	1	3

Appendix C

Table 2: Biomaterial Keywords

	collagen	silk	chitosan	HA	gelatin	PLLA	PCL	PU	PET
2000									
2001	1								
2002		1						1	
2004	1								
2005	4	1							
2006	1								2
2007	1	1							
2008	1				1				
2008	1	2							
2009		1							1
2010	4	1	3				1		
2011									
2012	2	1	1	1	1			1	
2013	2	3	1		1		1		
2014	2	3	1						
2015	2	1					2		1
2016		1							1
2017	3	1							1
2018	2						1		
2019	4	2		1	1		1		1
2020	1								1
2021		1		1	1				1
2022	3	1			1	1	2		
2023	3	3							
2024	1	1	1				1		
2025		1	1						
TOTAL	39	26	8	3	6	1	9	2	9

Appendix D

Table 4: The Top 100 Most-Cited Articles on ACL

Rank	First author	Title	Source	Citations	Year
1	Altman, GH	Silk matrix for tissue engineered anterior cruciate ligaments	BIOMATERIALS	723	2002
2	Lee, CH	Nanofiber alignment and direction of mechanical strain affect the ECM production of human ACL fibroblast	BIOMATERIALS	532	2005
3	Lu, HH	Anterior cruciate ligament regeneration using braided biodegradable scaffolds: in vitro optimization studies	BIOMATERIALS	293	2005
4	Woods, T	Effectiveness of three extraction techniques in the development of a decellularized bone-anterior cruciate ligament-bone graft	BIOMATERIALS	277	2005
5	Fan, HB	Anterior cruciate ligament regeneration using mesenchymal stem cells and silk scaffold in large animal model	BIOMATERIALS	222	2009
6	Fan, HB	In vivo study of anterior cruciate ligament regeneration using mesenchymal stem cells and silk scaffold	BIOMATERIALS	165	2008
7	Cheng, PF	High-purity magnesium interference screws promote fibrocartilaginous entheses regeneration in the anterior cruciate ligament reconstruction rabbit model via accumulation of BMP-2 and VEGF	BIOMATERIALS	148	2016
8	Guidoin, MF	Analysis of retrieved polymer fiber based replacements for the ACL	BIOMATERIALS	147	2000
9	Liu, HF	A comparison of rabbit mesenchymal stem cells and anterior cruciate ligament fibroblasts responses on combined silk scaffolds	BIOMATERIALS	112	2008
10	Wang, JL	Magnesium alloy based interference screw developed for ACL reconstruction attenuates peri-tunnel bone loss in rabbits	BIOMATERIALS	95	2018
11	Li, G	The effect of anterior cruciate ligament injury on knee joint function under a simulated muscle load: A three-dimensional computational simulation	ANNALS OF BIOMEDICAL ENGINEERING	87	2002
12	Cooper, JA	Evaluation of the anterior cruciate ligament, medial collateral ligament, achilles tendon and patellar tendon as cell sources for tissue-engineered ligament	BIOMATERIALS	85	2006
13	Shen, WL	Long-term effects of knitted silk-collagen sponge scaffold on anterior cruciate ligament reconstruction and osteoarthritis prevention	BIOMATERIALS	82	2014
14	Shao, Q	Estimation of Ligament Loading and Anterior Tibial Translation in Healthy and ACL-Deficient Knees During Gait and the Influence of Increasing Tibial Slope Using EMG-Driven Approach	ANNALS OF BIOMEDICAL ENGINEERING	78	2011
15	Steinert, AF	Mesenchymal Stem Cell Characteristics of Human Anterior Cruciate Ligament Outgrowth Cells	TISSUE ENGINEERING PART A	77	2011
16	Kimura, Y	Regeneration of anterior cruciate ligament by biodegradable scaffold combined with local controlled release of basic fibroblast growth factor and collagen wrapping	TISSUE ENGINEERING PART C-METHODS	73	2008
17	Ma, JJ	Three-Dimensional Engineered Bone-Ligament-Bone Constructs for Anterior Cruciate Ligament Replacement	TISSUE ENGINEERING PART A	71	2012
18	Murray, MM	The migration of cells from the ruptured human anterior cruciate ligament into collagen-glycosaminoglycan regeneration templates in vitro	BIOMATERIALS	69	2001
19	Mifune, Y	Tendon graft revitalization using adult anterior cruciate ligament (ACL)-derived CD34+cell sheets for ACL reconstruction	BIOMATERIALS	69	2013
20	Stajduhar, I	Semi-automated detection of anterior cruciate ligament injury from MRI	COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE	68	2017
21	Shao, HJ	Modulation of gene expression and collagen production of anterior cruciate ligament cells through cell shape changes on polycaprolactone/chitosan blends	BIOMATERIALS	65	2010
22	Laurent, CP	A multilayer braided scaffold for Anterior Cruciate Ligament: Mechanical modeling at the fiber scale	JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS	58	2012
23	Liljensten, E	Studies of polyurethane urea bands for ACL reconstruction	JOURNAL OF MATERIALS SCIENCE-MATERIALS IN MEDICINE	58	2002
24	Utturkar, GM	The Effects of a Valgus Collapse Knee Position on In Vivo ACL Elongation	ANNALS OF BIOMEDICAL ENGINEERING	58	2013
25	Xu, DT	Accurately and effectively predict the ACL force: Utilizing biomechanical landing pattern before and after-fatigue	COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE	55	2023
26	Takayama, K	The effect of blocking angiogenesis on anterior cruciate ligament healing	BIOMATERIALS	53	2015

		following stem cell transplantation			
27	Wang, JL	Magnesium-pretreated periosteum for promoting bone-tendon healing after anterior cruciate ligament reconstruction	BIOMATERIALS	52	2021
28	Roos, PE	Motor control strategies during double leg squat following anterior cruciate ligament rupture and reconstruction: an observational study	JOURNAL OF NEUROENGINEERING AND REHABILITATION	52	2014
29	Li, H	An osteogenesis/angiogenesis-stimulation artificial ligament for anterior cruciate ligament reconstruction	ACTA BIOMATERIALIA	51	2017
30	Wen, CY	The Use of Brushite Calcium Phosphate Cement for Enhancement of Bone-Tendon Integration in an Anterior Cruciate Ligament Reconstruction Rabbit Model	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS	50	2009
31	Adouni, M	Role of gastrocnemius activation in knee joint biomechanics: gastrocnemius acts as an ACL antagonist	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	46	2016
32	Petrigliano, FA	In Vivo Evaluation of Electrospun Polycaprolactone Graft for Anterior Cruciate Ligament Engineering	TISSUE ENGINEERING PART A	44	2015
33	Cheng, MY	Platelets and Plasma Proteins Are Both Required to Stimulate Collagen Gene Expression by Anterior Cruciate Ligament Cells in Three-Dimensional Culture	TISSUE ENGINEERING PART A	44	2010
34	Caruso, AB	Changes in mechanical properties and cellularity during long-term culture of collagen fiber ACL reconstruction scaffolds	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	44	2005
35	Oka, S	Local Administration of Low-Dose Simvastatin-Conjugated Gelatin Hydrogel for Tendon-Bone Healing in Anterior Cruciate Ligament Reconstruction	TISSUE ENGINEERING PART A	43	2013
36	Leong, NL	Evaluation of Polycaprolactone Scaffold with Basic Fibroblast Growth Factor and Fibroblasts in an Athymic Rat Model for Anterior Cruciate Ligament Reconstruction	TISSUE ENGINEERING PART A	42	2015
37	Gwiazda, M	The effect of melt electrospun writing fiber orientation onto cellular organization and mechanical properties for application in Anterior Cruciate Ligament tissue engineering	JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS	41	2020
38	Cai, JY	Electrodeposition of calcium phosphate onto polyethylene terephthalate artificial ligament enhances graft-bone integration after anterior cruciate ligament reconstruction	BIOACTIVE MATERIALS	41	2021
39	Harrison, RD	Effect of extraction protocols and epidermal growth factor on the cellular repopulation of decellularized anterior cruciate ligament allografts	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	41	2005
40	Li, X	A novel silk-based artificial ligament and tricalcium phosphate/polyether ether ketone anchor for anterior cruciate ligament reconstruction - Safety and efficacy in a porcine model	ACTA BIOMATERIALIA	39	2014
41	Schmidt, T	Sterilization with electron beam irradiation influences the biomechanical properties and the early remodeling of tendon allografts for reconstruction of the anterior cruciate ligament (ACL)	CELL AND TISSUE BANKING	38	2012
42	Jones, G	Decellularization and Characterization of Porcine Superflexor Tendon: A Potential Anterior Cruciate Ligament Replacement	TISSUE ENGINEERING PART A	38	2017
43	Li, H	The use of layer by layer self-assembled coatings of hyaluronic acid and cationized gelatin to improve the biocompatibility of poly(ethylene terephthalate) artificial ligaments for reconstruction of the anterior cruciate ligament	ACTA BIOMATERIALIA	38	2012
44	Li, X	A novel silk-TCP-PEEK construct for anterior cruciate ligament reconstruction: an off-the shelf alternative to a bone-tendon-bone autograft	BIOFABRICATION	37	2014
45	Cheng, MT	Comparison of Potentials Between Stem Cells Isolated from Human Anterior Cruciate Ligament and Bone Marrow for Ligament Tissue Engineering	TISSUE ENGINEERING PART A	36	2010
46	Jiang, QS	Canine ACL reconstruction with an injectable hydroxyapatite/collagen paste for accelerated healing of tendon-bone interface	BIOACTIVE MATERIALS	36	2023
47	Caruso, AB	Functional evaluation of collagen fiber scaffolds for ACL reconstruction: Cyclic loading in proteolytic enzyme solutions	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	35	2004
48	Tovar, N	A comparison of degradable synthetic polymer fibers for anterior cruciate ligament reconstruction	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	33	2010
49	Panas-Perez, E	Development of a silk and collagen fiber scaffold for anterior cruciate ligament reconstruction	JOURNAL OF MATERIALS SCIENCE-MATERIALS IN MEDICINE	33	2013
50	Shao, HJ	The phenotypic responses of human anterior cruciate ligament cells cultured on poly(ϵ -caprolactone) and chitosan	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	33	2010
51	Freeman, JW	Tissue Engineering of the Anterior Cruciate Ligament: The Viscoelastic Behavior and Cell Viability of a Novel Braid-Twist Scaffold	JOURNAL OF BIOMATERIALS SCIENCE-POLYMER EDITION	32	2009
52	Steinert, AF	In situ IGF-1 gene delivery to cells emerging from the injured anterior cruciate	BIOMATERIALS	32	2008

		ligament			
53	Li, X	Wired silk architectures provide a biomimetic ACL tissue engineering scaffold	JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS	31	2013
54	Mallett, KF	Digital image correlation-aided mechanical characterization of the anteromedial and posterolateral bundles of the anterior cruciate ligament	ACTA BIOMATERIALIA	31	2017
55	Canseco, JA	Effect on Ligament Marker Expression by Direct-Contact Co-culture of Mesenchymal Stem Cells and Anterior Cruciate Ligament Cells	TISSUE ENGINEERING PART A	30	2012
56	Bedi, A	Changes in dynamic medial tibiofemoral contact mechanics and kinematics after injury of the anterior cruciate ligament: A cadaveric model	PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART H- JOURNAL OF ENGINEERING IN MEDICINE	30	2013
57	Chung, EJ	A biodegradable tri-component graft for anterior cruciate ligament reconstruction	JOURNAL OF TISSUE ENGINEERING AND REGENERATIVE MEDICINE	29	2017
58	Bonato, P	EMG-based measures of fatigue during a repetitive squat exercise - Assessment of dynamic conditions can provide information about compensatory muscle function in ACL patients	IEEE ENGINEERING IN MEDICINE AND BIOLOGY MAGAZINE	29	2001
59	Zaffagnini, S	Computer investigation of ACL orientation during passive range of motion	COMPUTERS IN BIOLOGY AND MEDICINE	28	2004
60	Limbert, G	Finite Element Analysis of the Human ACL Subjected to Passive Anterior Tibial Loads	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	28	2004
61	Mahalingam, VD	Allogeneic Versus Autologous Derived Cell Sources for Use in Engineered Bone-Ligament-Bone Grafts in Sheep Anterior Cruciate Ligament Repair	TISSUE ENGINEERING PART A	27	2015
62	Tischer, T	Tissue Engineering of the Anterior Cruciate Ligament-Sodium Dodecyl Sulfate-Acellularized and Revitalized Tendons Are Inferior to Native Tendons	TISSUE ENGINEERING PART A	27	2010
63	Maerz, T	Biomechanical Characterization of a Model of Noninvasive, Traumatic Anterior Cruciate Ligament Injury in the Rat	ANNALS OF BIOMEDICAL ENGINEERING	27	2015
64	Guess, TM	Loading of the medial meniscus in the ACL deficient knee: A multibody computational study	MEDICAL ENGINEERING & PHYSICS	27	2017
65	Kar, J	A Musculoskeletal Modeling Approach for Estimating Anterior Cruciate Ligament Strains and Knee Anterior-Posterior Shear Forces in Stop-Jumps Performed by Young Recreational Female Athletes	ANNALS OF BIOMEDICAL ENGINEERING	26	2013
66	Cheng, MT	Modulation of Proliferation and Differentiation of Human Anterior Cruciate Ligament-Derived Stem Cells by Different Growth Factors	TISSUE ENGINEERING PART A	25	2009
67	Kar, J	A Numerical Simulation Approach to Studying Anterior Cruciate Ligament Strains and Internal Forces Among Young Recreational Women Performing Valgus Inducing Stop-Jump Activities	ANNALS OF BIOMEDICAL ENGINEERING	25	2012
68	Vavken, P	Translational Studies in Anterior Cruciate Ligament Repair	TISSUE ENGINEERING PART B- REVIEWS	24	2010
69	Herfat, ST	Applying Simulated In Vivo Motions to Measure Human Knee and ACL Kinetics	ANNALS OF BIOMEDICAL ENGINEERING	24	2012
70	Samsell, BJ	Use of controlled low dose gamma irradiation to sterilize allograft tendons for ACL reconstruction: biomechanical and clinical perspective	CELL AND TISSUE BANKING	24	2012
71	Ran, JS	Ectopic tissue engineered ligament with silk collagen scaffold for ACL regeneration: A preliminary study	ACTA BIOMATERIALIA	23	2017
72	Bae, JY	Finite element study on the anatomic trans tibial technique for single-bundle anterior cruciate ligament reconstruction	MEDICAL & BIOLOGICAL ENGINEERING & COMPUTING	22	2016
73	Ebrahimi, M	The effect of different preconditioning protocols on repeatability of bovine ACL stress-relaxation response in tension	JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS	22	2019
74	Proffen, BL	Bridge-Enhanced ACL Repair: A Review of the Science and the Pathway Through FDA Investigational Device Approval	ANNALS OF BIOMEDICAL ENGINEERING	22	2015
75	Ali, N	The application of musculoskeletal modeling to investigate gender bias in non-contact ACL injury rate during single-leg landings	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	22	2014
76	Nasseri, A	Modelling the loading mechanics of anterior cruciate ligament	COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE	21	2020
77	Cai, CB	Type I collagen and polyvinyl alcohol blend fiber scaffold for anterior cruciate ligament reconstruction	BIOMEDICAL MATERIALS	21	2013
78	Nguyen, DT	Healing of the Goat Anterior Cruciate Ligament After a New Suture Repair Technique and Bioscaffold Treatment	TISSUE ENGINEERING PART A	21	2013
79	Shi, HJ	Prediction of Knee Kinematics at the Time of Noncontact Anterior Cruciate Ligament Injuries Based on the Bone Bruises	ANNALS OF BIOMEDICAL ENGINEERING	21	2021
80	Saha, PK	A New Osteophyte Segmentation Algorithm Using the Partial Shape Model and Its Applications to Rabbit Femur Anterior Cruciate Ligament Transection	IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING	21	2011

		via Micro-CT Imaging			
81	Tovar, N	ACL reconstruction using a novel hybrid scaffold composed of polyarylate fibers and collagen fibers	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	21	2012
82	Mahalingam, VD	Fresh Versus Frozen Engineered Bone-Ligament-Bone Grafts for Sheep Anterior Cruciate Ligament Repair	TISSUE ENGINEERING PART C- METHODS	20	2015
83	Zago, M	Fatigue Induced by Repeated Changes of Direction in elite Female Football (Soccer) Players: Impact on Lower Limb Biomechanics and Implications for ACL Injury Prevention	FRONTIERS IN BIOENGINEERING AND BIOTECHNOLOGY	20	2021
84	Rachmat, HH	In-situ mechanical behavior and slackness of the anterior cruciate ligament at multiple knee flexion angles	MEDICAL ENGINEERING & PHYSICS	19	2016
85	Wan, C	Finite element simulations of different hamstring tendon graft lengths and related fixations in anterior cruciate ligament reconstruction	MEDICAL & BIOLOGICAL ENGINEERING & COMPUTING	19	2017
86	Pinese, C	Rolled knitted scaffolds based on PLA-pluronic copolymers for anterior cruciate ligament reinforcement: A step by step conception	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS	19	2017
87	Parry, JA	Three-Dimension-Printed Porous Poly(Propylene Fumarate) Scaffolds with Delayed rhBMP-2 Release for Anterior Cruciate Ligament Graft Fixation	TISSUE ENGINEERING PART A	19	2017
88	Seo, YK	Comparison of light-emitting diode wavelength on activity and migration of rabbit ACL cells	LASERS IN MEDICAL SCIENCE	19	2014
89	Homyk, A	Failure locus of the anterior cruciate ligament: 3D finite element analysis	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	18	2012
90	Xie, XR	Multiphasic bone-ligament-bone integrated scaffold enhances ligamentization and graft-bone integration after anterior cruciate ligament reconstruction	BIOACTIVE MATERIALS	18	2024
91	Orsi, AD	The effects of knee joint kinematics on anterior cruciate ligament injury and articular cartilage damage	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	18	2016
92	Martelli, S	KIN-Nav navigation system for kinematic assessment in anterior cruciate ligament reconstruction: features, use, and perspectives	PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART H- JOURNAL OF ENGINEERING IN MEDICINE	18	2007
93	Liu, XD	Use of the normalcy index for the assessment of abnormal gait in the anterior cruciate ligament deficiency combined with meniscus injury	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	18	2020
94	Atarod, M	Kinematic and Kinetic Interactions During Normal and ACL-Deficient Gait: A Longitudinal In Vivo Study	ANNALS OF BIOMEDICAL ENGINEERING	18	2014
95	Yao, J	Deterioration of Stress Distribution Due to Tunnel Creation in Single-Bundle and Double-Bundle Anterior Cruciate Ligament Reconstructions	ANNALS OF BIOMEDICAL ENGINEERING	17	2012
96	Bublitz, C	Low-level laser therapy prevents degenerative morphological changes in an experimental model of anterior cruciate ligament transection in rats	LASERS IN MEDICAL SCIENCE	17	2014
97	Zarychta, P	Features extraction in anterior and posterior cruciate ligaments analysis	COMPUTERIZED MEDICAL IMAGING AND GRAPHICS	16	2015
98	Vairis, A	Evaluation of an intact, an ACL-deficient, and a reconstructed human knee joint finite element model	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	16	2016
99	Ogata, Y	Anterior cruciate ligament-derived mesenchymal stromal cells have a propensity to differentiate into the ligament lineage	REGENERATIVE THERAPY	15	2018
100	Zaffagnini, S	Rotational laxity after anterior cruciate ligament injury by kinematic evaluation of clinical tests	JOURNAL OF MEDICAL ENGINEERING & TECHNOLOGY	15	2000

Appendix E

Table 5: Top Journals Publishing the 100 Most-Cited Articles on ACL

	Source	Documents	Citations	Mean Citation	Impact Factor
1	BIOMATERIALS	18	3221	178.9	12.8 (2023)
2	TISSUE ENGINEERING PART A	14	544	38.9	3.5 (2023)
3	ANNALS OF BIOMEDICAL ENGINEERING	11	403	36.6	3.0 (2023)
4	COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	7	166	23.7	1.7 (2023)
5	ACTA BIOMATERIALIA	6	197	32.8	9.4 (2023)
6	JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	6	207	34.5	3.9 (2023)
7	JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS	4	152	38.0	3.3 (2023)
8	BIOACTIVE MATERIALS	3	95	31.7	18.0 (2023)
9	COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE	3	144	48.0	4.9 (2023)

Appendix F

Table 6: Top Authors Contributing to the 100 Most-Cited Articles on ACL

Author	Articles	First Author	Co-Author
Murray, MM	6	1	5
Jiang, J	5	0	5
Dunn, MG	4	0	4
Arruda, EM	4	0	4
Zhao, JZ	3	0	3
Laurencin, CT	3	0	3
Fan, HB	3	2	1
Liu, HF	3	1	2
Toh, SL	3	0	3
Goh, JCH	3	0	3
Li, X	3	3	0
Snedeker, JG	3	0	3
Smietana, MJ	3	0	3
Wojtys, EM	3	0	3
Larkin, LM	3	0	3
Martelli, S	3	1	2
Zaffagnini, S	3	2	1
Matsumoto, T	3	0	3
Kuroda, R	3	0	3
Kurosaka, M	3	0	3
Qin, L	3	0	3