

Research Article

Biological Augmentation in Meniscal Repair: A Bibliometric and Knowledge-Mapping Analysis of Global Trends and Emerging Regenerative Strategies

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ABSTRACT

Objective: To map the global research landscape of biological augmentation in meniscal repair and identify the regenerative strategies shaping current research and potential clinical translation.**Methods:** The Web of Science Core Collection was searched from inception to August 18, 2026. After document-type filtering and relevance screening, 558 publications addressing biological or regenerative strategies for meniscal repair, healing, or regeneration were included. Publication trends, citation metrics, collaboration networks, author-keyword co-occurrence, thematic evolution, and reference co-citation were analysed.**Results:** The 558 publications (1988-2026) accumulated 19,786 citations. Research output increased markedly during the last decade and peaked in 2022 (n=47). The United States (n=180), China (n=126), and Japan (n=72) were the leading contributors. Tissue engineering, platelet-rich plasma, mesenchymal stem cells, and scaffolds were dominant themes. Recent thematic shifts involved decellularized matrices, extracellular vesicles, immunomodulation, and three-dimensional printing.**Conclusion:** Biological augmentation of meniscal repair is progressing from conventional biological stimulation towards cell-based, biomaterial, and biofabrication strategies. However, bibliometric prominence should not be equated with clinical effectiveness. Future studies should prioritise comparative clinical validation and determine which augmentation strategy is most appropriate for specific tear patterns and patient profiles.

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Introduction

The menisci are essential fibrocartilaginous structures that contribute to load transmission, shock absorption, joint stability, lubrication, and long-term preservation of articular cartilage (Fox et al., 2012; Makris et al., 2011; Mordecai et al., 2014). Loss of functional meniscal tissue disrupts normal tibiofemoral biomechanics and is associated with subsequent degenerative changes. Contemporary evidence supports meniscal preservation and repair whenever technically feasible (Migliorini et al., 2023; Nepple et al., 2012).

Despite advances in arthroscopic fixation techniques, biological healing remains a major limitation of meniscal repair. Classic anatomical investigations demonstrated that only the peripheral portion of the adult human meniscus receives penetrating vascular supply (Arnoczky & Warren, 1982; Arnoczky & Warren, 1983). Consequently, tears involving relatively avascular regions have less intrinsic healing potential, and successful repair depends not only on mechanical fixation but also on the local biological environment (Makris et al., 2011; Vaquero & Forriol, 2016).

These limitations have stimulated increasing interest in biological augmentation of meniscal repair. Strategies have evolved from techniques intended to stimulate local bleeding and vascular responses, including trephination, synovial abrasion, fibrin clot application, and marrow stimulation, toward orthobiologic and regenerative approaches such as platelet-rich plasma (PRP), bone marrow aspirate concentrate (BMAC), mesenchymal stem/stromal cells (MSCs), growth factors, scaffolds, and tissue-engineering constructs (Keller et al., 2022; Chen et al., 2024; Za et al., 2024; Tuszyńska et al., 2025).

Among clinically investigated approaches, PRP has received particular attention. Meta-analytic evidence suggests that PRP augmentation may reduce meniscal repair failure, although effects on patient-reported functional outcomes remain inconsistent and the underlying studies demonstrate considerable methodological heterogeneity (Zaffagnini et al., 2021; Li & Weng, 2022). More recent appraisal of the systematic-review literature has emphasized limitations in methodological quality, supporting cautious interpretation of the apparent benefits of PRP (Hantouly et al., 2026).

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Parallel advances in regenerative medicine have broadened the field. MSC-based therapies, scaffolds, hydrogels, extracellular matrix-derived biomaterials, and tissue-engineering approaches seek not merely to stimulate intrinsic healing but to modify or reconstruct the biological microenvironment of the injured meniscus (Chen et al., 2024; Za et al., 2024; Tuszyńska et al., 2025; Bian et al., 2025). Tissue-engineering research has increasingly integrated cells, biomaterials, biological signaling, and physical stimuli, although a considerable translational gap persists between promising preclinical findings and reproducible clinical efficacy (Bian et al., 2025).

More recently, advanced technologies including decellularized extracellular matrix (dECM), injectable delivery systems, extracellular vesicles (EVs), and three-dimensional (3D) printing or bioprinting have emerged as potential next-generation strategies (Tuszyńska et al., 2025; Stocco et al., 2022; Deepak et al., 2025).

Previous bibliometric research evaluated the broader meniscus literature and identified scaffolds and tissue engineering among emerging research fronts (Zhou et al., 2020). A subsequent analysis specifically examined stem-cell therapy for meniscal regeneration (Yang et al., 2023). However, these analyses did not specifically map the broader biological augmentation ecosystem of meniscal repair, integrating clinically applicable orthobiologics with cell-based therapy, marrow-derived strategies, scaffolds, biomaterials, tissue engineering, and emerging regenerative technologies.

Therefore, the present study aimed to characterize the global research landscape of biological augmentation in meniscal repair through bibliometric and knowledge-mapping methods, with particular emphasis on scientific productivity, collaboration networks, intellectual structure, keyword co-occurrence, thematic evolution, and emerging therapeutic strategies.

Materials and methods

Study Design

This study was designed as a bibliometric and knowledge-mapping analysis to characterize the global research landscape of biological augmentation in meniscal repair. The analysis focused on publication growth, influential journals and publications, authorship and geographic patterns, international collaboration, intellectual structure, keyword co-occurrence, thematic evolution, and emerging regenerative strategies.

Data Source and Search Strategy

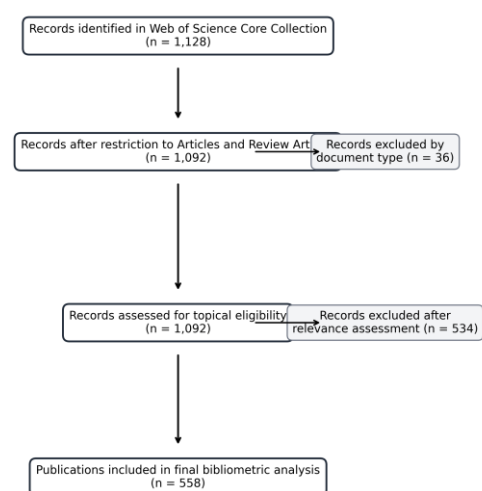
Bibliographic data were retrieved from the Web of Science Core Collection (WoSCC). The search was conducted on August 18, 2026, without restriction on publication year. Three Topic fields were combined with the Boolean operator AND: meniscus, repair, and a biological/regenerative augmentation block comprising platelet-rich plasma (PRP), fibrin clot, fibrin glue, bone marrow aspirate concentrate (BMAC), bone marrow stimulation, marrow stimulation, marrow venting, mesenchymal stem cell, mesenchymal stromal cell, stem cell, growth factor, scaffold, and tissue engineering. The complete reproducible search string is provided in Supplementary Table S1. The search initially yielded 1,128 records. After restriction to Articles and Review Articles, 1,092 records remained. The search block intentionally used broad umbrella concepts, particularly scaffold and tissue engineering. Because a Web of Science Topic search interrogates titles, abstracts, author keywords, and Keywords Plus, publications concerning emerging subtopics such as dECM, EVs, and 3D printing could be retrieved when linked to these broader concepts.

These emerging terms were subsequently identified during keyword normalization and thematic analysis; the search was not expanded post hoc on the basis of the observed results.

Eligibility and Relevance Screening

Publications were eligible when the meniscus represented a primary study focus and an explicit relationship was present between meniscal repair, healing, regeneration, tear, or defect and a biological or regenerative intervention. Studies focusing primarily on non-meniscal cartilage or osteoarthritis, purely mechanical repair without a biological component, meniscal replacement or transplantation without a repair-augmentation component, and broad biomaterial studies without a direct meniscal repair/regeneration relationship were excluded. Following sequential relevance assessment, 558 publications were retained and 534 records were excluded.

Figure 1. Study-selection flow diagram for the bibliometric dataset.



Data Extraction and Preprocessing

Bibliographic records were exported from WoSCC in BibTeX format in three batches (500, 500, and 92 records) and merged. Publication year, title, source journal, authors, affiliations, country information, author keywords, Keywords Plus, citation counts, DOI, and cited references were extracted where available. Author keywords were standardized for capitalization, punctuation, singular/plural variants, abbreviations, and synonymous terminology.

Bibliometric Indicators

Descriptive indicators included annual scientific production, total citations, mean and median citations per publication, citations per year, publication-year-normalized citation impact, and the most productive journals, authors, countries, and institutions. Citations per year were calculated as total citations divided by publication age (2026 - publication year + 1). Publication-year-normalized impact was calculated by dividing each publication's citation count by the mean citation count of all included publications published in the same year. Citation counts corresponded to WoSCC values at the time of retrieval.

Author keywords were used to characterize the conceptual structure. Of the 558 included publications, 437 contained author-keyword information. Following normalization, unique author keywords were identified. For the principal keyword network, the 35 most frequent normalized terms meeting a minimum occurrence threshold of six were retained, and links were displayed when two terms co-occurred in at least three publications.

A deterministic force-directed layout with expanded spacing and label displacement was used to improve readability in dense central regions.

Thematic Evolution and Emerging Topics

Temporal evolution was evaluated across four periods: 1988-2009, 2010-2015, 2016-2020, and 2021-2026. Major themes included platelet-derived products, MSC-based strategies, scaffold and biomaterial approaches, tissue engineering, growth factors, and 3D printing. Emerging concepts included biologic augmentation, decellularized matrices, extracellular vesicles, immunomodulation, and 3D printing.

Collaboration Network Analysis

Scientific collaboration was examined at author and country levels. Country productivity was calculated from all author affiliations using publication-level full counting: each country received one publication credit when it appeared at least once in a publication, irrespective of the number of contributing addresses. The same counting rule was used in Table 2, the Results, and Figure 6. For the main international collaboration visualization, the network was restricted to the 15 most productive countries and links representing at least three joint publications were displayed.

Reference Co-citation Analysis

A co-citation relationship was defined when two cited references appeared together in the reference lists of an included publication. Across the final dataset, 12,968 distinct cited references were identified. The principal visualization focused on the 20 most frequently cited references, with links of at least 12 co-citations displayed.

Visualization and Ethics

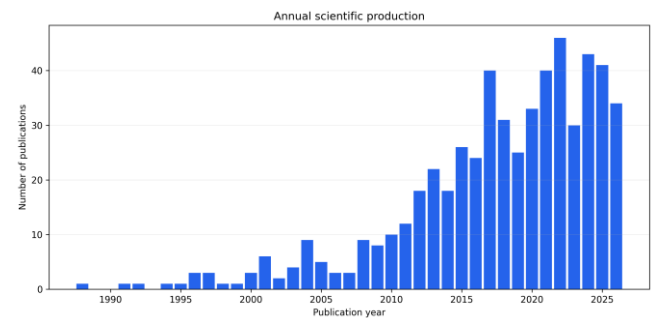
Bibliographic data processing, terminology normalization, descriptive analyses, network construction, and graphical visualization were performed in Python 3.13.5 using custom scripts. Network construction and graph-based analyses used NetworkX 3.6.1, and figures were generated with Matplotlib 3.10.8. Visualization thresholds were selected to balance information retention and graphical readability. Ethics approval was not required because this bibliometric study used publicly available bibliographic metadata and involved no human participants, animals, or identifiable individual-level health data. Informed consent was therefore not applicable.

Results

Bibliometric Characteristics and Temporal Trends

A total of 1,092 records remained after document-type filtering. Following title and abstract relevance screening, 558 publications were included in the final bibliometric analysis. The literature covered 1988-2026 and accumulated 19,786 citations, corresponding to a mean of 35.5 citations per publication and a median of 20 citations. Scientific production increased substantially over time and peaked in 2022 (n=46), followed by 2024 (n=43), 2025 (n=41), and 2021 (n=40) (Figure 2).

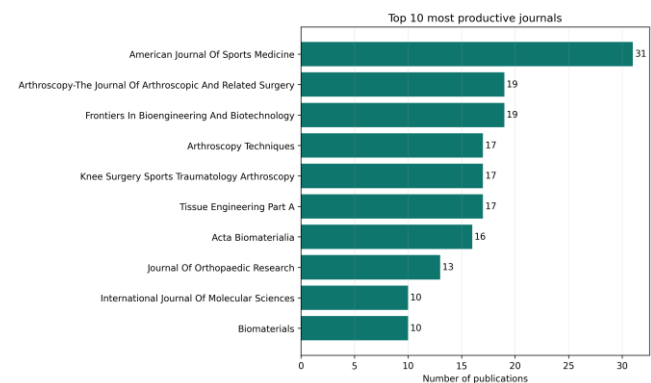
Figure 2. Annual scientific production on biological augmentation in meniscal repair. The 2026 count represents an incomplete calendar year.



Leading Journals and Sources

The American Journal of Sports Medicine was the most productive source with 31 publications, followed by Arthroscopy: The Journal of Arthroscopic and Related Surgery and Frontiers in Bioengineering and Biotechnology (each n=19), Arthroscopy Techniques and Knee Surgery, Sports Traumatology, Arthroscopy (each n=17), Tissue Engineering Part A (n=17), and Acta Biomaterialia (n=16) (Figure 3).

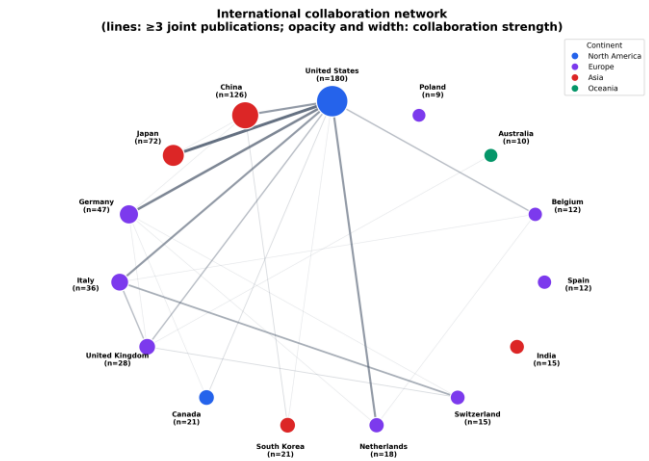
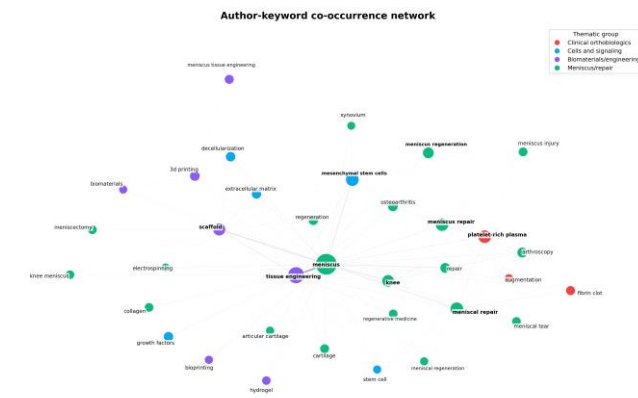
Figure 3. Top 10 most productive journals in the analyzed literature.



Keyword Structure and Major Research Themes

Author keywords were available for 437 publications. Following normalization, the most frequent terms were meniscus (n=212), tissue engineering (n=99), meniscal repair (n=48), mesenchymal stem cells (n=46), meniscus repair (n=46), scaffold (n=41), and platelet-rich plasma (n=40). The normalized frequency analysis demonstrated close relationships among meniscal repair, tissue engineering, regenerative medicine, cellular therapies, biomaterials, and orthobiologic augmentation (Figure 4).

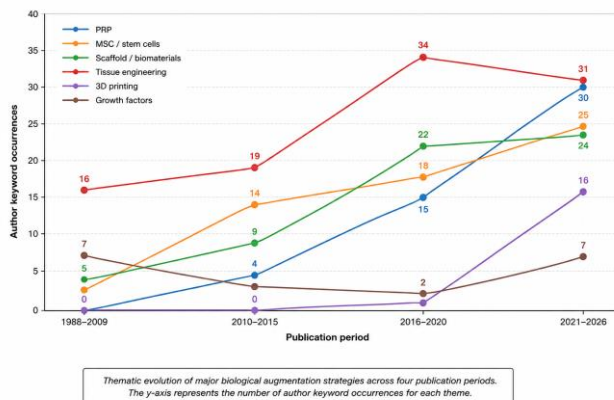
Figure 4. Author-keyword co-occurrence network. Node size represents keyword frequency, node color indicates broad thematic grouping, and edge width represents co-occurrence strength. The visualization includes the 35 most frequent normalized keywords meeting the minimum occurrence threshold of six; links represent at least three co-occurrences. An expanded force-directed layout and displaced labels were used to improve readability.



Evolution of Biological Augmentation Strategies

Temporal analysis demonstrated a progressive transition in research priorities (Figure 5). Earlier studies emphasized healing biology and growth-factor-related mechanisms, followed by increasing interest in tissue engineering, scaffold-based repair, MSC approaches, and PRP. The most recent period was characterized by diversification toward biologic augmentation, decellularized matrix, extracellular vesicles, immunomodulation, and 3D printing.

Figure 5. Thematic evolution of major biological augmentation strategies across four publication periods.



Geographic Productivity and International Collaboration

Using publication-level full counting, the United States was the most productive country with 180 publications, followed by China (n=126), Japan (n=72), Germany (n=47), and Italy (n=36). The same country counts were used in Table 2 and Figure 6. International collaboration was most frequently organized around the United States, China, Japan, and major European contributors (Figure 6).

Figure 6. International collaboration network. Node size reflects scientific production, node color indicates continent, and connecting lines represent international co-authorship. Edge width and opacity increase with collaboration strength; weak links are intentionally attenuated to emphasize the principal collaboration axes in print. The network includes the 15 most productive countries and links representing at least three joint publications.

Table 1. General bibliometric characteristics of the included literature

Bibliometric characteristic	Result
Initial WoS records after document-type filtering	1,092
Publications included in final analysis	558
Publication period	1988-2026
Total citations	19,786
Mean citations per publication	35.5
Median citations per publication	20
Countries represented	39
Institutions represented	541
Authors represented	2,572
Publications with author keywords	437
Unique normalized author keywords	882
Distinct cited references	13,105
Peak publication year	2022 (n=46)
Search date	August 18, 2026

Table 2. Leading journals and countries

Rank	Journal	Publications	Country	Publications
1	American Journal of Sports Medicine	31	United States	180
2	Arthroscopy: The Journal of Arthroscopic and Related Surgery	19	China	126
3	Frontiers in Bioengineering and Biotechnology	19	Japan	72
4	Arthroscopy Techniques	17	Germany	47
5	Knee Surgery, Sports Traumatology, Arthroscopy	17	Italy	36
6	Tissue Engineering Part A	17	United Kingdom	28
7	Acta Biomaterialia	16	Canada	21
8	Journal of Orthopaedic Research	13	South Korea	21
9	International Journal of Molecular Sciences	10	Netherlands	18
10	Biomaterials	10	Switzerland	15

The most productive authors were Quanyi Guo (n=19), Shuyun Liu (n=16), Ichiro Sekiya and Darryl D. D'Lima (each n=14), and Hideyuki Koga, Xiaoqing Hu, and Yingfang Ao (each n=12). The leading institutions after affiliation-name harmonization were Peking University (n=35), Chinese People's Liberation Army General Hospital (n=22), Tokyo Medical and Dental University/Institute of Science Tokyo (n=18), and the University of Pennsylvania, Shanghai Jiao Tong University, and the University of Pittsburgh (each n=14) (Table 3).

Table 3. Most productive authors and institutions

Rank	Author	Publications	Institution	Publications
1	Guo, Quanyi	19	Peking University	35
2	Liu, Shuyun	16	Chinese People's Liberation Army General Hospital	22
3	Sekiya, Ichiro	14	Tokyo Medical and Dental University / Institute of Science Tokyo	18
4	D'Lima, Darryl D.	14	University of Pennsylvania	14
5	Koga, Hideyuki	12	Shanghai Jiao Tong University	14
6	Hu, Xiaoqing	12	University of Pittsburgh	14
7	Ao, Yingfang	12	Zhejiang University	13
8	Chen, Mingxue	11	Scripps Research Institute	13
9	Krych, Aaron J.	10	Mayo Clinic	12
10	Yuan, Zhiguo	10	Pennsylvania Medicine	12

Because raw citation totals favor older publications, citation rates and publication-year-normalized impact were additionally examined. Mean citations per year were 2.92 for 1988-2009, 4.32 for 2010-2015, 4.62 for 2016-2020, and 2.90 for 2021-2026; the most recent period was affected by short citation windows. Accordingly, publications were described as "most frequently cited" when ranked by raw total citations, whereas Table 4 presents total citations together with annualized and publication-year-normalized values.

Table 4. Most frequently cited publications with time-adjusted citation indicators

Rank	Publication	Year	Total citations	Citations/year	Year-normalized impact
1	Makris, Eleftherios A. et al.	2011	846	52.9	7.02
2	Kwon, Heenam et al.	2019	580	72.5	10.29
3	ARNOCZKY, SP et al.	1988	348	8.9	1.00
4	Lee, Chang H. et al.	2014	275	21.2	4.52
5	Ishida, Kazunari et al.	2007	268	13.4	2.10
6	Stone, KR et al.	1997	245	8.2	2.29
7	Kopf, Sebastian et al.	2020	239	34.1	6.13
8	Buma, P et al.	2004	203	8.8	3.25
9	Staerke, Christian et al.	2009	184	10.2	3.00
10	Sweigart, MA et al.	2001	172	6.6	2.02

Table 5. Major author keywords defining the conceptual structure

Rank	Normalized author keyword	Occurrences
1	Meniscus	205
2	Meniscal repair	106
3	Tissue engineering	100
4	Platelet-rich plasma	54
5	Mesenchymal stem cells	52
6	Scaffold	42
7	Meniscal regeneration	40

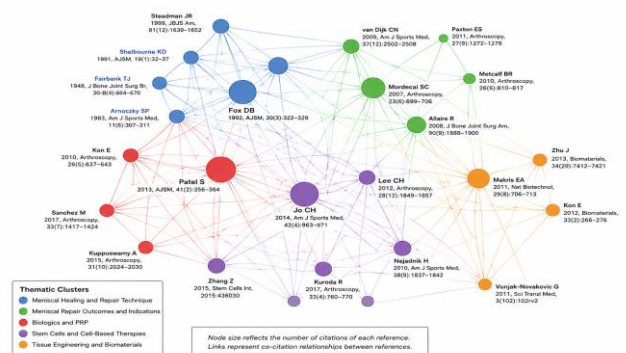
Table 6. Thematic evolution of biological augmentation in meniscal repair

Period	Dominant/representative themes	Interpretation
1988-2009	Meniscal healing; vascularity; growth factors; early tissue engineering	Establishment of the biological basis of meniscal healing
2010-2015	PRP; MSCs; tissue engineering; scaffolds	Expansion toward orthobiologic and cell-based augmentation
2016-2020	MSCs; scaffolds; hydrogels; regenerative medicine	Integration of cells, biomaterials, and engineered repair environments
2021-2026	Biologic augmentation; decellularized matrix; extracellular vesicles; immunomodulation; 3D printing	Transition toward advanced bioengineering and molecular regenerative strategies

Intellectual Structure and Co-citation Analysis

The included publications collectively cited 13,105 distinct references. Co-citation analysis identified the 2011 Biomaterials review by Makris et al. as the most frequently cited reference within the analyzed knowledge base, appearing in 188 publications in the dataset. Classical studies concerning meniscal vascularity and healing were also prominent, demonstrating that contemporary regenerative approaches remain conceptually grounded in fundamental meniscal biology (Figure 7).

Figure 7. Reference co-citation network. Node size reflects citation frequency within the analyzed corpus and links represent co-citation relationships.



Discussion

Principal Findings

This bibliometric and knowledge-mapping analysis demonstrates that biological augmentation of meniscal repair has evolved from a relatively focused investigation of intrinsic healing mechanisms into a rapidly expanding multidisciplinary field. Scientific production accelerated during the last decade, while tissue engineering, PRP, MSCs, scaffolds, and meniscal regeneration emerged as major conceptual themes. Recent research fronts included decellularized matrices, extracellular vesicles, immunomodulatory approaches, and 3D printing.

From Intrinsic Healing to Biological Augmentation

The intellectual structure identified by co-citation analysis was strongly anchored in classical studies of meniscal vascular anatomy and healing (Makris et al., 2011; Arnoczky & Warren, 1982; Arnoczky & Warren, 1983). Modern biological augmentation can be viewed as increasingly sophisticated attempts to overcome restricted intrinsic healing, progressing from fibrin clot, trephination, synovial stimulation, and marrow-derived exposure toward PRP, cellular therapies, growth factors, biomaterials, and engineered constructs (Keller et al., 2022; Chen et al., 2024; Za et al., 2024; Tuszynska et al., 2025).

PRP and Clinically Accessible Orthobiologics

PRP was among the most frequent biological keywords. Meta-analytic evidence has reported lower failure rates in some PRP-augmented repairs (Zaffagnini et al., 2021; Li & Weng, 2022), but the clinical literature remains heterogeneous. A 2026 systematic overview found all 13 included PRP systematic reviews to have critical methodological flaws; 11 were rated critically low and two low quality (Hantouly et al., 2026). Bibliometric prominence should therefore be interpreted as sustained scientific interest rather than proof of clinical superiority.

MSCs and Cell-based Regenerative Strategies

MSCs represented another major component of the conceptual network. Their emergence reflects a transition from stimulating endogenous healing toward modifying the cellular and paracrine environment. However, the translational gap remains substantial (Chen et al., 2024; Bian et al., 2025). Emerging augmentation strategies are still predominantly preclinical; a 2024 systematic review identified 19 eligible studies evaluating 12 non-PRP/non-MSc/non-fibrin factors, of which 18 were animal studies (Mazy et al., 2024).

Scaffolds, Biomaterials, and Tissue Engineering

Tissue engineering was the third most frequent normalized author keyword. Scaffolds may provide mechanical architecture while supporting cellular adhesion, migration, proliferation, matrix deposition, and delivery of biological agents. Hydrogels extend this concept through localized delivery and retention of cells or bioactive molecules (Tuszynska et al., 2025; Bian et al., 2025).

Fibrin-based Augmentation

Fibrin represents a historical bridge between conventional repair and biological augmentation. Fibrin clot techniques provide a provisional matrix that may support cellular migration and concentrate biological mediators. Their continued presence in the literature illustrates how relatively simple biological strategies coexist with advanced regenerative technologies (Keller et al., 2022; Chen et al., 2024; Za et al., 2024).

Emerging Regenerative Frontiers

Decellularized extracellular matrices, extracellular vesicles, immunomodulation, and 3D printing emerged as recent research fronts. Decellularized matrices may retain tissue-specific biochemical and architectural signals, while 3D printing and bioprinting may enable control of geometry, pore architecture, regional composition, and mechanical anisotropy (Stocco et al., 2022; Deepak et al., 2025). Taken together, the thematic trajectory can be summarized as intrinsic healing biology -> biological stimulation -> orthobiologics -> cell-based therapy -> scaffold/tissue engineering -> biofabrication and molecular regenerative therapy.

Global Research Structure

The United States was the leading contributor, followed by China and Japan, and occupied a central position in several strong bilateral collaborations. The internationalization of the field is important because successful regenerative technologies require integration among orthopaedic surgeons, cell biologists, material scientists, biomedical engineers, and translational researchers.

Intellectual Foundations

Makris et al. (2011) was the most frequently cited reference in the dataset, appearing in 188 included publications. The classical studies by Arnoczky and Warren (1982, 1983) were also prominent. Despite rapid technological development, contemporary regenerative research therefore remains grounded in fundamental knowledge of meniscal vascularity and healing physiology.

Clinical Implications

Biological augmentation should not be considered a single therapeutic category. PRP, fibrin clot, marrow stimulation, BMAC, MSC-based therapies, scaffolds, hydrogels, and advanced biofabrication differ in mechanism, invasiveness, regulatory complexity, clinical maturity, and evidence. The expanding publication volume should not be interpreted as evidence that augmentation is required for every repair. Future research should increasingly ask which strategy is appropriate for which tear and patient rather than simply whether augmentation works. Future clinical trials should report PRP preparation using standardized minimum datasets, including platelet dose, leukocyte content, activation method, and injection schedule. Outcomes should be stratified by tear morphology, vascular zone, chronicity, concomitant anterior cruciate ligament reconstruction, and repair technique. Adequately powered randomized controlled trials (RCTs) with prespecified failure definitions, patient-reported outcomes, imaging or second-look endpoints where appropriate, and long-term follow-up are required to define clinically meaningful indications.

Strengths and Limitations

This study integrates publication trends, citation analysis, author-keyword patterns, thematic evolution, collaboration networks, and reference co-citation analysis within a focused dataset. The exclusive use of WoSCC represents an important coverage limitation: journals and records indexed only in Scopus or PubMed/MEDLINE may have been omitted, and database-specific differences in journal coverage and citation indexing may limit the generalizability of productivity and citation estimates. Conversely, use of a single source avoided cross-database duplication and incompatibility among citation fields. Additional limitations include residual author/institution naming variation, dependence of keyword analyses on author terminology, and visualization thresholds selected for interpretability. Although citations per year and publication-year-normalized impact were added to reduce time-related bias, citation indicators remain database- and time-dependent and should not be interpreted as measures of methodological quality.

Bibliometric prominence measures scientific activity and citation visibility rather than therapeutic efficacy. Finally, 2026 was incomplete at the August 18 search date.

Conclusion

Biological augmentation of meniscal repair has evolved into a multidisciplinary research field linking sports surgery with orthobiologics, cell biology, biomaterials, tissue engineering, and regenerative medicine. PRP, MSCs, scaffolds, and tissue engineering currently form major conceptual pillars, while decellularized matrices, extracellular vesicles, immunomodulation, and 3D biofabrication represent emerging frontiers. The overall trajectory indicates a transition from stimulating intrinsic meniscal healing toward engineering the biological environment of repair. However, the rapid expansion of regenerative technologies has outpaced high-level clinical validation, and many emerging approaches remain predominantly preclinical.

Authors contributions

O.A. constructed the main idea and hypothesis of the study and developed the theory. O.A. arranged and edited the material and method section and evaluated the data in the Results section. The Discussion section of the article was written by O.A. and Ş.S. Ş.S. contributed to the study design and data interpretation and reviewed, corrected, and approved the manuscript. Both authors served as observers in the agreement sub-study, measuring independently and blinded to the automated output and to each other. In addition, all authors discussed the entire study and approved the final version.

Ethical approval

Not applicable. This bibliometric study analysed publicly available bibliographic metadata and did not involve human participants, animals, or identifiable individual-level data.

Conflicts of interest

The authors declare that they have no conflicts of interest

Funding

No specific funding was received for this study.

Data availability

The bibliographic dataset was derived from the Web of Science Core Collection. Processed bibliometric tables and network matrices supporting the reported results are available from the corresponding author on reasonable request, subject to Web of Science licensing restrictions.

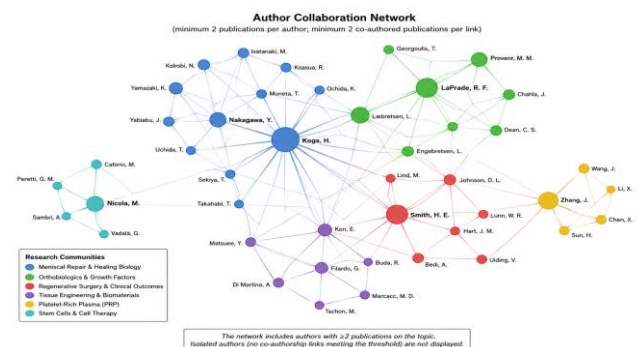
Author Contributions

Abdurrahim Oğuz: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing - original draft, Writing - review & editing, Project administration. Necati Çiçek: Methodology, Validation, Investigation, Interpretation of data, Writing - review & editing. Both authors reviewed and approved the final manuscript.

Supplementary Table S1. Exact Web of Science search strategy

Item	Search specification
Database	Web of Science Core Collection (WoSCC)
Search field	Topic (TS)
Exact search string	TS=(meniscus) AND TS=(repair) AND TS=("platelet-rich plasma" OR PRP OR "fibrin clot" OR "fibrin glue" OR "bone marrow aspirate concentrate" OR BMAC OR "bone marrow stimulation" OR "marrow stimulation" OR "marrow venting" OR "mesenchymal stem cell" OR "mesenchymal stromal cell" OR "stem cell" OR "growth factor" OR scaffold OR "tissue engineering")
Search date	August 18, 2026
Timespan	Inception to August 18, 2026; no publication-year restriction
Initial records	1,128
Document-type restriction	Article OR Review Article
Records after document-type restriction	1,092

Supplementary Figure S1. Author collaboration network. Node size reflects publication output and links represent co-authorship relationships



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