Collagen Meniscal Implantation Outcomes Following Partial and Full Meniscectomies

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Introduction

Meniscal injuries are a common result of trauma to the knee. The two main surgical treatments available are partial meniscectomy or full meniscectomy due to the lack of blood flow in that region. These two treatments cause long-term complications such as pain, lack of mobility, and/or osteoarthritis.

To avoid these complications, researchers have looked at placing collagen meniscal implantations (CMI) into the knee. The collagen implantation is composed of type I collagen from bovine Achilles tendon and was infused with glycosaminoglycans (GAGs) to trigger cellular growth.

Methodology

Patients were selected based on if they have a history of a partial or full meniscectomy. Once the initial criteria were made, each patient underwent an exploratory arthroscopy to ensure the need for the implant. All patients received a collagen meniscal implantation made up of bovine material. The research also evaluated a comparison study using Acifit which is a synthetic model.

Once the implantation was complete, analysis of the data was completed. One evaluation study was the International Knee Documentation Committee. Another evaluation study was Lysholm's scores to evaluate knee specific symptoms such as pain, clicking, swelling, and function. A third evaluation study was the Tegner Scales which determines the level of activity allowed. Finally, MRI evaluations were completed to determine the reduction of the implantation or any abnormalities of the implant along with the survival rates. Scores were given for each evaluation study pre-operatively and then during the follow-up from one year, two years, five years, and ten years. Averages were then calculated among all studies. The implantation failed when the patient required another surgery, or the implantation had to be taken out.

Figure 1.
CMI composed of Type 1 collagen derived from bovine Achilles tendon that is infused with glycosaminoglycans (GAGs).

Results

Medial Results: The medial implantation had an initial IKDC score of 83, Lysholm score of 60.67, and Tegner score of 2.05. At the one-year follow-up, the IKDC score was not evaluated, Lysholm was 92.5, and Tegner was 5. At the two-year follow-up, the IKDC score was 96, Lysholm was 93.73, and Tegner was 5. The MRI results showed 69.73% of patients with scaffold abnormalities. At the five-year follow-up, the IKDC score was 100, Lysholm was 92.5, and Tegner was 4.5. The ten-year follow-up did not show an IKDC score, Lysholm of 74.5, and Tegner of 4.5. The survival rate found at 10 years was 90.4%. See Table 1.

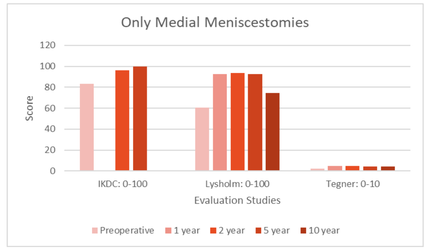

Table 1.

Mixed Results: The mixture of medial and lateral implantations had an initial preoperative Lysholm score of 48.62, Tegner score of 3.02, and they did not take an IKDC score. The one-year follow-up had an IKDC of 90, Lysholm of 93, and Tegner of 6. 76% of patients had scaffold abnormalities seen on an MRI. The overall survival rate was 87.8%. The two-year follow-up had an IKDC score of 96 and Lysholm of 86.4. No Tegner score was calculated. The five-year follow-up had an IKDC score of 97, Lysholm of 86.67, and Tegner of 6.33. The ten-year follow-up had an IKDC score of 71.6, Lysholm of 88.5, and Tegner of 5.25. The overall survival rate was 77.4%. See Table 2.

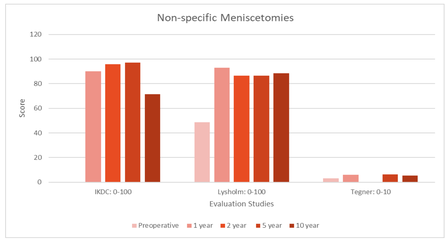

Table 2.

Comparison Results: The comparison results had an initial preoperative Lysholm score of 67 and a Tegner Score of 4. At the one-year follow-up, Lysholm was 87.4 and Tegner was 4. At the two-year follow-up, Lysholm was 90.3 and Tegner was 90.3. At the two-year follow-up, the MRI showed that 79% had reductions with Actifit.

Discussion

From the results shown, collagen implantation showed a 90.4% survival rate of the medial implantation and a 77.4% of the mixture of lateral and medial implantations over a ten-year period. The medial implantation showed a much better survival rate compared to the mixture. A study done by Lucidi et al. (2022) showed that this could be due to the lateral meniscal implants being a risk factor for survival. However, it was shown lateral implantations had a better survival rate when combined with ACL injury repairs. The results also showed that the IKDC, Lysholm, and Tegner scores increased over time. Scores started decreasing at the 10-year mark potentially due to time of implantation and current studies not to the 10-year follow-up mark.

Conclusion

Researchers used evaluation studies that included patient satisfaction, function, and utilized MRIs to get an entire picture of the outcomes of the implantation. CMI has proved to be a practical possibility for patients who have had a partial or full meniscectomy due to the regenerative qualities and reduced deterioration of the knee itself. The research showed that there were significant improvements in quality of life and long-term outcomes.

Some of the limitations that were found in the research are the diverse age ranges. The age ranges were not split into different categories when grading the knee functionality, which may have influenced the data. Another limitation was that researchers could not control the time between the meniscectomy and implantation. The longer the period, the more at risk the implant is, so that could also influence the implant. Overall, this is a practical option for patients that live an active lifestyle or occupations that require adequate range of motion or in patients that want to improve knee function with activities of daily living.

Sources
1. Bulgheroni E, Grassi A, Bulgheroni P, Marcheggiani Muccioli GM, Zaffagnini S, Marcacci M. Long-term outcomes of medial CMI implant versus partial medial meniscectomy in patients with concomitant ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(11):3221-3227. doi:10.1007/s00167-014-3136-9
2. Bulgheroni E, Grassi A, Campagnoli M, Bulgheroni P, Mudhigere A, Gobbi A. Comparative Study of Collagen versus Synthetic-Based Meniscal Scaffolds in Treating Meniscal Deficiency in Young Active Population. *CARTILAGE.* 2016;7(1):29-38. doi:10.1177/1947603515600239
3. Bulgheroni P, Murena L, Ratti C, Bulgheroni E, Ronga M, Cherubino P. Follow-up of collagen meniscus implant patients: Clinical, radiological, and magnetic resonance imaging results at 5 years. *The Knee.* 2010;17(3):224-229. doi:10.1016/j.knee.2009.08.011
4. Ciemniewska-Gorzela K, Bąkowski P, Naczk J, Jakob R, Piontek T. Complex Meniscus Tears Treated with Collagen Matrix Wrapping and Bone Marrow Blood Injection: Clinical Effectiveness and Survivorship after a Minimum of 5 Years' Follow-Up. *CARTILAGE.* 2021;13(1_suppl):228S-238S. doi:10.1177/1947603520924762
5. Ghodbane SA, Patel JM, Brzezinski A, Lu TM, Gatt CJ, Dunn MG. Biomechanical characterization of a novel collagen-hyaluronan infused 3D-printed polymeric device for partial meniscus replacement. *J Biomed Mater Res.* 2019;107(8):2457-2465. doi:10.1002/jbm.b.34336
6. Grassi A, Lucidi GA, Filardo G, et al. Minimum 10-Year Clinical Outcome of Lateral Collagen Meniscal Implants for the Replacement of Partial Lateral Meniscal Defects: Further Results From a Prospective Multicenter Study. *Orthopaedic Journal of Sports Medicine.* 2021;9(5):2325967121994919. doi:10.1177/2325967121994919
7. Gunes OC, Kara A, Bayram G, et al. Fabrication of 3D Printed poly(lactic acid) strut and wet-electrospun cellulose nano fiber reinforced chitosan-collagen hydrogel composite scaffolds for meniscus tissue engineering. *J Biomater Appl.* 2022;37(4):683-697. doi:10.1177/08853282221109339
8. Hirschmann MT, Keller L, Hirschmann A, et al. One-year clinical and MR imaging outcome after partial meniscal replacement in stabilized knees using a collagen meniscus implant. *Knee Surg Sports Traumatol Arthrosc.* 2013;21(3):740-747. doi:10.1007/s00167-012-2259-0
9. Kovacs BK, Huegli R, Harder D, et al. MR variability of collagen meniscal implant remodelling in patients with good clinical outcome. *Knee Surg Sports Traumatol Arthrosc.* 2021;29(1):90-99. doi:10.1007/s00167-019-05715-9
10. Lucidi GA, Grassi A, Agostinone P, et al. Risk Factors Affecting the Survival Rate of Collagen Meniscal Implant for Partial Meniscal Deficiency: An Analysis of 156 Consecutive Cases at a Mean 10 Years of Follow-up. *Am J Sports Med.* 2022;50(11):2900-2908. doi:10.1177/03635465221112685
11. Marcheggiani Muccioli GM, Lullini G, Cammisa E, Leardini A, Zaffagnini S. A professional athlete functionally active 10 years after an arthroscopic lateral collagen meniscus implant. *Knee Surg Sports Traumatol Arthrosc.* 2021;29(1):117-119. doi:10.1007/s00167-020-05876-y
12. Monllau JC. Collagen Meniscal Implant (CMI). In: Verdonk R, Espregueira Mendes J, Monllau JC, eds. *Meniscal Transplantation*. Springer Berlin Heidelberg; 2013:73-82. doi:10.1007/978-3-642-38106-5_6
13. Oda S, Otsuki S, Kurokawa Y, Hoshiyama Y, Nakajima M, Neo M. A new method for meniscus repair using type I collagen scaffold and infrapatellar fat pad. *J Biomater Appl.* 2015;29(10):1439-1448. doi:10.1177/0885328215568984
14. Piontek T, Ciemniewska-Gorzela K, Naczk J, et al. Complex Meniscus Tears Treated with Collagen Matrix Wrapping and Bone Marrow Blood Injection: A 2-Year Clinical Follow-Up. *CARTILAGE.* 2016;7(2):123-139. doi:10.1177/1947603515608988
15. Reale D, Lucidi GA, Grassi A, Poggi A, Filardo G, Zaffagnini S. A Comparison Between Polyurethane and Collagen Meniscal Scaffold for Partial Meniscal Defects: Similar Positive Clinical Results at a Mean of 10 Years of Follow-Up. *Arthroscopy: The Journal of Arthroscopic & Related Surgery.* 2022;38(4):1279-1287. doi:10.1016/j.arthro.2021.09.011
16. Reguzzoni M, Manelli A, Ronga M, Raspanti M, Grassi FA. Histology and ultrastructure of a tissue-engineered collagen meniscus before and after implantation. *J Biomed Mater Res.* 2005;74B(2):808-816. doi:10.1002/jbm.b.30314
17. Rodkey WG, DeHaven KE, Montgomery WH, et al. Comparison of the Collagen Meniscus Implant with Partial Meniscectomy: A Prospective Randomized Trial. *The Journal of Bone and Joint Surgery-American Volume.* 2008;90(7):1413-1426. doi:10.2106/JBJS.G.00656
18. Schenk L, Bethge L, Hirschmann A, et al. Ongoing MRI remodeling 3–7 years after collagen meniscus implantation in stable knees. *Knee Surg Sports Traumatol Arthrosc.* 2020;28(4):1099-1104. doi:10.1007/s00167-019-05714-w
19. Steadman JR, Rodkey WG. Tissue-Engineered Collagen Meniscus Implants: 5- to 6-Year Feasibility Study Results. *Arthroscopy: The Journal of Arthroscopic & Related Surgery.* 2005;21(5):515-525. doi:10.1016/j.arthro.2005.01.006
20. Yan R, Chen Y, Gu Y, et al. A collagen-coated sponge silk scaffold for functional meniscus regeneration. *J Tissue Eng Regen Med.* 2019;13(2):156-173. doi:10.1002/term.2727
21. Zaffagnini S, Giordano G, Vascellari A, et al. Arthroscopic collagen meniscus implant results at 6 to 8 years follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2007;15(2):175-183. doi:10.1007/s00167-006-0144-4
22. Zaffagnini S, Marcheggiani Muccioli GM, Bulgheroni P, et al. Arthroscopic Collagen Meniscus Implantation for Partial Lateral Meniscal Defects: A 2-Year Minimum Follow-up Study. *Am J Sports Med.* 2012;40(10):2281-2288. doi:10.1177/0363546512456835
23. Zaffagnini S, Marcheggiani Muccioli GM, Lopomo N, et al. Prospective Long-Term Outcomes of the Medial Collagen Meniscus Implant Versus Partial Medial Meniscectomy: A Minimum 10-Year Follow-Up Study. *Am J Sports Med.* 2011;39(5):977-985. doi:10.1177/0363546510391179