Early Hyaluronic Acid Application After Arthroscopic Debridement For The Treatment Of Middle-Aged Osteoarthritic Knee

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Citation

B Demirag, C Ozturk. *Early Hyaluronic Acid Application After Arthroscopic Debridement For The Treatment Of Middle-Aged Osteoarthritic Knee*. The Internet Journal of Orthopedic Surgery. 2004 Volume 2 Number 2.

Abstract

Purpose: Arthroscopic debridement and intraarticular hyaluronic acid injection are two treatment methods in the management of symptomatic middle-aged knee osteoarthritis. We combined these two methods for appropriate patients to strengthen the limited and temporary effect of arthroscopic debridement.

Methods: We retrospectively reviewed of 38 patients who had early intraarticular hyaluronic acid injections after arthroscopic debridement. The average follow-up was averagely 16 months. The standard arthroscopic debridement performed in these patients. The treatment course continued of a series of three intraarticular injections of 2 ml sodium hyaluronate administered during 3 consecutive weeks beginning from first postoperative day.

Results: Subjective pain scores were detected as meanly 8.8 for preoperative period and 2.3 for last control examination. Pain relief was established in all patients at 2.6 months meanly after the first injection. The Hospital for Special Surgery (HSS) knee scores increased from 67.1 before the procedure to 97.6 at the last follow-up examination. The last follow-up HSS knee scores of 28 (73.6%) patients were over 95.

Conclusions: We support the combined use of both arthroscopic debridement and consequent three weekly intraarticular hyaluronic acid injections in patients with mild to moderate ostearthritis of the knee.

INTRODUCTION

Osteoarthritis is a common non-inflammatory condition, which can be found radiographically in over 80% of patients over 40 years of age[1]. The knee is the most frequently affected joint, and the primary and often disabling complaint is pain. Patients with symptomatic osteoarthritis of the knee who have pain that has failed to respond to medical therapy and have progressive limitations in activities of daily living should be referred for surgical consideration. Multiple options exist for treatment of gonarthrosis, many of which remain extremely controversial. Indications for which technique to use are number of factors, including patient age, activity level and degree of arthritis.

Few options are available for the treatment of symptomatic middle-aged knee osteoarthritis. Exercise, weight loss, non-steroidal anti-inflammatory medications and intraarticular steroid injections are the common non-surgical methods in the management. Arthroscopic debridement and intraarticular hyaluronic acid injection are other two treatment methods in the management of symptomatic middle-aged knee osteoarthritis advocated recently in the literature[2,3,4,5,6,7].

Arthroscopic debridement is frequently advocated as a treatment option to relieve the symptoms of a painful degenerative knee[1,5,8]. Arthroscopic debridement of the degenerative knee involves lavage, partial menisectomy, limited synovectomy, excision of osteophytes, loose body removal, and cartilage shaving or thermal chondroplasty. There appears to be a select group of patients who will benefit from debridement with regard to pain relief and functional improvement and, therefore, may be able to postpone or even avoid more complex and morbid procedures such as high tibial osteotomy or joint arthroplasty[9,10]. The rationale for offering arthroscopic

debridement in the selected patient is that it may improve symptomatology and function, has minimal morbidity, provides a temporizing therapeutic procedure, and documents the stage of the disease process.

Hyaluronic acid is a long polysaccharide chain, which is normally found in the cartilage matrix[11]. Hyaluronic acid is postulated to protect the knee structure by facilitating joint gliding with slow movements and serving as a shock absorber with faster actions. Also, hyaluronic acid plays a role in meniscal, cartilage and ligament healing. There is a protective effect of hyaluronic acid on chondrocyte protection and collagen network stabilization[12,13]. The properties of the hyaluronan molecule are altered in osteoarthritis. The elasticity and viscosity of synovial fluid is less than that of a normal joint[14]. There is a decrease in molecular weight and concentration of hyaluronic acid in knee osteoarthritis. So, to restore the protective effect of healthy synovial fluid, it has been advised that the deficient hyaluronic acid should be replaced in the treatment of osteoarthritis[13,15].

With the application of early intraarticular hyaluronic acid injection after arthroscopic debridement, we combined these two methods for appropriate patients to strengthen the limited and temporary effect of arthroscopic debridement. The clinical results of patients receiving this treatment method were investigated in this study.

PATIENTS AND METHODS

Between 2000 and 2002, we retrospectively reviewed of 38 patients who had early intraarticular hyaluronic acid injections after arthroscopic debridement (Table I). There were 25 (65%) male and 13 (35%) female patients ranging in age from 39 to 72 years (mean; 51.8 years). The average follow-up was averagely 16 months (range; 10 to 24).

Figure 1

Table I: Data of the patients

No	Initials	Age	Sex	Follow-up (month)	Preop. pain score	Postop. pain score	Duration of pain relief (month)	Ahlback grade	Outerbridge grade	Preop. HSS knee score	Postop. HSS knee score	Patient satisfaction
1	SK	53	F	12	8	0	3	I	II	51	100	Yes
2	TC	64	M	20	9	2	4	II	III	53	96	No
3	NC	45	M	10	8	2	2	I	I	64	100	Yes
4	AD	72	F	18	10	5	2	IV	IV	58	90	Yes
5	HI	62	M	22	10	4	1	III	IV	50	90	No
6	TK	58	F	16	9	3	2	II	II	61	99	Yes
7	EE	39	M	18	10	4	2	I	I	80	100	Yes
8	IU	47	M	14	8	0	2	I	I	81	100	Yes
9	AP	44	M	12	7	5	2	I	I	75	100	Yes
10	MK	56	F	15	10	1	1	I	I	70	98	Yes
11	EY	42	M	16	9	3	3	I	I	75	99	Yes
12	MS	45	M	14	10	0	3	II	I	69	100	Yes
13	EF	42	F	15	10	4	5	I	I	70	98	Yes
14	MO	45	M	16	8	2	2	I	I	69	99	Yes
15	IK	40	M	24	8	5	3	I	I	77	99	Yes
16	HB	58	M	18	9	2	2	II	II	57	95	Yes
17	AA	58	M	14	8	2	4	III	III	55	91	No
18	MB	65	M	12	9	3	1	IV	IV	52	92	No
19	SB	53	M	20	9	2	3	II	II	52	91	No
20	FA	60	M	11	10	3	4	III	III	63	93	No
21	NF	53	F	10	10	2	2	I	I	78	100	Yes
22	HO	59	F	24	9	3	2	II	III	63	96	Yes
23	SK	44	M	18	8	1	3	I	I	74	100	Yes
24	NK	40	F	22	8	0	2	I	I	78	100	Yes
25	KB	58	M	10	7	1	2	II	II	61	100	Yes
26	NK	56	F	10	8	2	4	II	II	78	100	Yes
27	RC	42	F	12	9	3	3	I	I	90	100	Yes
28	FO	56	F	14	9	2	2	II	II	71	100	Yes
29	SO	43	F	24	9	3	2	I	I	80	100	Yes
30	SS	45	M	20	9	2	2	I	I	78	100	Yes
31	LK	62	F	18	10	2	4	III	III	60	95	No
32	AA	61	M	20	10	2	5	III	III	61	94	No
33	AT	40	M	16	9	1	1	I	I	81	100	Yes
34	MD	60	M	14	10	2	2	III	III	52	95	No
35	FA	41	M	16	8	2	1	I	I	64	100	Yes
36	ND	56	M	18	8	4	3	II	II	60	99	Yes
37	ST	47	M	14	9	3	4	I	I	78	100	Yes
38	YN	57	M	11	10	0	4	II	II	61	100	Yes

Patients indicated for surgery were those who had discrete chief complaints being acute onset of well localized joint line pain, persistent effusion and mechanical symptoms such as catching or locking. In addition, unsuccessful non-operative treatment was another indication criterion. We were choosy about patients with normal or near normal lower extremity alignment and had mild to moderate degenerative changes by roentgenograms.

The knee radiographies of the all patients were evaluated and graded on disease severity according to Ahlback classification[16]. Minimal narrowing of the joint space, minimum osteophyte formation and slight sclerosis as Grade I; moderate joint space narrowing, spur formation and sclerosis as Grade II; some bony changes without loss of bone stock as Grade III and complete obliteration of the joint, loss of bone stock, and severe sclerosis as Grade IV[16].

Articular cartilage degeneration was graded at the time of surgery according to Outerbridge Scale from I to IV. Softening and blistering of the articular cartilage as Grade I; fragmentation and fissuring in an area less than 1 cm as Grade II; if that area is greater than 1 cm as Grade III and cartilage erosion down to bone as Grade IV.

The standard arthroscopic debridement performed in these patients included lavage of the joint with varying amounts of

serum saline solution. Limited synovectomy was performed. Partial menisectomies were carried out removing only loose unstable fragments. Care was taken to preserve as much meniscal tissue as possible. Outerbridge Grade I-II lesions underwent the shaving of fibrillated cartilage, which was not performed in Grade III-IV lesions.

The surgical procedure was performed under spinal anesthesia or intravenous sedation and local anesthesia infiltration when the patient so desired. Patients were discharged on the first day after surgery. The patients were encouraged to bear as much weight as tolerated. They began range of motion and muscle strengthening exercises as soon as possible.

The treatment course continued of a series of three intraarticular injections of 2 ml sodium hyaluronate (Orthovisc , 2 ml, 15mg/ml, Anika, USA) administered during 3 consecutive weeks beginning from first postoperative day.

The clinical records and operative notes of all cases were reviewed. The same surgeon performed all surgeries. We asked and collected the data on age, sex, patient preoperative and last follow-up subjective pain scores, duration of pain relief, increase in activity level, patients' satisfaction with the treatment and preoperative versus last control Hospital for Special Surgery knee scores. These data were correlated with the clinical results.

The correlations were assessed by using student “t” test and a p-value of < 0.05 was considered significant.

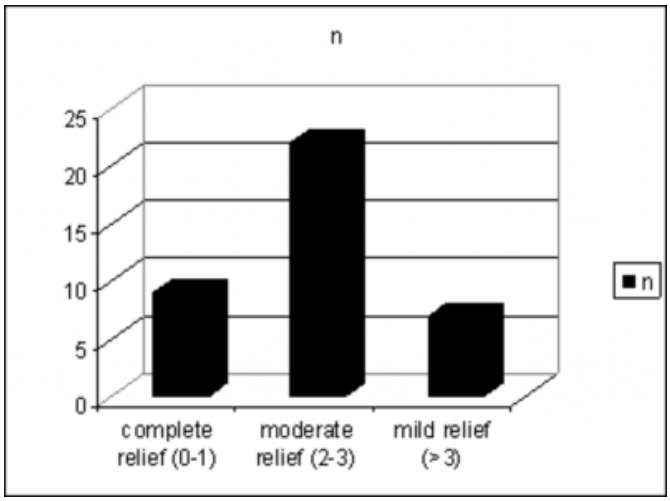
RESULTS

Patients were asked to grade their pain on a scale of zero to 10 for both preoperative and last follow-up visit. These subjective pain scores were detected as meanly 8.8 for preoperative period and 2.3 for last control examination. Pain relief was established in all patients at 2.6 months meanly after the first injection. All patients declared that their level of activity increased when compared the situation before the procedure.

The last follow-up subjective pain scores were 0 or 1 in 9 (23.6%) patients, 2 or 3 in 22 (57.8) patients and more than 3 in 7 (18.6%) patients (Figure I). Pain relief was acceptable in 31 (81.4%) patients. Twenty-nine (76%) out of all patients were satisfied with their overall response to the treatment.

Figure 2

Figure I: Clinical assessment and pain relief correlations.

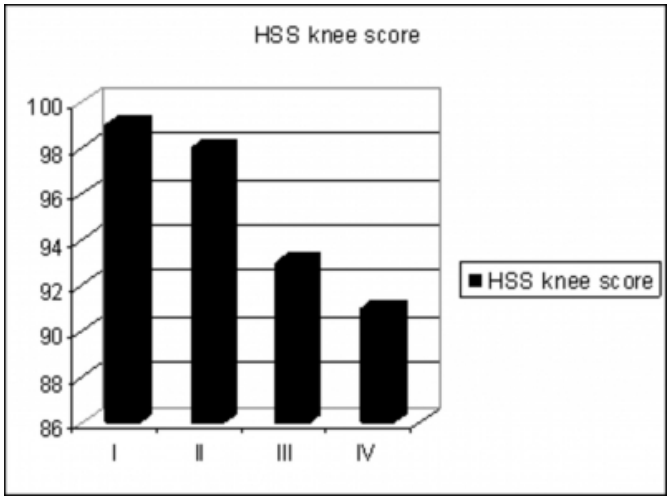


Hospital for Special Surgery (HSS) knee scores increased from 67.1 before the procedure to 97.6 at the last follow-up examination. The last follow-up HSS knee scores of 28 (73.6%) patients were over 95 and this rate was accepted as the overall success in the treatment.

According to Ahlback classification; 19 (50%) patients were Grade I, 11 (29%) Grade II, 6 (15.7%) Grade III and 2 (5.3%) Grade IV (Figure II). When we grouped the Grade I-II and Grade III-IV changes, there was a significant difference between the last HSS scores of Grade I-II and Grade III-IV knees ($p<0.05$).

Figure 3

Figure II: Ahlback classification and clinical correlations.

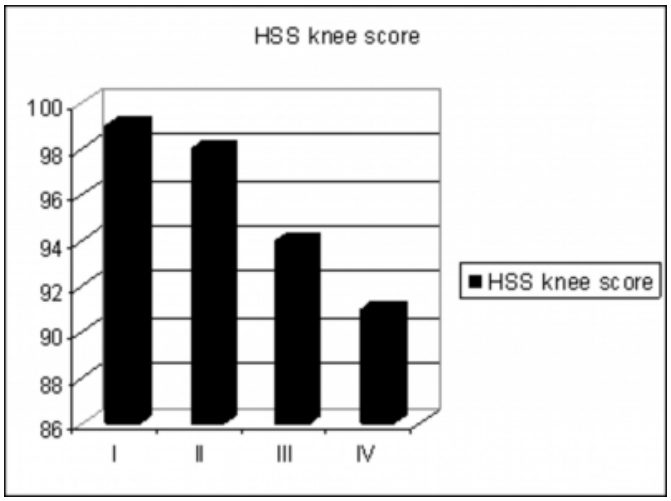


We compared the degree of articular wear observed at arthroscopy to patient outcome by the help of Outerbridge scale. According to this; 19 (50%) patients were Grade I, 9

(23.7%) Grade II, 7 (18.4%) Grade III and 3 (7.9%) Grade IV (Figure III). Twenty-eight (73.7%) patients were evaluated as having Grade I-II lesions and the rest with Grade III-IV. There was a statistically significant difference between two groups in terms of knee scores ($p<0.05$).

Figure 4

Figure III: Outerbridge classification and clinical correlations.



The ages of the patients were divided into three groups (<50, 50-60 and >60 years of age). The knee scores were statistically significantly lower in patients with an age of more than 60 years ($p<0.05$). On the other hand, there were no statistically significant difference between males and females in terms of last control HSS knee scores ($p>0.05$).

When the follow-up time was considered, a follow-up of less than one year (10 cases) had more favorable knee scores than the follow-up of more than one year (28 cases) ($p<0.05$).

The complications seen in early postoperative period were as follows; pain in 6 (16%) patients, decreased range of motion (ROM) in 8 (21%) patients, swelling in 4 (10%) patients and tenderness on injection site in 3 (8%) patients.

DISCUSSION

In the treatment of osteoarthritis, conservative measures, including weight loss, analgesia and physiotherapy have a proven benefit in symptom relief. At the other end of scale, joint arthroplasty has become readily available for patients with severe disease and joint destruction. There remains a third group of patients whose symptoms do not respond to conservative measures and in whom joint replacement is not warranted. Arthroscopic debridement is a well-documented technique used in the knee joint of such patients, and substantial evidence is available in the literature to support its selective use[1,17,18].

It is unclear whether this treatment alters the natural history of the disease process symptomatically or structurally. In the series of Harwin[10], 63.2% (129 knees) of patients were better, 21.1% (43 knees) unchanged and 15.7% (32 knees) were worse after the surgery for a mean of 7 years follow-up. Gross et al.([19]) found 72% good results at an average 2-year follow-up. Hernberg and Nilson[20] reported that at the end of minimum 10 years follow-up, only 17% of the knees improved, 27% remained unchanged and 56% became worse. Similarly, Bird and Ring[17] reported that arthroscopic debridement resulted in improvement in 93% of patients at the end of one month and only 50% maintained their improvement at one year. More recently, Timoney et al.[21] published a long-term follow-up of arthroscopically treated knees with advanced osteoarthritis. They reported a 63% success rate but noted a deterioration of results over time. Our study demonstrated that the 73.6% of the patients showed good results for an average of 16 months follow-up period. But, it should be always in mind that the evaluation of arthroscopic debridement results is difficult to compare due to heterogeneous patient population and disease severity.

The clinical results differ according to underlying pathology in the knee joint. The clinical results are better if meniscal tissue lesion is prominent than the cartilage defect. In our practice, in Outerbridge grade I-II knees, we apply cartilage shaving, which is not applied in grade III-IV knees. By the administration of hyaluronic acid intraarticularly, the adverse effects of alone use of arthroscopic debridement are minimized. Also, the severity of osteoarthritis can be determined by arthroscopic debridement. And help us to guess the possibility of future surgery after this combined treatment method. The ineffectiveness of alone use of arthroscopic debridement on cartilage defects and ineffectiveness of alone use of intraarticular hyaluronic acid injection on meniscal tissue lesion decrease by the use of combination of these two treatment modalities.

Overall, reports on arthroscopic treatment of the osteoarthritic knee are difficult to compare. The aggressiveness of the procedure performed through arthroscope can differ substantially between centers. In general, results of this procedure range from a success rate of 52-72%[19,22,23,24,25]. It has been said that use of arthroscopic washout and limited joint debridement in patients with mild

to moderate osteoarthritis of the knee whose symptoms are out of proportion to their clinical and radiological findings is suitable[1].

In osteoarthritis, degenerating articular cartilage and synovium release proinflammatory cytokines leading to degradation of type II collagen and proteoglycans. Arhtroscopic debridement may wash out or dilute these inflammatory mediators. The effect is temporary[5,24], so arthroscopy in most cases is a palliative measure. Arthroscopic debridement removes intraarticular debris and degredative enzymes. So, exogenous hyaluronic acid acts on clear environment and its effect increases by this mean.

The function of hyaluronic acid includes joint lubrication, chondrocyte protection and collagen network stabilization. The regenerating effects of hyaluronic acid on menisci, cruciate ligaments and cartilage tissues have been established on experimental studies[26,27]. Deficiency of this material is thought to be harmful to the joint health[2,12,13,28]. In osteoarthritis, the molecular weight and concentration of the hyaluronan molecule are decreased[14]. As in osteoarthritis, amount of this material is decreased; direct replacement of hyaluronic acid has been advocated to restore the protective effect of healthy synovial fluid.

It has been reported that the half-life of the hyaluronic acid is as short as 2 days[29]. That is the reason that explains the logic behind the application of multiple injections, which attempt to increase its residence time within the joint. It is enough to administer hyaluronic acid three times weekly to ensure the normal circulation of this molecule. The tissues clear the pathological hyaluran and new molecule is directed to the regenerating tissues.

In our study, we inject the hyaluronic acid on postoperative first day in contrary to the literature. As we do not know the effect of hyaluronic acid molecule on epithelization and wound healing, we wait for 24 hours for primary epithelization and formation of closed synovial cavity by the help of wound healing.

Several authors have compared intraarticular hyaluronic acid to saline placebo[7,10,12,28,30]. While some authors found some clinical benefit of hyaluronic acid over saline[7,28,30], others found no difference between hyaluronic acid and saline based on pain and function parameters[12,31]. Lussier et al.[6] reported that overall clinical response in their 458 knees study group of an average of 26 weeks follow-up was 76%.

In another study in which clinical efficacy results based on the use of intraarticular hyaluronic acid treatment was investigated, only 65% of the patients had pain relief, which was 79% in current study[4].

There are some advantages of combined use of arthroscopic debridement and intraarticular hyaluronic acid injection in middle age osteoarthritis. We think that intraarticular hyaluronic acid application has additional positive effect on cartilage healing after the arthroscopic debridement.

Evaluation of adverse reactions is important because untoward effects may limit the use of a specific treatment option. Significant and frequently occurring adverse reactions likely would prohibit the use of a certain modality in a matter how great the benefit. We determined pain on injection site in 3 (8%) patients.

Age alone should not play an important role in selecting arthroscopic treatment for the degenerative knee. It was reported that the patient age at the time of surgery is not important predictors of outcome[1,10,32]. However, although our patient population was small, we found that clinical outcome had become worse as the patient age was over 60 years.

When we consider the results, in addition the positive effect of this treatment on mild cases, there is also some positive effect on the moderate and severe cases determined by Outerbridge classification.

Increase in activity level was based on the patients' report. It was thought that this accurately reflects a clinically appreciable improvement in function[4]. In our study group, all the patients declared that their level of activity increased at the end of the treatment period.

Patient satisfaction is also important goal in the treatment of osteoarthritis. Satisfaction reflects the summation of all factors relating to successful clinical treatment. Seventy-six per cent of the patients in this study satisfied with their overall response to this different treatment method.

CONCLUSION

In conclusion, we support the combined use of both arthroscopic debridement and consequent three weekly intraarticular hyaluronic acid injections in patients with mild to moderate ostearthritis of the knee. With the removal of degenerating tissues by arthroscopy, the affinity of the hyaluronic acid to the regenerating tissues increases so that

penetration of hyaluronic acid occurs deeper. By this mean, the individual effect of each treatment method may appear synergically on the clinical results in patients with middle-aged knee osteoarthritis. However, to determine the exact benefit of this method, a prospective blind study is required.

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References

1. Shannon FJ, Devitt AT, Poynton AR, et al. Short-term benefit of arthroscopic washout in degenerative arthritis of the knee. Int Orthop 2001; 25: 242-5.
2. Adams ME, Atkinson MH, Lussier AJ. The role of viscosupplementation with hylan G-F 20 (Synvisc) in the treatment of osteoarthritis of the knee: A Canadian multicenter trial comparing hylan G-F 20 alone, hylan G-F 20 with NSAIDs, and NSAIDs alone. Osteoarthritis Cartilage 1995; 3: 213-26.
3. Altman RD, Moskowitz R. Intraarticular sodium hyaluronate (Hyalgan) in the treatment of patients with osteoarthritis of the knee: A Randomized clinical trial. J Rheumatol 1998; 25: 2203-12.
4. Evanich JD, Evanich CJ, Wright MB, et al. Efficacy of intraarticular hyaluronic acid injections in knee osteoarthritis. Clin Orthop 2001; 390: 173-81.
5. Hanssen AD, Scott RD, Scuderi GR, et al. Surgical options in the middle aged arthritic knee. American Academy of Orthopaedic Surgeons 69th Annual Meeting Instructional Course Lectures, Dallas, 2002.
6. Lussier A, Cividino AA, McFarlane CA. Viscosupplementation with hylan for the treatment of osteoarthritis: Findings from clinical practice in Canada. J Rheumatol 1996; 23: 1579-85.
7. Wobing M, Dickhut A, Wolpert W. Viscosupplementation with hylan G-F 20: A 26-week controlled trial of efficacy and safety in the osteoarthritic knee. Clin Ther 1998; 20: 410-23.
8. Dandy DJ. Editorial - Arthroscopic debridement of the knee for osteoarthritis. J Bone Joint Surg (Br) 1991; 73: 877-8.
9. Burks RT. Arthroscopy and degenerative arthritis of the knee: A review of the literature. Arthroscopy 1990; 6: 43-7.
10. Harwin SF. Arthroscopic debridement for osteoarthritis of the knee: Predictors of patient satisfaction. Arthroscopy 1999; 15: 142-6.
11. Balazs EA. Physical chemistry of hyaluronic acid. Fed Proc 1958; 17: 1086-93.
12. Lomander LS, Dalen N, Englund G. Intraarticular hyaluronan injections in the treatment of osteoarthritis of the knee: A randomized, double blind, placebo controlled multicenter trial. Ann Rheum Dis 1996; 55: 424-31.
13. Pelletier JP, Pelletier JM. The pathophysiology of osteoarthritis and the implication of the use of hyaluronan and hylan as therapeutic agents in viscosupplementation. J Rheumatol 1993; 20 (Suppl 39): 19-24.
14. Balazs EA, Watson D, Duff IF. Hyaluronic acid in synovial fluid. I: Molecular parameters of hyaluronic acid in normal and arthritic human fluids. Arthritis Rheum 1967; 10: 357-75.
15. Balazs EA, Denlinger JL. Viscosupplementation: A new concept in the treatment of osteoarthritis. J Rheumatol 1993; 20 (Suppl 39): 4-9.
16. Holden DL, James SL, Larson RL. Proximal tibial osteotomy in patients who are fifty years old or less. J Bone Joint Surg 1988; 70A: 977-82.
17. Bird HA, Ring EF. Therapeutic value of arthroscopy. Ann Rheum Dis 1978; 37: 78-79
18. Burman MS, Finkelstein H, Meyer L. Arthroscopy of the knee joint. J Bone Joint Surg 1934; 16: 255-68.
19. Gross DE, Brenner SL, Esformes I, et al. Arthroscopic treatment of degenerative joint diseases of the knee. Orthopedics 1991; 14: 1317-21.
20. Hernberg JS, Nilsson BE. The natural course of untreated osteoarthritis of the knee. Clin Orthop 1977; 123: 130-7.
21. Timoney JM, Kneisl JS, Barrack RL, et al. Arthroscopy in the osteoarthritic knee: Long-term follow-up. Orthop Rev 1990; 19: 371-9.
22. Baumgaertner MR, Cannon DW, Vittori JM, et al. Arthroscopic debridement of the arthritic knee. Clin Orthop 1990; 253: 197-202.
23. Jennings JE. Arthroscopic debridement as an alternative to total knee replacement. Arthroscopy 1986; 2: 123-4.
24. McLaren AC, Blokker CP, Fowler PJ, et al. Arthroscopic debridement of the knee for osteoarthrosis. Can J Surg 1991; 34: 595-8.
25. Wouters E, Basset III FH, Hardaker WT, et al. An algorithm for arthroscopy in the over-50 age group. Am J Sports Med 1992; 20: 141-5.
26. Ishima M, Wada Y, Sonoda M, et al. Effects of hyaluronan on the healing of rabbit meniscus injured in the peripheral region. J Orthop Sci 2000; 5: 579-84.
27. Suzuki Y, Takeuchi N, Sagehashi Y, et al. Effects of hyaluronic acid on meniscal injury in rabbits. Arch Orthop Trauma Surg 1998; 117: 303-6.
28. Scale D, Wobing M, Wolpert M. Viscosupplementation of osteoarthritic knees with hylan: A treatment study schedule. Curr Ther Res 1994; 55: 220-32.
29. Namicki O, Toyoshima H, Morisaki N. Therapeutic effect of intra-articular injection of high molecular weight hyaluronic acid on osteoarthritis of the knee. Int J Clin Pharmacol Ther Toxicol 1982; 20: 501-7.
30. Huskisson EC, Donnelly S. Hyaluronic acid in the treatment of osteoarthritis of the knee. Rheumatology 1999; 38: 602-7.
31. Henderson EB, Smith EC, Pegley F. Intraarticular injections of 750 kD hyaluronan in the treatment of osteoarthritis: A randomized single center double-blind placebo-controlled trial of 91 patients demonstrating lack of efficacy. Ann Rheum Dis 1994; 53: 524-9.
32. David T, Gambardella RA. Arthroscopic debridement of the arthritic knee: indications and results. Curr Opin In Orthop 2000; 11: 9-13.

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