Review Article

The Efficacy and Duration of Intra-articular Corticosteroid Injection for Knee Osteoarthritis: A Systematic Review of Level I Studies

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Abstract

We performed a systematic review of the current literature to determine the efficacy and duration of intra-articular corticosteroid injection in reducing pain caused by knee osteoarthritis and to determine whether the type of corticosteroid used affected these results. Following an electronic search of multiple databases and a review of reference lists from various articles, we found six trials in five papers that compared corticosteroid versus placebo and four papers that compared different corticosteroids. Results of corticosteroid compared with placebo showed both a statistically and clinically significant reduction in pain at 1 week, with an average difference between groups of 22%. Two of four trials showed triamcinolone to be more effective in pain reduction than other corticosteroids. We concluded that intra-articular corticosteroids reduce knee pain for at least 1 week and that intra-articular corticosteroid injection is a short-term treatment of a chronic problem.

Osteoarthritis (OA) of the knee is a frequently disabling disease, the incidence and severity of which increase with age, knee injury with or without surgical repair, and repetitive occupational trauma, as well as in women who are overweight.[1-4] As the average age of the population rises and baby boomers enter their retirement years, the increasing prevalence of OA will place a growing physical, emotional, and financial burden on society. In 1987, the Framingham Osteoarthritis Study showed that 44% of patients aged >80 years had OA of the knee.[1] In 2006, the Centers for Disease Control reported that 46.4 million persons (22% of the adult US population) exhibited symptoms of arthritis.[5]

Physical activity provides important emotional and physical health benefits. OA of the knee threatens the ability to participate in healthy physical activity, thereby predisposing one to increased cardiovascular disease, weight gain, diabetes, and potential loss of independence. Treatment of OA includes oral agents (over-the-counter nutrisupplements such as glucosamine and prescription anti-inflammatory medications), topically applied creams and braces, and invasive procedures, including intra-articular (IA) corticosteroid injections, arthroscopic débridement, and, in end-stage disease, total knee arthroplasty. Corticosteroid injection is a common procedure for reducing pain asso-

ciated with OA. We pose two clinical questions: What is the efficacy and duration of benefit from corticosteroid injection in reducing knee pain secondary to OA? Is there a difference between various corticosteroids in efficacy of pain reduction for knee OA?

To answer these questions, we performed a systematic review of the prospective, randomized controlled trials within the current literature, using an evidence-based medicine approach. Evidence-based medicine requires weighing and ranking the available data by the validity and design of the individual studies examined. The approach aids clinicians in updating their practices when reproducible clinical data become available. It also helps clinicians in sorting through the vast amount of accessible literature for both statistically and clinically relevant data. Practicing evidence-based medicine enables physicians to provide more effective patient care, and it may assist in preventing malpractice, misappropriation of resources, and the use of nonefficacious treatments.

Methods

The initial search was performed on the Cochrane database and produced 21 articles.[6-26] Search terms used were "corticosteroid," "knee," "injection," and "osteoarthritis." The search was limited to prospective, randomized controlled trials published in English. Further inclusion criteria included only those articles that directly compared IA corticosteroid injection versus placebo for OA of the knee. No preference was given to the specific corticosteroid used. Excluded from this study were nonrandomized, nonprospective controlled trials, corticosteroid injection with confounding factors (eg, in association with lavage, postarthroscopic surgery), rheumatoid arthritis as opposed to osteoarthritic disease, and studies comparing corticosteroids versus a preparation of hyaluronic acid.

Only two of these articles met our inclusion criteria of corticosteroid versus placebo: Ravaud et al[9] and Friedman and Moore.[14] The remaining 19 articles were excluded as follows: four examined nonsteroidal anti-inflammatory drugs (NSAIDs) or other forms of pharmacotherapy in OA of the knee; one compared peripatellar and IA routes of injection; three examined hyaluronic acid or viscosupplementation; three examined neck pathology; one studied patellofemoral pain; one studied hip fracture; one was a Cochrane review of IA corticosteroid versus placebo; one studied adult rheumatoid arthritis; one examined Achilles tendinitis; two examined acupuncture for shoulder and low back pain; and one was a meta-analysis. We then reviewed the references of the two papers selected from this original search for other articles that would fit our search criteria. From these references, we obtained the other three articles used in this study: Dieppe et al,[27] Jones and Doherty,[28] and Gaffney et al.[29]

With the assistance of an independent examiner, we followed our original search with a search of Medline, using PubMed as the search engine, followed by the Web of Science database. The Medline search was limited to articles published between 1966 and June 2006. Search terms included the MeSH explosion terms "osteoarthritis," "knee," "injections," and "intra-articular." The term "corticosteroids" was used as a text word. The Web of Science database was used for examination of references. Neither Medline nor the Web of Science searches found any article that we had not already identified.

The articles meeting all inclusion criteria were analyzed using an evidence-based worksheet developed by clinicians and biostatisticians at an academic medical center.[30] The authors' primary and secondary hypotheses were determined and their methods evaluated for randomization, number of participants, percentage follow-up, duration of follow-up, design of the study (eg, single-blind, double-blind, crossover), corticosteroid and placebo preparations, and method used for confirmation of injection placement into the joint space. Table 1

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Table 1

Corticosteroid Versus Placebo for Knee Osteoarthritis: Summary of Studies

Study	F/U (%)	F/U (wk)	Study Design	Corticosteroid (dose)	Placebo
Gaffney et al[29]	NR	1, 6	NR	Triamcinolone 20 mg in 1 mL	0.9% normal saline solution, 1 mL
Dieppe et al[27]	100	1, 2, 4, 6	Single-blind	Triamcinolone 20 mg in 1 mL	Saline solution, 1 mL
Dieppe et al[27]	100	1, 2	Single-blind, 1-wk crossover	Triamcinolone 20 mg in 1 mL	Saline solution, 1 mL
Ravaud et al[9]	89	1, 4, 12, 24	2 × 2 factorial	Cortivazol 3.75 mg in 1.5 mL	0.9% normal saline solution, 1.5 mL
Jones and Doherty[28]	78.3	3, 8	Double-blind crossover	Methylprednisolone 40 mg in 1 mL	0.9% normal saline solution, 1 mL
Friedman and Moore[14]	NR	1, 4, 6, 8	Double-blind	Triamcinolone 20 mg	Polysorbate, sorbitol, benzyl alcohol, water

F/U = follow-up, NR = not reported, SD = standard deviation

represents the six studies from five papers that compared corticosteroid injection versus placebo and provides the demographic information of each study, including age, percentage of female subjects, and mean duration of symptoms.[9,14,27-29] Table 2 shows the results from each article regarding pain reduction between corticosteroid and placebo as determined by visual analog scale (VAS).[9,14,27-29]

A few studies did not provide statistical analysis for their data, either from baseline to certain weeks following corticosteroid injection or between the placebo and treatment groups. Therefore, statistical analysis was performed to determine *P* values at specific time points to help elicit patterns of response between studies. This was accomplished via the simple Student *t* test using the mean and standard deviation reported in the respective studies requiring analysis. More specifically, the study by Gaffney et al[29] required calculation for the *P* value between treatment and placebo groups at week 6. The study by Ravaud et al[9] required calculation for all *P* values between groups at weeks 1, 4, and 12. Finally, the study by Friedman and Moore[14] needed *P* values both from baseline and between groups at week 4.

All studies included herein used standardized inclusion-exclusion criteria for OA and all were, by definition, appropriately powered, enabling them to show statistically significant differences between treatment and control groups. Patients in each study demonstrated OA on plain radiographic examination of the knee. No uniform system for grading knee OA was used. Gaffney et al[29] graded radiographs for overall severity of knee OA on a 0-to-3 scale. Similarly, Dieppe et al[27] used a 0-to-4 scale. Ravaud et al[9] graded knee radiographs according to the Kellgren-Lawrence grading system (0 to 4); all patients demonstrated at least grade 2 changes. All patients in the study by Friedman and Moore[14] demonstrated radiographic changes consistent with mild to moderate OA, but a formal grading system was not used. Jones and Doherty[28] also did not grade the severity of OA based on radiographic examinations. To our knowledge, none of the studies in this review were sponsored by pharmaceutical companies.

Results

Demographics and Study Design of Corticosteroid Versus Placebo Injection

Table 1 summarizes the studies for corticosteroid versus placebo injection. Study design varied greatly from single-blind to a complex, two-by-two factorial design. The paper by Dieppe et al[27] reported two studies. The first study used 12 patients with clinically documented arthritis in both knees. Each patient served as a control by the randomizing of one knee to be injected with corticosteroid and the other to be injected with placebo. The second study used a 1-week crossover design (Table 1). Jones and Doherty[28] also used a crossover design. Ravaud et al[9] used a two-by-two factorial design to examine the effects of placebo, corticosteroid injection, lavage, and lavage plus corticosteroid. Individual data were reported for each treatment group and compared statistically with each of the other treatment groups.

In five of six trials, normal saline solution was used for placebo,

Table 1 (continued)

Corticosteroid Versus Placebo for Knee Osteoarthritis: Summary of Studies

Confirmation in Joint	No. of Pts	Mean/Median Age in Years (SD)	Women (%)	Duration of Symptoms in Years (SD)
Aspiration of synovial fluid	84	67.0 (9.2)	71	6.9 (6.5)
5 mL synovial fluid aspirated	12 (24 knees)	63.5 (8.2)	67	7.5 (5.7)
5 mL synovial fluid aspirated	16 (24 knees)	65.0 (8.1)	81	6.0 (4.5)
No	53	64.9 (11.5)	68	—
Aspiration of synovial fluid	60	70.6 (range, 51.0-89.0)	62	—
Aspiration of synovial fluid	34	60 (range, 42-77)	—	2.5

F/U = follow-up, NR = not reported, SD = standard deviation

whereas in one trial, polysorbate, sorbitol, benzyl alcohol, and water were used. In all studies, placebo injection contained no other medication, such as lidocaine or bupivacaine. Five of the six trials confirmed needle placement within the joint by fluid aspiration. The number of patients within the studies ranged from 12 to 84 (average, 43). Most were women, with an age range of 60 to 70.6 years and an average age of 65 years. Signs and symptoms of disease were long-standing, with a range of 2.5 to 7.5 years (average, 5.7 years) in the studies that reported duration of disease.

Four studies used the 100-point VAS as a validated outcome measure of pain. Dieppe et al[27] used a VAS pain score with a 10-point scale. To avoid confusion in comparison of results, the 10-point scale was converted to a 100-point scale for display in Table 2.

Outcomes

At week 1, four of four studies assessing VAS pain reported a statistically significant decrease between the corticosteroid and placebo groups, with a range of reduction of 13 to 33 (average, 22). The first trial of Dieppe et al[27] reported a statistically significant difference in pain reduction, but it was unclear whether this difference was in comparison to baseline or between groups; therefore, it was not accounted for at week 1. Within the corticosteroid group at week 1, four of four studies also showed a statistically significant decrease in pain from baseline, with a range of 30.3 to 39.0 (average, 34.5). Interestingly, three of five studies also showed a statistically significant decrease in pain within the placebo group at week 1, with a range of 10.7 to 16 (average, 13).

Three to 4 weeks postinjection, no statistically significant decreases in pain were found between the treatment and placebo groups. Only the study by Ravaud et al[9] reported a statistically significant decrease from baseline within the corticosteroid group at week 4 (to 42.8 from 69.4). No difference in pain from baseline was statistically significant within the placebo group.

Six to 8 weeks postinjection, no study demonstrated statistically significant differences between corticosteroid and placebo. However, the study by Gaffney et al[29] demonstrated a statistically significant decrease in pain from baseline within both the corticosteroid and placebo groups, with average mean decreases of 16.2 and 14.1, respectively.

The study by Ravaud et al[9] carried follow-up to 12 and 24 weeks (data not included in Table 2). At week 12, a statistically significant decrease in pain was found between groups, with an absolute difference of 14.2 points ($P < 0.05$). However, in looking at decreases in pain from baseline within both the corticosteroid and placebo groups, no statistically significant decrease was noted. Week 24 demonstrated no statistically significant decrease in pain between or within groups.

Corticosteroid Versus Corticosteroid Demographics, Study Design, and Outcome

In comparing various corticosteroids for pain reduction, four studies examined three different corticosteroids: triamcinolone, methylprednisolone, and betamethasone. Only the study by Pyne et al[31] employed a validated outcome questionnaire in the

Table 2

Pain Reduction Results: Visual Analog Scales

	Baseline		Week 1				Week 2	
Study	Mean	SD Range	Mean	SD Range	*P* Value Baseline	*P* Value Groups	Mean	SD Range
Gaffney et al[29]								
Treatment	52	21.1	21.7	20.7	0.01	<0.01	—	—
Control	57	22.0	43.1	28.7	0.05	—	—	—
Abs diff	5	—	21.4	—	—	—	—	—
Dieppe et al[27*]								
Treatment	52	17	34	21	0.05	—	40	25
Control	—	—	—	—	—	—	—	—
Abs diff	—	—	—	—	—	—	—	—
Dieppe et al[27*†]								
Treatment	76	22	37	32	0.05	<0.01	26	30
Control	82	19	70	30	0.05	—	38	29
Abs diff	6	—	33	—	—	—	12	—
Ravaud et al[9]								
Treatment	69.4	19.6	33.7	23.6	0.003	<0.01	—	—
Control	63.7	20.8	53.0	27.9	NS	—	—	—
Abs diff	–5.7	—	19.3	—	—	—	—	—
Jones and Doherty[28]								
Treatment	62.6	5.6-68.2	—	—	—	—	—	—
Control	55.5	43.75-79.75	—	—	—	—	—	—
Abs diff	–7.1	—	—	—	—	—	—	—
Friedman and Moore[14]								
Treatment	56	40-90	23	—	0.005	<0.01	—	—
Control	52	2-10	36	—	0.005	—	—	—
Abs diff	–4	—	13	—	—	—	—	—

* The 10-point visual analog scale was converted to a 100-point scale for this table.
† Crossover design: treatment group = corticosteroid first, followed by placebo; control = placebo first, followed by corticosteroid
‡ Values reported are extrapolated from graph and are not exact. No statistical significance existed for either group after week 1.
Abs diff = absolute difference, NS = not statistically significant, *P* value baseline = statistical *P* value compared with baseline measure within group, *P* value groups = statistical *P* value when treatment groups are compared, SD Range = standard deviation or range of values

VAS pain scale. The other three studies reported pain reduction based on a numeric scale derived from patient opinion.[32-34] This made comparison between studies difficult. Three of four studies were double-blinded, and three of four compared triamcinolone with methylprednisolone. Only Valtonen[32] compared triamcinolone with betamethasone. One of the four studies[31] confirmed injection within the joint by aspiration of synovial fluid. The number of patients in the studies ranged from 32 to 57 (average, 44). The age range was from 62.5 to 69.2 years (average, 66 years). The population was predominantly female with long-standing disease of 4.2 to 6.6 years (average, 5.3 years).

At week 1, Valtonen[32] found triamcinolone to be more effective than betamethasone, with an absolute difference between groups of 7 ($P < 0.01$). Within each group, the decrease in pain was statistically significant; triamcinolone decreased pain by 16 points ($P < 0.05$), and betamethasone decreased pain by 9 points ($P < 0.05$). No clinically significant differences were found between groups at any other time point (data not shown). Pyne et al[31] found triamcinolone to be more efficacious than methylprednisolone at week 3, with an absolute difference of VAS pain between groups of 19.2 ($P < 0.01$). Two[33,34] of the four studies failed to find any statistically significant difference between triamcinolone and methylprednisolone.

Discussion

Cochrane Database Results

During the drafting of this review, the Cochrane Musculoskeletal Group pre-

Table 2 (continued)

Pain Reduction Results: Visual Analog Scales

Week 2 (continued)		Week 3 or 4				Week 6 or 8			
P Value Baseline	*P* Value Groups	Mean	SD Range	*P* Value Baseline	*P* Value Groups	Mean	SD Range	*P* Value Baseline	*P* Value Groups
—	—	—	—	—	—	35.8	26.8	0.01	NS
—	—	—	—	—	—	42.9	26.0	0.01	—
—	—	—	—	—	—	7.1	—	—	—
NS	—	46	28	NS	—	55	27	NS	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
NS	NS	—	—	—	—	—	—	—	—
0.05	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	42.8	26.4	0.02	NS	—	—	—	—
—	—	54.0	26.6	NS	—	—	—	—	—
—	—	11.2	—	—	—	—	—	—	—
—	—	60.6	46.35-66.6	—	—	62.6	48.1-70.6	—	—
—	—	55.5	46.5-61.75	—	—	56.0	53.5-66.75	—	—
—	—	–5.1	—	—	—	–6.6	—	—	—
—	—	28‡	—	—	—	26*	—	—	—
—	—	26‡	—	—	—	26‡	—	—	—
—	—	–2	—	—	—	0	—	—	—

* The 10-point visual analog scale was converted to a 100-point scale for this table.
† Crossover design: treatment group = corticosteroid first, followed by placebo; control = placebo first, followed by corticosteroid
‡ Values reported are extrapolated from graph and are not exact. No statistical significance existed for either group after week 1.
Abs diff = absolute difference, NS = not statistically significant, *P* value baseline = statistical *P* value compared with baseline measure within group, *P* value groups = statistical *P* value when treatment groups are compared, SD Range = standard deviation or range of values

sented a systematic review that evaluated the efficacy and safety of IA corticosteroids in the treatment of knee OA.[20] Their report includes the results of 10 studies; therefore, they included 5 studies that we did not include.[35-39] Raynauld et al[38] was excluded because the premise of their study was long-term safety of injection; thus, their study did not correlate with our questions. Cederlöf and Jonson,[39] Wright et al,[37] and Miller et al[35] were excluded from our study because of a lack of validated outcome measures. Miller et al,[35] Popov et al,[36] and Wright et al[37] were not found within our original search parameters using Cochrane, Medline, or the Web of Science. Popov et al[36] was excluded because the article was not written in English.

Supporting our data, the Cochrane group also reports week 1 as the only time point at which a statistically significant difference can be found between corticosteroids and placebo.[20] Although corticosteroids seem to provide benefit from baseline past 1 week, the benefit is not statistically significant compared with placebo injection. Therefore, our claims are independently substantiated and strengthened by this Cochrane review.[20]

Reproducibility of Intra-articular Injection

Some have questioned the reproducibility and reliability of IA injection because of the necessary skill required to accurately place the needle into the IA space. Confirmation of injection within the knee joint was documented in most of the studies examined in this systematic review. Two studies showed that IA injection is possible, reproducible, and accurate when performed by a clini-

cian.[40,41] These authors demonstrate that a physician can accurately inject the joint space by using the right technique and confirmatory method. Therefore, corticosteroid injections for knee OA can be effectively delivered by a properly trained medical professional. Concerns that extra-articular injection of medication affects both study results and reports of pain reduction because of inaccurate delivery of medication are not substantiated.

Strengths, Weaknesses, and Bias

Strengths of this review include analyzing only prospective, randomized controlled trials using evidence-based medicine techniques; thus, we reviewed only the most reliable data currently available regarding the efficacy of corticosteroid injections for knee OA. Moreover, the systematic review format allowed us to examine data from several authors and different studies, letting us perceive the broader picture and assess common trends. All studies had adequate follow-up based on the current recommendation of a minimum of 70% follow-up. Reporting such data provides medical professionals with firm scientific evidence affecting clinical practice. Given the variety of methods used to examine corticosteroid injections for knee OA, we attempted to ensure that our analysis compared equal study parameters. By doing so, a straightforward, to-the-point analysis is presented, minimizing bias and extraneous information.

There are some weaknesses associated with this review. Few studies examine the duration and efficacy of IA corticosteroids for knee OA. There is a diversity of clinical assessment outcomes used by the authors of each study; the subsequent difficulty in obtaining a "standard" outcome measure between the studies made a systematic review format more appropriate. Should a standard outcome measure (eg, Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC], Medical Outcomes Study 36-Item Short Form [SF-36]) be used by each study at similar follow-up intervals, a meta-analysis may be appropriate. At this time, however, these data are not available.

As with all studies, bias is a potential problem. Selection bias was seen in a few articles, resulting from inadequate randomizing techniques, lack of double-blind design, or use of crossover study design. Detection bias was noted in a few studies that did not use blind or independent examiners, thereby increasing the possibility of examiners influencing outcomes. Perhaps the greatest source of bias throughout the articles was the concomitant use of NSAIDs or other pharmaceuticals for the duration of the study. Few studies controlled for the use of NSAIDs or analgesics to help alleviate joint pain during the clinical trial. Because study participants were not required to record use of analgesics/NSAIDs, the effect these medications had on the corticosteroid injection is unknown.

Summary

Consistent with clinical experience, corticosteroids are efficacious, clinically and statistically, in decreasing the pain of OA of the knee. However, this efficacy is seen consistently only at 1 week, not beyond. Patients receiving corticosteroid experienced approximately 22% greater reduction in pain within the first week than did patients receiving placebo. From baseline, VAS pain scores decreased an average of 35 points, a statistically significant difference. Interestingly, the decrease in pain from baseline within the placebo group was also statistically significant at week 1, averaging 13 points. However, because of such short-term efficacy, physicians should be aware of this duration of effect when considering the use of corticosteroid injection for chronic symptoms in knee OA. When longer-term pain reduction is desirable, clinicians should look to other treatment modalities that may better attain that goal.

Specific patterns and trends cannot be observed in comparing various corticosteroids for knee OA. First, the number of studies is limited. Second, the examination time point in different studies is not consistent, thus making temporal conclusions difficult. However, two of four studies favored the use of triamcinolone. Pyne et al[31] reported a statistically significant decrease in pain favoring triamcinolone compared with methylprednisolone at week 3 (but at no other time point). Importantly, this was the only study of the four that used a validated outcome measure, the VAS pain scale. Valtonen[32] reported triamcinolone to be more efficacious than betamethasone, although this was without the use of a validated outcome measure and was at week 1 (not week 3, as in the study of Pyne et al[31]). Based on the results of two studies of corticosteroid versus corticosteroid, triamcinolone appears to be the more efficacious drug. Further study of this topic would benefit from standard, validated outcome measurements (eg, WOMAC, VAS, SF-36), standardized follow-up time points, and standardized corticosteroid doses.

Corticosteroids are proven, both scientifically and clinically, to be effective at reducing pain in knee OA, although duration and exact efficacy of these treatments is controversial. Current evidence demonstrates that use of corticosteroids decreases pain by roughly one third, as measured by

VAS pain scale, but provides that benefit for only 1 week. There appears to be no prolonged benefit. From the limited studies available, triamcinolone appears to be more efficacious than either methylprednisolone or betamethasone. However, further study of corticosteroids is necessary to determine the most efficacious agent. Thus, corticosteroids may be incorporated into clinical practice for short-term relief of knee OA symptoms. For longer pain relief, the clinician should consider other treatment options.

References

Citation numbers printed in **bold type** indicate references published within the past 5 years.

1. Felson DT, Naimark A, Anderson J, Kazis L, Castelli W, Meenan RF: The prevalence of knee osteoarthritis in the elderly: The Framingham Osteoarthritis Study. *Arthritis Rheum* 1987;30:914-918.
2. Felson DT, Zhang Y: An update on the epidemiology of knee and hip osteoarthritis with a view to prevention. *Arthritis Rheum* 1998;41:1343-1355.
3. Felson DT: Clinical practice: Osteoarthritis of the knee. *N Engl J Med* 2006;354:841-848.
4. Hunter DJ, Felson DT: Osteoarthritis. *BMJ* 2006;332:639-642.
5. Centers for Disease Control and Prevention: Prevalence of doctor-diagnosed arthritis and arthritis-attributable activity limitation: United States, 2003-2005. *MMWR Morb Mortal Wkly Rep* 2006;Oct 13;55:1089-1092.
6. Kwoh CK: Ibuprofen or acetaminophen for osteoarthritis of the knee. *ACP J Club* 1991;115:78.
7. Garner SE, Fidan DD, Frankish RR, Maxwell LJ: Rofecoxib for osteoarthritis. *Cochrane Database Syst Rev* 2005;25:CD005115.
8. Mazières B, Masquelier AM, Capron MH: A French controlled multicenter study of intraarticular orgotein versus intraarticular corticosteroids in the treatment of knee osteoarthritis: A one-year followup. *J Rheumatol Suppl* 1991; 27:134-137.
9. Ravaud P, Moulinier L, Giraudeau B, et al: Effects of joint lavage and steroid injection in patients with osteoarthritis of the knee: Results of a multicenter, randomized, controlled trial. *Arthritis Rheum* 1999;42:475-482.
10. Sambrook PN, Champion GD, Browne CD, et al: Corticosteroid injection for osteoarthritis of the knee: Peripatellar compared to intra-articular route. *Clin Exp Rheumatol* 1989;7:609-613.
11. Dougados M, Nguyen M, Listrat V, Amor B: High molecular weight sodium hyaluronate (hyalectin) in osteoarthritis of the knee: A 1 year placebo-controlled trial. *Osteoarthritis Cartilage* 1993;1:97-103.
12. Leopold SS, Redd BB, Warme WJ, Wehrle PA, Pettis PD, Shott S: Corticosteroid compared with hyaluronic acid injections for the treatment of osteoarthritis of the knee: A prospective, randomized trial. *J Bone Joint Surg Am* 2003;85:1197-1203.
13. Bellamy N, Campbell J, Robinson V, Gee T, Bourne R, Wells G: Viscosupplementation for the treatment of osteoarthritis of the knee. *Cochrane Database Syst Rev* 2006;19:CD005321.
14. Friedman DM, Moore ME: The efficacy of intraarticular steroids in osteoarthritis: A double-blind study. *J Rheumatol* 1980;7:850-856.
15. Samborski W, Stratz T, Mackiewicz S, Müller W: Intra-articular treatment of arthritides and activated osteoarthritis with the 5-HT3 receptor antagonist tropisetron: A double-blind study compared with methylprednisolone. *Scand J Rheumatol* 2004;119:51-54.
16. Gross AR, Aker PD, Goldsmith CH, Peloso P: Physical medicine modalities for mechanical neck disorders. *Cochrane Database Syst Rev* 2000;2:CD000961.
17. Heintjes E, Berger MY, Bierma-Zeinstra SM, Bernsen RM, Verhaar JA, Koes BW: Pharmacotherapy for patellofemoral pain syndrome. *Cochrane Database Syst Rev* 2004;3:CD003470.
18. Gross AR, Aker PD, Goldsmith CH, Peloso P: Patient education for mechanical neck disorders. *Cochrane Database Syst Rev* 1998;2:CD000962.
19. Avenell A, Handoll HH: Nutritional supplementation for hip fracture aftercare in older people. *Cochrane Database Syst Rev* 2006;18:CD001880.
20. Peloso PM, Gross AR, Haines TA, Trinh K, Goldsmith CH, Aker P: Medicinal and injection therapies for mechanical neck disorders: A Cochrane systematic review. *J Rheumatol* 2006;33:957-967.
21. Bellamy N, Campbell J, Robinson V, Gee T, Bourne R, Wells G: Intraarticular corticosteroid for treatment of osteoarthritis of the knee. *Cochrane Database Syst Rev* 2006;19:CD005328.
22. Wallen M, Gillies D: Intra-articular steroids and splints/rest for children with juvenile idiopathic arthritis and adults with rheumatoid arthritis. *Cochrane Database Syst Rev* 2006;25:CD002824.
23. McLauchlan GJ, Handoll HH: Interventions for treating acute and chronic Achilles tendinitis. *Cochrane Database Syst Rev* 2001;2:CD000232.
24. Green S, Buchbinder R, Hetrick S: Acupuncture for shoulder pain. *Cochrane Database Syst Rev* 2005;18: CD005319.
25. Furlan AD, van Tulder MW, Cherkin DC, et al: Acupuncture and dry-needling for low back pain. *Cochrane Database Syst Rev* 2005;25:CD001351.
26. Arroll B, Goodyear-Smith F: Corticosteroid injections for osteoarthritis of the knee: Meta-analysis. *BMJ* 2004;328:869.
27. Dieppe PA, Sathapatayavongs B, Jones HE, Bacon PA, Ring EF: Intra-articular steroids in osteoarthritis. *Rheumatol Rehabil* 1980;19:212-217.
28. Jones A, Doherty M: Intra-articular corticosteroids are effective in osteoarthritis but there are no clinical predictors of response. *Ann Rheum Dis* 1996;55:829-832.
29. Gaffney K, Ledingham J, Perry JD: Intra-articular triamcinolone hexacetonide in knee osteoarthritis: Factors influencing the clinical response. *Ann Rheum Dis* 1995;54:379-381.
30. Spindler KP, Kuhn JE, Dunn W, Matthews CE, Harrell FE Jr, Dittus RS: Reading and reviewing the orthopaedic literature: A systematic, evidence-based medicine approach. *J Am Acad Orthop Surg* 2005;13:220-229.
31. Pyne D, Ioannou Y, Mootoo R, Bhanji A: Intra-articular steroids in knee osteoarthritis: A comparative study of triamcinolone hexacetonide and methylprednisolone acetate. *Clin Rheumatol* 2004;23:116-120.
32. Valtonen EJ: Clinical comparison of triamcinolonehexacetonide and betamethasone in the treatment of osteoarthritis of the knee-joint. *Scand J Rheumatol Suppl* 1981;41:1-7.
33. Thorpe P: Intra-articular triamcinolone acetonide and methyprednisolone acetate in arthritis. *Curr Ther Res* 1985;38:513-518.
34. Bain LS, Balch HW, Wetherly JM, Yeadon A: Intraarticular triamcinolone hexacetonide: Double-blind comparison with methylprednisolone. *Br J Clin Pract* 1972;26:559-561.

35. Miller JH, White J, Norton TH: The value of intra-articular injections in osteoarthritis of the knee. *J Bone Joint Surg Br* 1958;40:636-643.

36. Popov VV, Boonchook NV, Apeniesheva NP: Treatment of patients with gonarthrosis by intra-articular administration of drugs. *Klin Med (Mosk)* 1989;67:104-108.

37. Wright V, Chandler GN, Morison RA, Hartfall SJ: Intra-articular therapy in osteo-arthritis: Comparison of hydrocortisone acetate and hydrocortisone tertiary-butylacetate. *Ann Rheum Dis* 1960;19:257-261.

38. Raynauld JP, Buckland-Wright C, Ward R, et al: Safety and efficacy of long-term intraarticular steroid injections in osteoarthritis of the knee: A randomized, double-blind, placebo-controlled trial. *Arthritis Rheum* 2003;48:370-377.

39. Cederlöf S, Jonson G: Intraarticular prednisolone injection for osteoarthritis of the knee: A double blind test with placebo. *Acta Chir Scand* 1966;132:532-537.

40. Jackson DW, Evans NA, Thomas BM: Accuracy of needle placement into the intra-articular space of the knee. *J Bone Joint Surg Am* 2002;84:1522-1527.

41. Glattes RC, Spindler KP, Blanchard GM, Rohmiller MT, McCarty EC, Block J: A simple, accurate method to confirm placement of intra-articular knee injection. *Am J Sports Med* 2004;32:1029-1031.