

Musculoskeletal Injections: A Review of the Evidence

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Injections are valuable procedures for managing musculoskeletal conditions commonly encountered by family physicians. Corticosteroid injections into articular, periarticular, or soft tissue structures relieve pain, reduce inflammation, and improve mobility. Injections can provide diagnostic information and are commonly used for postoperative pain control. Local anesthetics may be injected with corticosteroids to provide additional, rapid pain relief. Steroid injection is the preferred and definitive treatment for de Quervain tenosynovitis and trochanteric bursitis. Steroid injections can also be helpful in controlling pain during physical rehabilitation from rotator cuff syndrome and lateral epicondylitis. Intra-articular steroid injection provides pain relief in rheumatoid arthritis and osteoarthritis. There is little systematic evidence to guide medication selection for therapeutic injections. The medication used and the frequency of injection should be guided by the goal of the injection (i.e., diagnostic or therapeutic), the underlying musculoskeletal diagnosis, and clinical experience. Complications from steroid injections are rare, but physicians should understand the potential risks and counsel patients appropriately. Patients with diabetes who receive periarticular or soft tissue steroid injections should closely monitor their blood glucose for two weeks following injection. (*Am Fam Physician.* 2008;78(8):971-976. Copyright © 2008 American Academy of Family Physicians.)

Injections have been an important adjunct for the management of musculoskeletal disease for more than 50 years. As with any procedure, success depends on knowing the right diagnosis (**who** to inject), performing the correct procedure (**how** to inject), and using the most appropriate pharmacologic agent (**what** to inject).

Who to Inject?

The most common indications for therapeutic injections are presented in *Table 1*. In general, injections can be within the joint space (intra-articular), around the joint space (periarticular), or within specific soft tissue structures. Injections can be used to definitively treat a condition, to provide a pain-free window for rehabilitative therapy (which is ultimately curative), or to provide episodic pain and symptom relief.

Injections for Definitive Treatment DE QUERVAIN TENOSYNOVITIS

Corticosteroid injections are curative for de Quervain tenosynovitis, a common overuse tendon injury of the hand and wrist. Steroid injections provide the highest cure rate compared with nonsteroidal anti-inflammatory

drug (NSAID) therapy, splinting, or combination therapy.^{1,2} A pooled analysis of seven observational studies found that steroid injection alone was curative in 83 percent of cases compared with splinting alone (14 percent), rest (0 percent), or NSAID therapy (0 percent).² Most patients are symptom free after a single injection, and injection for the treatment of de Quervain tenosynovitis is safe during pregnancy, postpartum (when the incidence increases), and while breastfeeding.³

TROCHANTERIC BURSITIS

Trochanteric bursitis is the second leading cause of hip pain in adults. Trochanteric steroid injection is simple, safe, diagnostic, and usually therapeutic.⁴ Patients treated with a steroid-anesthetic injection report rapid and prolonged improvement of pain and disability,⁵ often after a single injection. A retrospective cohort study comparing treatments for trochanteric bursitis showed a 2.7-fold increase in the number of patients who were pain free five years after a single corticosteroid injection compared with those who did not receive an injection.⁶

Because it is safe, simple, and effective, physicians should offer steroid injection as

SORT: KEY RECOMMENDATIONS FOR PRACTICE

<i>Clinical recommendation</i>	<i>Evidence rating</i>	<i>References</i>
Corticosteroid injection without splinting is the preferred initial treatment for de Quervain tenosynovitis.	B	1, 2
Corticosteroid injection for trochanteric pain is safe and highly effective. With trochanteric pain, satisfactory pain relief often is achieved with a single corticosteroid injection.	C	4, 5
Subacromial corticosteroid injection provides short-term pain relief that is greater than placebo and at least equal to nonsteroidal anti-inflammatory drug therapy.	B	9, 11, 12
Corticosteroid injection reduces short-term (less than six weeks) symptoms from lateral epicondylitis, but physical therapy is superior to steroid injection after six weeks.	A	13, 15, 16
Intra-articular steroid injections reduce pain and swelling in osteoarthritis of the knee.	A	17
The addition of local anesthetics to steroid injections improves pain relief and can be used to differentiate local from referred pain.	C	30, 46, 47

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to <http://www.aafp.org/afpsort.xml>.

first-line treatment for trochanteric bursitis, particularly in older adults. Physical therapy modalities and NSAIDs are second-line agents for pain relief in patients with trochanteric bursitis. Therapeutic strengthening and stretching exercises are helpful for younger or more athletic patients and for those with recurrent symptoms.

INJECTION FOR PAIN CONTROL DURING REHABILITATION

Injected corticosteroids decrease swelling and reduce pain, permitting improved range of motion and facilitating rehabilitative and strengthening exercises that resolve many forms of tendinopathy or bursitis.⁷⁻¹⁰

SUBACROMIAL PAIN

Definitive treatment of subacromial pain (rotator cuff syndrome) always involves physical therapy to strengthen the rotator cuff. Shoulder pain prevents many patients from adequately performing rehabilitative exercises, carrying out activities of daily living, and obtaining uninterrupted sleep. Therefore, a common clinical dilemma is how to best control pain to allow for adequate rehabilitative physical therapy. Systematic reviews of treatments for subacromial pain, subacromial impingement, and rotator cuff syndrome favor corticosteroid injection over the following options: ergonomic changes, nonsteroidal drug therapy, acupuncture, range of motion and strengthening exercises, ultrasound, ice, heat, and physical therapy.^{11,12} Subacromial injection is particularly helpful in differentiating between shoulder weakness caused by impingement (shoulder strength improves after injection) and a true rotator cuff tear (no change in strength is noted following injection).

LATERAL EPICONDYLITIS

Lateral epicondylitis (i.e., tennis elbow) is a common cause of elbow pain. Corticosteroid injection yields a predictable short-term (less than six weeks) decrease in pain^{13,14} that is superior to nonsteroidal drug therapy¹⁵ and physical therapy.¹⁶ After six weeks, however, physical therapy reduces symptoms more than corticosteroid injection.¹⁶ Therefore, corticosteroid injection should be reserved for patients whose symptoms limit participation in physical therapy or activities of daily living.

Table 1. Common Indications for Therapeutic Injections

Inflammatory arthritides

Adult and juvenile rheumatoid arthritis
Crystal-induced arthritis (gout; pseudogout)
Spondyloarthropathies (Reiter syndrome; psoriatic arthritis)

Noninflammatory arthritides

Osteoarthritis (most commonly of knee, distal interphalangeal, proximal interphalangeal, carpometacarpal and metatarsophalangeal joints)

Periarticular/soft-tissue injections*

Bursitis
Carpal tunnel syndrome
Epicondylitis
Tenosynovitis

*—Therapeutic injections can be used for other nonarticular conditions as well.

Injection for Pain Relief: Arthritis

The most common indication for intra-articular injection is arthritis. For short-term treatment of osteoarthritis of the knee, intra-articular steroid injection improves function and reduces swelling and pain.¹⁷ The onset of action is rapid (typically within 24 hours) and clinical effects last four to eight weeks. Repeated steroid injections for osteoarthritis of the knee are safe and do not accelerate disease progression.¹⁸ Although steroid injections are effective for osteoarthritis of the hip,¹⁹ technical challenges with this procedure preclude its routine use. Intra-articular corticosteroids are less effective for treating osteoarthritis of the thumb²⁰ and shoulder.¹¹

Injection for Symptom Relief: Carpal Tunnel Syndrome

Carpal tunnel syndrome affects nearly 4 percent of the general population. Local corticosteroid injections provide greater symptom relief for one month after injection compared with placebo (number needed to treat [NNT] = 2) and oral corticosteroids. However, significant symptom relief after one month has not been demonstrated following injection.²¹ Also, as many as one third of patients will improve spontaneously. Prospective data suggest that for patients who fail initial therapy with bracing or oral anti-inflammatory medications, clinical outcomes at one year are similar in patients treated with corticosteroid injections versus surgery.²²

How Often to Inject?

Data from studies of patients with rheumatoid arthritis²³ suggest it is safe to perform multiple steroid injections on the same joint. The recommended interval between intra-articular injections is three months.²⁴ Injection frequency should be guided by the underlying disease process, the response to past injections, the availability of other treatment options, patient preferences, and clinical judgment.

What about Diabetes?

A clinical concern is the effect of steroid injection on blood glucose levels in patients with underlying diabetes. Single intra-articular steroid injections have little or no effect on glycemic control.²⁵ However, injection of soft tissues or peritendinous injections can cause elevations in blood glucose^{26,27} that persist from five to 21 days. Patients with diabetes who undergo soft tissue injections require closer glycemic monitoring and follow-up in the weeks following the procedure.

How to Inject?

A series of articles reviewing the technical aspects of joint and soft-tissue-specific injections has been published in *American Family Physician*.²⁸⁻³⁰ Contraindications to intra-articular injection are presented in *Table 2*. If the underlying diagnosis is unknown, aspiration and synovial fluid analysis should be performed for diagnostic purposes. Although ultrasound imaging can be used to direct or confirm injection location,³¹ the use of standard anatomic landmarks results in correct needle placement in most uncomplicated cases.³²

Informed consent should always be obtained before performing the procedure. Injections should be performed using aseptic technique. A 1.5 inch, 21-gauge needle is typically used to inject larger joints such as the knee or shoulder. Smaller (0.5 inch) 23- or 25-gauge needles suffice for smaller joints. The viscosity of some steroid preparations precludes injection through smaller-bore needles. To perform aspiration and injection consecutively, physicians can either use a reciprocating device³³ or the joint injection technique described in *Table 3*.

The most common complications of intra-articular injection are a postinjection flare of pain (2 to 10 percent), skin atrophy (1 percent), fat atrophy (1 percent), and facial flushing (less than 1 to 12 percent) (*Table 4*).³⁴⁻³⁶ Less commonly reported side effects include iatrogenic infection (risk of 1 in 1,000) and tendon rupture (less than 1 percent). The risk of tendon rupture is highest with soft tissue injections around the Achilles tendon and plantar fascia.³⁷

What to Inject?

SELECTING CORTICOSTEROIDS

There is little systematic evidence to guide corticosteroid selection for therapeutic injections. Most recommendations are based on a combination of clinical experience

Table 2. Contraindications to Intra-Articular Injection

Broken skin at injection site
Known hypersensitivity to intra-articular agent
Osteochondral/intra-articular fracture
Prosthetic joint*
Severe joint destruction
Skin infection overlying injection site
Unstable coagulopathy

*—Relative contraindication.

Table 3. Joint Injection Procedure*Steps for combined intra-articular aspiration and injection*

1. Determine indication for procedure.
2. Obtain informed consent; discuss risks, benefits, and alternatives with the patient.
3. Prepare equipment, including laboratory requests, needles, syringes, and medication.
4. Identify and mark the appropriate anatomic landmarks to guide needle placement.
5. Clean overlying skin using isopropyl alcohol (povidone iodine [Betadine] also can be used).
6. Use cooling spray or local anesthetic for patient comfort (as needed).
7. Select appropriate length and gauge of needle; judiciously guide needle into intra-articular space.
8. Gently aspirate fluid (procedure should not be painful).
9. Anchor needle with hemostat to prevent migration from the intra-articular space.
10. Remove aspirant syringe and replace with syringe containing steroid and/or anesthetic for injection.
11. Inject medication into the intra-articular space (fluid should move freely into the joint space); if resistance is met, try rotating or repositioning syringe to ensure that the needle is still in the correct space.
12. Remove needle and apply bandage.
13. Provide post-procedural counseling.

Table 4. Complications of Intra-Articular Steroid Injections

<i>Complication</i>	<i>Incidence (%)</i>
Joint effects	
Post-injection flare	2 to 10
Steroid arthropathy	0.8
Joint infection	< 0.001 to 0.072
Surrounding tissue effects	
Pericapsular calcification	43
Tendon rupture	< 1
Skin atrophy/depigmentation	< 1
Systemic effects	
Vasovagal reaction	10 to 20
Facial flushing	< 1
Hypersensitivity reaction	< 1

Information from references 34 through 36.

leukocyte and inflammatory modulator response,³⁹ and alter local collagen synthesis.⁴⁰ These effects combine to reduce pain and inflammation. Hydrocortisone esters are more effective in producing these effects than their parent compounds. Branched esterification further reduces solubility, allowing steroids to remain at the injection site longer.³⁸ Clinically, insoluble steroids have a longer duration of action and a higher incidence of cutaneous side effects. Triamcinolone hexacetonide (Aristospan) is the least soluble of the commonly used injectable steroids, followed by triamcinolone acetonide (Kenalog).

In the United States, methylprednisolone acetate (Depo-Medrol) is the most commonly used intra-articular steroid, followed by triamcinolone hexacetonide and triamcinolone acetonide.⁴¹ Many physicians empirically use triamcinolone hexacetonide (low solubility, longer duration of action) for intra-articular injection, and betamethasone (high solubility, shorter duration of action, fewer cutaneous side effects) for soft tissue injections.

Early trials of intra-articular corticosteroids showed equal systemic absorption of methylprednisolone in patients with rheumatic and osteoarthritic hands⁴² and knees.⁴³ This suggests that steroid pharmacokinetics, rather than disease-related factors, should guide steroid selection. A recent review by the National Health Service of the United Kingdom⁴⁴ recommends triamcinolone and methylprednisolone as preferred agents for injection of large joints (e.g., knee). For smaller joints (e.g., finger), either hydrocortisone or methylprednisolone (Hydeltrasol, brand no longer available in the United States) is recommended. *Tables 5 and 6*⁴⁵ compare commonly available steroid preparations.

ADDING ANESTHETICS

Local anesthetics are often combined with corticosteroids for intra-articular injection. Local anesthetics relieve pain and can be used diagnostically to differentiate between local and referred pain.^{30,46,47} They also add volume to the injectate and help to distribute corticosteroid within the joint space. Most local anesthetics are short-acting (*Table 7*).

As with the choice of corticosteroids, the choice of local anesthetic for injection is based more on clinical preference than evidence. When corticosteroids and local anesthetics are used together, many patients will experience relatively rapid relief of symptoms following the injection. This is the initial action of the local anesthetic. Patients then often experience a transient increase in pain as the local anesthetic wears off. Longer-term symptom relief results as the injected corticosteroid takes effect. It is helpful to provide this anticipatory guidance to patients before the injection.

and personal preference. However, knowledge about the mechanism of action of individual steroids can guide steroid selection in various situations.

The clinical effects of steroids result from several different mechanisms of action. Intra-articular corticosteroids reduce synovial blood flow,³⁸ lower the local

Table 5. Steroid Dosing and Equivalents

<i>Steroid</i>	<i>Common concentration (mg per mL)</i>	<i>Common equivalent dose* (mg)</i>	<i>Approximate duration of action (days)</i>
Methylprednisolone acetate (Depo-Medrol)	40 or 80	40	8
Triamcinolone acetonide (Kenalog)	10 or 40	40	14
Triamcinolone hexacetonide (Aristospan)	20	40	21
Dexamethasone acetate (Decadron-LA†)	8	8	8
Dexamethasone sodium (Decadron†, Solurex†)	4	8	6

NOTE: Steroid agents listed in order of prevalence of use.

*—Dose equivalent to 40 mg of methylprednisolone acetate or triamcinolone acetonide (the most commonly used intra-articular steroid; see Table 6⁴⁵).

†—Brand no longer available in the United States.

Table 6. Joint Specific Injections (Proximal to Distal)

<i>Joint</i>	<i>Steroid dose* (mg)</i>	<i>Anesthetic dose† (mL)</i>	<i>Needle length (inch)</i>	<i>Needle gauge</i>
Shoulder	20 to 40	5	1.5	21
Elbow	20	3	1.0	23
Wrist	20 to 40	3	0.5 to 1.5	23 or 25
Knee	20 to 80	5	1.5	21
Ankle	20 to 40	3 to 5	1.0 to 1.5	23

*—Dosing for methylprednisolone acetate (Depo-Medrol).

†—Dosing for 1% lidocaine (Xylocaine).

Information from reference 45.

Table 7. Local Anesthetics for Joint Injection

<i>Medication</i>	<i>Onset of action (minutes)</i>	<i>Duration of action (hours)</i>	<i>Max volume of injection*</i>
0.25% Bupivacaine (Marcaine)	30	8	60 mL
0.5% Bupivacaine	30	8	30 mL
1% lidocaine (Xylocaine)	1 to 2	1	20 mL
2% lidocaine	1 to 2	1	10 mL

*—Increased risk of cardiac toxicity or arrhythmia above these dosages.

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REFERENCES

- Lane LB, Boretz RS, Stuchin SA. Treatment of de Quervain's disease: role of conservative management. *J Hand Surg [Br]*. 2001;26(3):258-260.
- Richie CA III, Briner WW Jr. Corticosteroid injection for treatment of de Quervain's tenosynovitis: a pooled quantitative literature evaluation. *J Am Board Fam Pract*. 2003;16(2):102-106.
- Avci S, Yilmaz C, Sayli U. Comparison of nonsurgical treatment measures for de Quervain's disease of pregnancy and lactation. *J Hand Surg [Am]*. 2002; 27(2):322-324.
- Foley B, Christopher TA. Injection therapy of bursitis and tendinitis. In: Roberts JR, Hedges JR, Chanmugan AS, eds. *Clinical Procedures in Emergency Medicine*. 4th ed. Philadelphia, Pa.: W.B. Saunders; 2004:1020-1040.
- Shbeeb MI, O'Duffy JD, Michet CJ Jr, O'Fallon WM, Matteson EL. Evaluation of glucocorticosteroid injection for the treatment of trochanteric bursitis. *J Rheumatol*. 1996;23(12):2104-2106.

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6. Lievens A, Bierma-Zeinstra S, Schouten B, Bohnen A, Verhaar J, Koes B. Prognosis of trochanteric pain in primary care. *Br J Gen Pract.* 2005;55(512):199-204.
7. Visnes H, Bahr R. The evolution of eccentric training as treatment for patellar tendinopathy (jumper's knee): a critical review of exercise programmes. *Br J Sports Med.* 2007;41(4):217-223.
8. Wilson JJ, Best TM. Common overuse tendon problems: a review and recommendations for treatment. *Am Fam Physician.* 2005;72(5):811-818.
9. Blair B, Rokito AS, Cuomo F, Jarolem K, Zuckerman JD. Efficacy of injections of corticosteroids for subacromial impingement syndrome. *J Bone Joint Surg Am.* 1996;78(11):1685-1689.
10. Hay EM, Thomas E, Paterson SM, Dziedzic K, Croft PR. A pragmatic randomised controlled trial of local corticosteroid injection and physiotherapy for the treatment of new episodes of unilateral shoulder pain in primary care. *Ann Rheum Dis.* 2003;62(5):394-399.
11. Buchbinder R, Green S, Youd JM. Corticosteroid injections for shoulder pain. *Cochrane Database Syst Rev.* 2003;(1):CD004016.
12. Johansson K, Oberg B, Adolfsson L, Foldevi M. A combination of systematic review and clinicians' beliefs in interventions for subacromial pain. *Br J Gen Pract.* 2002;52(475):145-152.
13. Lewis M, Hay EM, Paterson SM, Croft P. Local steroid injections for tennis elbow: does the pain get worse before it gets better? Results from a randomized controlled trial. *Clin J Pain.* 2005;21(4):330-334.
14. Assendelft WJ, Hay EM, Adshear R, Bouter LM. Corticosteroid injections for lateral epicondylitis: a systematic overview. *Br J Gen Pract.* 1996;46(405):209-216.
15. Smidt N, van der Windt DA, Assendelft WJ, Devillé WL, Korthals-de Bos IB, Bouter LM. Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomised controlled trial. *Lancet.* 2002;359(9307):657-662.
16. Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *BMJ.* 2006;333(7575):939.
17. Bellamy N, Campbell J, Robinson V, Gee T, Bourne R, Wells G. Intra-articular corticosteroid for treatment of osteoarthritis of the knee. *Cochrane Database Syst Rev.* 2006;(2):CD005328.
18. Arroll B, Goodyear-Smith F. Corticosteroid injections for osteoarthritis of the knee: meta-analysis. *BMJ.* 2004;328(7444):869.
19. Qvistgaard E, Christensen R, Torp-Pedersen S, Bliddal H. Intra-articular treatment of hip osteoarthritis: a randomized trial of hyaluronic acid, corticosteroid, and isotonic saline. *Osteoarthritis Cartilage.* 2006;14(2):163-170.
20. Meenagh GK, Patton J, Kynes C, Wright GD. A randomised controlled trial of intra-articular corticosteroid injection of the carpometacarpal joint of the thumb in osteoarthritis. *Ann Rheum Dis.* 2004;63(10):1260-1263.
21. Marshall S, Tardif G, Ashworth N. Local corticosteroid injection for carpal tunnel syndrome. *Cochrane Database Syst Rev.* 2007;(2):CD001554.
22. Ly-Pen D, Andréu JL, de Blas G, Sánchez-Olaso A, Millán I. Surgical decompression versus local steroid injection in carpal tunnel syndrome: a one-year, prospective, randomized, open, controlled clinical trial. *Arthritis Rheum.* 2005;52(2):612-619.
23. Combe B. Early rheumatoid arthritis: strategies for prevention and management. *Best Pract Res Clin Rheumatol.* 2007;21(1):27-42.
24. Raynauld JP, Buckland-Wright C, Ward R, et al. Safety and efficacy of long-term intra-articular steroid injections in osteoarthritis of the knee: a randomized, double-blind, placebo-controlled trial. *Arthritis Rheum.* 2003;48(2):370-377.
25. Habib GS, Abu-Ahmad R. Lack of effect of corticosteroid injection at the shoulder joint on blood glucose levels in diabetic patients. *Clin Rheumatol.* 2007;26(4):566-568.
26. Wang AA, Hutchinson DT. The effect of corticosteroid injection for trigger finger on blood glucose level in diabetic patients. *J Hand Surg [Am].* 2006;31(6):979-981.
27. Younes M, Neffati F, Touzi M, et al. Systemic effects of epidural and intra-articular glucocorticoid injections in diabetic and non-diabetic patients. *Joint Bone Spine.* 2007;74(5):472-476.
28. Cardone DA, Tallia AF. Diagnostic and therapeutic injection of the hip and knee. *Am Fam Physician.* 2003;67(10):2147-2152.
29. Denkler K. Helpful hints for injections of wrist and hand region. *Am Fam Physician.* 2003;68(10):1912.
30. Tallia AF, Cardone DA. Diagnostic and therapeutic injection of the shoulder region. *Am Fam Physician.* 2003;67(6):1271-1278.
31. Naredo E, Cabero F, Beneyto P, et al. A randomized comparative study of short term response to blind injection versus sonographic-guided injection of local corticosteroids in patients with painful shoulder. *J Rheumatol.* 2004;31(2):308-314.
32. Hall S, Buchbinder R. Do imaging methods that guide needle placement improve outcome? *Ann Rheum Dis.* 2004;63(9):1007-1008.
33. Bankhurst AD, Nunez SE, Draeger HT, Kettwich SC, Kettwich LG, Sibbitt WL Jr. A randomized controlled trial of the reciprocating procedure device for intraarticular injection of corticosteroid. *J Rheumatol.* 2007;34(1):187-192.
34. Courtney P, Doherty M. Joint aspiration and injection. *Best Pract Res Clin Rheumatol.* 2005;19(3):345-369.
35. O'Connor FG. Common injections in sports medicine: general principles and specific techniques. In: O'Connor FG, ed. *Sports Medicine: Just the Facts.* New York, NY: McGraw-Hill Medical Pub. Division; 2005:426-433.
36. Gray RG, Gottlieb NL. Intra-articular corticosteroids. An updated assessment. *Clin Orthop Relat Res.* 1983;177:235-263.
37. Acevedo JI, Beskin JL. Complications of plantar fascia rupture associated with corticosteroid injection. *Foot Ankle Int.* 1998;19(2):91-97.
38. Caldwell JR. Intra-articular corticosteroids. Guide to selection and indications for use. *Drugs.* 1996;52(4):507-514.
39. Lavelle W, Lavelle ED, Lavelle L. Intra-articular injection. *Med Clin North Am.* 2007;91(2):241-250.
40. Wei AS, Callaci JJ, Juknelis D, et al. The effect of corticosteroid on collagen expression in injured rotator cuff tendon. *J Bone Joint Surg Am.* 2006;88(6):1331-1338.
41. Centeno LM, Moore ME. Preferred intraarticular corticosteroids and associated practice: a survey of members of the American College of Rheumatology. *Arthritis Care Res.* 1994;7(3):151-155.
42. Hermosilla Molina A. Treatment of refractory traumatic arthritis of the fingers with intra-articular Ledercort [in Spanish]. *Hisp Med.* 1965;22(250):223-228.
43. Bertouch JV, Meffin PJ, Sallustio BC, Brooks PM. A comparison of plasma methylprednisolone concentrations following intra-articular injection in patients with rheumatoid arthritis and osteoarthritis. *Aust N Z J Med.* 1983;13(6):583-586.
44. National Library for Health. Osteoarthritis: management issues. Clinical knowledge summaries. http://www.cks.library.nhs.uk/osteoarthritis/in_depth/management_issues. Accessed December 14, 2007.
45. Pfenninger JL. Injections of joints and soft tissue: part II. Guidelines for specific joints. *Am Fam Physician.* 1991;44(5):1690-1701.
46. Rifat SF, Moeller JL. Injection and aspiration techniques for the primary care physician. *Compr Ther.* 2002;28(4):222-229.
47. Tallia AF, Cardone DA. Diagnostic and therapeutic injection of the ankle and foot. *Am Fam Physician.* 2003;68(7):1356-1362.

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