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Review Article:
HAND DEFORMITIES IN RHEUMATOID ARTHRITIS

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ABSTRACT

RA (rheumatoid arthritis) is a chronic progressive autoimmune disease with a high socio-economic burden. This disease is more common in women compared to men (3:1). Joint involvement occurs early in the natural history of the condition. At the cellular level, the immune system continues to recognize and responds to the autoantigen that leads to persistent activation CD4+ T cells and B cells. Activated B produces rheumatoid factor that lead to the formation of immune complexes in the synovial space, activating complement to stimulate migration of neutrophils into the synovial space. Chemokine production enhances the migration of mononuclear cells into the joint space, adding further to the exudative component of the disease. Proinflammatory cytokines also stimulate the production of collagenases, OPGL (osteoprotegerin ligand), and IL-6. IL-6, IL-18, and other growth factors stimulate fibroblast proliferation, resulting in invasive pannus formation, leading to osteoclast activation and bone destruction. In the final stage, the inflammatory reaction extinguishes and is replaced by fibrosis, which causes tendon adhesions and fixed deformities One of the end results of this pathological inflammation is the disruption of the balance between flexor and extensor tendons, which produces the characteristic hand deformities.

***Keywords**: hand deformities, rheumatoid arthritis*

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INTRODUCTION

The prevalence of RA across the world is around 0.5% to 5%. A community study in Malang Regency, East Java, Indonesia reported that the prevalence of RA was 0.5% (Kalim 2000). Although inflammation and deformity are most often seen initially in the hands and feet, later the disease often extends to larger joints even in other organs. Until recently, the rate of permanent work disability has been high despite development of anti rheumatic therapy (Emery 2002; Scott 2000; Smolen 2005). Joint damage progresses constantly over the first 20 year of RA. It accounts for ~25% of disability in established RA Gordon AD, 1998. Initiating treatment as soon as possible after diagnosis may produce significant clinical and functional benefit and appears to retard the rate of radiographic progression of erosions. Delaying in treatment drugs may of RA may set the stage for damage that cannot be reversed. All treatment paradigms also stress early, aggressive disease modifying antirheumatic drug (DMARD) as well as biologic agents such as, anti IL-1 and anti-TNF are the important treatments in RA (Emery 2002; Smolen 2005).

PATHOGENESIS

Specific and nonspecific responses by immune cells lead to four key findings in RA. In genetically susceptible individuals, antigens from an infectious agent may mimic host proteins, resulting in recognition of microbial agents as self and loss of T-cell tolerance (molecular mimicry). The immune system continues to recognize and responds to the autoantigen, which leads to persistent activation CD4+ T cells and B cells. Activated B produces immunoglobulins such as rheumatoid factor that lead to the formation of immune complexes in the synovial space, activating complement. Activated complement stimulates migration of neutrophils into the synovial space. The release of IL-2, IL-15, IL-17, and IFN-γ by activated CD4+ T cells stimulates synovial macrophages to produce both proinflammatory. Proinflammatory cytokines such as IL-1 and TNF-alpha induce synthesis of secondary cytokines such as IL-6 and chemokines such as IL-8 by synovial fibroblasts. IL-1 and TNF-alpha also induce expression of PGE2 (prostaglandin E2), PLA2 (phospholipase A2), and iNOS (inducible nitric oxide synthase), resulting in a 1000-fold increase in the production of COX-2 (cyclooxygenase-2), LTB4 (leukotrien B4), and NO in the joint space and

contributing to increased pain and joint swelling. Chemokine production enhances the migration of mononuclear cells into the joint space, adding further to the exudative component of the disease. Proinflammatory cytokines also stimulate the production of collagenases, OPGL (osteoprotegerin ligand), and IL-6. IL-6 and other growth factors stimulate fibroblast proliferation, resulting in invasive pannus formation. IL-6, IL-1, and OPGL part of the cascade leading to osteoclast activation and bone destruction (Choy 2001; McInnes 2001).

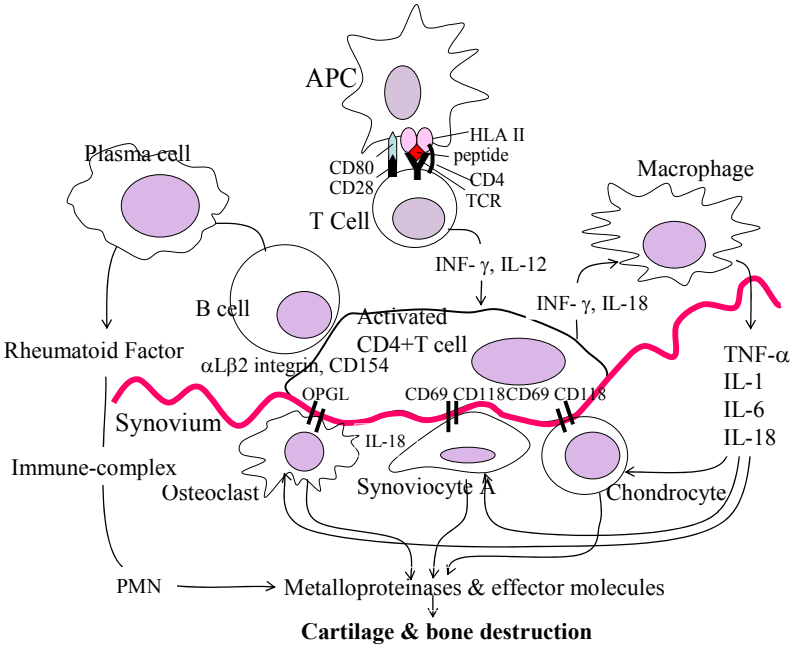

Figure 1. Proposed mechanisms of cartilage and bone destruction in RA (Choy EHA, 2001, McInnes IB, 2001).

DIAGNOSIS

The diagnosis of RA should be considered in any patient with polyarticular inflammatory arthritis of more than 6 weeks' duration, especially if the hands and feet are involved. In the hands, it is the proximal interphalangeal (PIP) joints and metacarpophalangeal (MCP) joint that are most likely to be involved early. If synovial-based inflammation persists over time, permanent damage, including tendon, ligament, cartilage, and subchondral bone destruction, will occur, with resultant joint deformity and disability. The currently accepted classification scheme for rheumatoid arthritis (RA) is the 1987 American College of Rheumatology (ACR) criteria set with a sensitivity in the range 77-95% and specificity in the range 85-98% (Arnett 1988). For classification purposes, a patient is said to have rheumatoid arthritis if four of seven criteria are satisfied. Criteria 1-4 must have been present for at least 6 weeks. Patients with two clinical diagnoses are not excluded. MCP, metacarpophalangeal; MTP, metatarsophalangeal; PIP, proximal intraphalangeal (Arnett 1988).

CLINICAL PICTURE

Stiffness, and joint pain are the specific symptoms of RA. While, the clinical features reflecting systemic involvement in rheumatoid arthritis include: fevers, malaise and weight loss, and extra articular involvement may indicate poor prognosis in RA. Those signs, and symptoms are contributory to disability in RA.

Morning Stiffness

Morning joint stiffness is a major symptom of RA that may at times be disabling. Edema of the synovium and periarticular structures contributes to stiffness in RA by mechanically interfering with the usual motion of the joint. Stiffness is most pronounced after sleep, in part due to redistribution of interstitial fluid while sleeping. On physical examination, stiffness is manifested by limitation of motion (Gordon 1998; O'Dell 2005).

Table 1. 1987 American College of Rheumatology revised criteria for the classification of RA

Criterion	Definition
1. Morning stiffness	Morning stiffness in/around the joints, lasting at least 1 hour before maximal improvement
2.Arthritis of three or more joint areas	At least three joint areas simultaneously with soft tissue swelling or joint fluid observed by a physician; the 14 possible areas are (right or left): PIP, MCP, wrist, elbow, knee, ankle, and MTP joints
3. Arthritis of hand joints	At least one area swollen in a wrist MCP, or PIP joint
4. Symmetric arthritis	Simultaneous involvement of the same joint areas on both sides of the body (bilateral involvement of PIP, MCP, or MTP acceptable without perfect symmetry)
5. Rheumatoid nodules	Subcutaneous nodules over bony prominences or extensor surfaces, or in juxtaarticular regions, observed by a physician
6. Serum rheumatoid factor	Abnormal amount of serum rheumatoid factor by any method for which the result has been positive in < 5% of control subjects
7. Radiographic changes	Erosions or unequivocal bony decalcification localized in or most marked adjacent to the involved joints (osteoarthritis changes excluded), typical of rheumatoid arthritis on posteroanterior hand and wrist radiographs

Pain

Pain is a major problem for most patients with RA. Joint with rapidly evolving effusions, as seen in early disease, or swollen joints with an applied load, may be extremely painful due to high intraarticular pressures that lead to excessive stresses on the extensively innervated, periarticular supporting structures.

Tenderness

Palpation of the joints may elicit tenderness. The enlarged synovial membrane, periarticular ligaments, and supporting structures are the major pain-sensitive structures. A lateral squeeze of the MCP and metatarsophalangeal (MTP) joint row will detect tenderness in inflamed joints.

Pain on Motion

Pain on motion is often used as a surrogate for tenderness in joints that are difficult to palpate directly due to overlying muscle and other tissues; these include the cervical spine, shoulder, and hip. Additionally, joint instability or subluxation may cause pain on motion

Swelling

Swelling of a joint results from proliferation of the synovial tissues, effusions, or from bony proliferation. This soft tissue swelling is most evident in the small joints.

Limitation of Motion

Limitation of motion occurs as a result of articular surface damage, joint and tendon sheath swelling, or alteration of joint-supporting structures. Effusions, pain and fibrosis may limit joint. Joint deformities and subluxations invariably limit motion due to mechanical factors (Gordon 1998; Neumister 2004; O'Dell 2005).

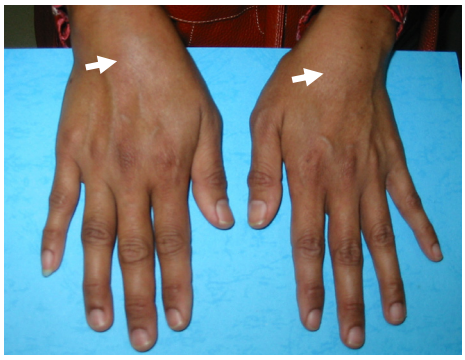

Figure 2. Early RA (< 2 months) with synovitis (arrows) in both hands (Gordon 1998).

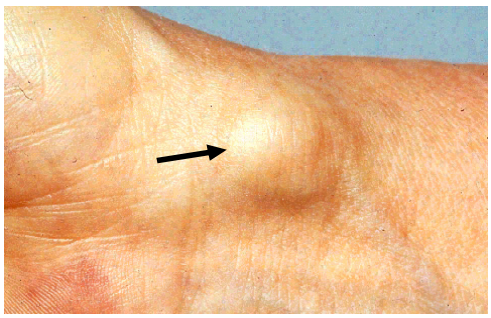

Figure 3. A rheumatoid nodule (Gordon 1998).

DEFORMITIES

More than 10% of RA patients will develop deformity of the small joints of the hands within the first 2 years of disease and at least one third develop such deformities over time. Joint instability is seen if disruption of supporting structures has occurred. Loss of cartilage as a result of enzymatic and mechanical degradation, combined with stretching and weakening of the periarticular ligaments and their attachments, allows forces acting across the joints to deform them. Unfortunately, once deformities develop they are permanent. Therefore, initiating treatment early to prevent this is crucial (Gordon 1998; Neumister 2004; O'Dell 2005).

EFFECTS OF RHEUMATOID ARTHRITIS ON HAND

Fingers

Boutonnière deformity

Boutonnière deformity is nonreducible flexion at the PIP joint with concomitant hyperextension of the DIP joint of the finger. This occurs as a consequence of synovitis with stretching of, or rupture of, the PIP joint through the central extensor tendon with concomitant volar displacement of the lateral bands. When the lateral bands have subluxed far enough to pass the transverse axis of the joint, they become flexors of the PIP joint. Hyperextension of the DIP joint will occur as the tendons shorten with time (McInnes et al. 2001; Neumeister et al. 2004). With mild boutonniere deformity, minimal distortion of the joint positions and functional loss occur. A slight extensor lag (10-15°) is present at the PIP joint with slight hyperextension at the DIP joint and no involvement of the MP joint. With moderate boutonniere deformity, the flexion deformity at the PIP joint increases to 30-40° and the MP joint begins to hyperextend in order to compensate (Gordon 1998; Neumister 2004; O'Dell 2005).

Swan-neck Deformity

Swan-neck deformity is a result of hyperextension at the PIP joint with flexion of the DIP joint. This deformity may be initiated by (a) disruption of the extensor tendon at the DIP joint with secondary shortening of the central extensor tendon and hyperextension of the PIP joint, or (b) volar herniation of the PIP joint capsule due to weakening from chronic synovitis with subsequent tightening of the lateral bands and central extensor tendon.

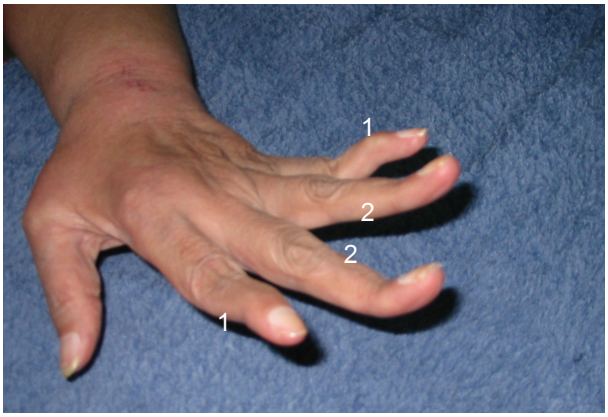

Figure 4. Swan-neck (1) and Boutonnière (2) deformities (Gordon 1998; O'Dell 2005).

Trigger Finger

Synovial proliferation produces discrete rheumatoid nodules on tendons, which can result in trigger finger. The size and location of these nodules on the flexor tendon determine the degree of triggering. Intrinsic muscle (interossel, lumbricals) tightness may cause major declines in mobility of the fingers. This is evident on examination when the PIP joint cannot be flexed while the MCP joint is fully extended, but can be flexed if the MCP joint is in flexion Flexor tenosynovitis of the fingers is common and portends a poor prognosis. Stiffness and crepitance along the tendon sheath with limitation of flexion and extension may follow. "Triggering" of the finger occurs when thickening or nodule formation of the tendon interacts with the concomitant tenosynovial proliferation, trapping the tendon (stenosing tenosynovitis).

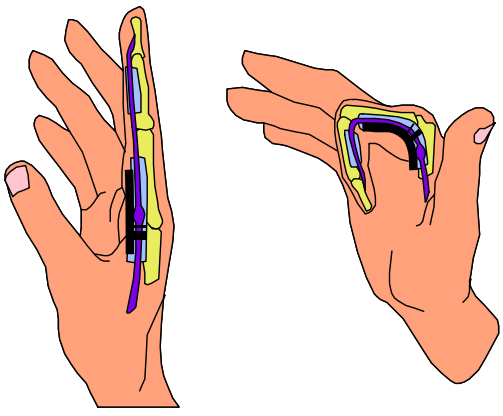

Figure 5. Anatomic representation of trigger finger (Gordon 1998; Neumister 2004)

Tendon Rupture

The main causes of tendon rupture are chronic attrition of the tendon over a bony prominence and synovial invasion of the tendon. The most frequent sites for extensor tendon rupture are at the distal end of the ulna. Sudden loss of finger extension or flexion is the cardinal sign of tendon rupture. Usually, it is painless and can occur during normal use of the hand, therefore patients with RA frequently ignore the new development because it may be subtle in the context of the other constraints on their normal function. Multiple extensor tendon ruptures are usually initiated by attrition of a single tendon and progress in a radial manner, frequently beginning with the small finger extensor.

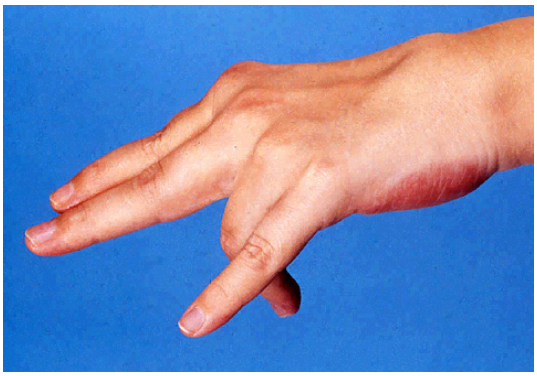

Figure 6. Extensor tendon rupture of the fourth finger (Gordon 1998)

Opera Glass Hands

Opera glass hands (arthritis mutilans) results if destruction is severe and extensive, with dissolution of bone. In the small joints of the hands, the phalanges may shorten and the joints become grossly unstable. *Pulling on the fingers during examination may lengthen the digit much like opening opera glasses*, or the joint may bend in unusual directions merely under the pull of gravity. Striking resorption of subchondral bone can develop over a fairly short period of time and lead to arthritis mutilans (Gordon 1998; Neumister 2004; O'Dell 2005).

Thumb

There are 6 types of deformities of the thumb associated with RA. The treatment of these deformities depends on the severity of disease in each involved joint (Neumister 2004)

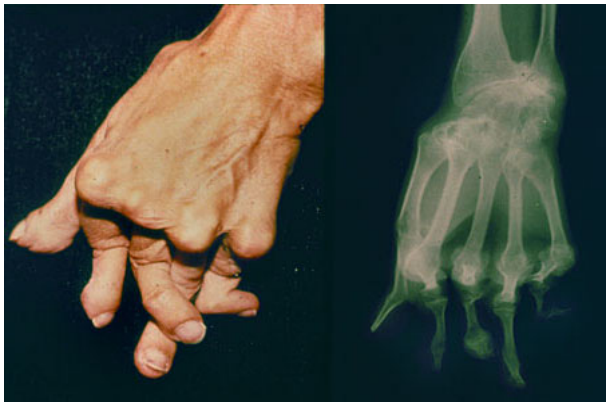

Figure 7. Opera Glass hand (Gordon 1998; O'Dell 2005)

1. Type 1 thumb deformity. This is a boutonniere deformity, and is the most common thumb disorder in persons with RA.
2. Type 2 thumb deformity. The deformity maintains the hyperextension at the MP joint, but it is also associated with hyperextension at the IP joint. Also, the CMC joint is often subluxed.
3. The type 3 thumb deformity. This is a swan-neck deformity and is the second most common type of thumb disfigurement in persons with RA.
4. The type 4 thumb deformity. This is analogous to skier's or gamekeeper's thumb. The MP joint synovitis initiates the pathology, with resultant laxity of the ulnar collateral ligament with or without subsequent adduction of the first metacarpal
5. The type 5 thumb deformity. This is identical to the type 3 deformity but does not involve adduction of the first metacarpal
6. The type 6 deformity involves isolated IP joint and/or MP joint destruction with subluxation, as a result of bone resorption and destruction.

Metacarpophalangeal Joints

Two typical deformities may occur at the MCP joints that alter the alignment of the palmar skeletal arches and the stability of the fingers: volar subluxation of the fingers relative to the metacarpal bones and ulnar deviation.

Volar subluxation

The volar plate is firmer and more substantial than other portions of the MCP joint capsule and therefore effectively limits extension and dorsal movement at the joint. The greater relative strength of the flexor muscles, as compared with the extensors, causes volar migration of the proximal phalanx after synovial-based

inflammation has weakened ligament and tendon insertions about the MCP joint capsule.Volar dislocation or subluxation is also caused by weakening of the collateral ligaments and dorsal extensor mechanism when the extensor tendons are dislocated between the metacarpal heads. As a result, no force counters the extrinsic and intrinsic flexors, and a flexion contraction at the MP joint occurs, which is evident by prominent metacarpal heads.

Ulnar Deviation

Ulnar Drift

RA is the most common cause of ulnar deviation. The classic deformities associated with RA of the MP joints are ulnar drift, which is made up of *ulnar shift and ulnar deviation, and volar dislocation.* This is caused by stretching of MP capsule and ligamentous structures by the proliferation of the synovium, which loosens the collateral ligaments and decreases joint stability. Normally, in the flexed position, minimal lateral movement occurs at the MP joint, but, with increased laxity of the collateral ligaments, up to 45° of lateral deviation occurs in this position (Gordon 1998; Neumister 2004).

Wrists

de Quervain's tenosynovitis

Tenosynovitis of the common sheath of the abductor pollicis longus and extensor pollicis brevis tendons on the radial aspect of the wrist is a common painful and disabling condition. Pain is felt on the radial aspect of the wrist and may extend proximally into the forearm. It is usually caused by unusual or repeated use of the thumbs involving strain on the tendons.

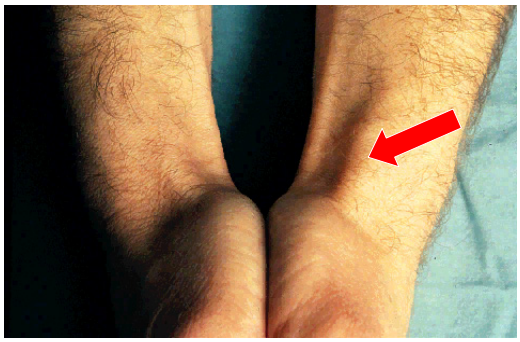

Figure 8. de Quervain's tenosynovitis (Gordon 1998).

Zigzag deformity

This is caused by disruption of the radioulnar joint with dorsal subluxation of the ulna (caput ulna) and rotation of the carpus on the distal radius with an ulnary translocated lunate are common. The combination of ulnar drift of the fingers and carpal rotation is known as a "zigzag" deformity. Shortening of the carpal height (noted on radiographs), due in part to cartilage loss, is seen with rotational deformities. Dorsal subluxation of the ulna may also lead to rupture of the extensor tendons of the little, ring, and long fingers because the end of the distal ulna may be roughened secondary to erosion of bone and may abrade the tendons as they move back and forth during normal hand function, This process is especially likely to lead to tendon rupture if there is associated tenosynovitis (Gordon 1998; O'Dell 2005; Neumister 2004).

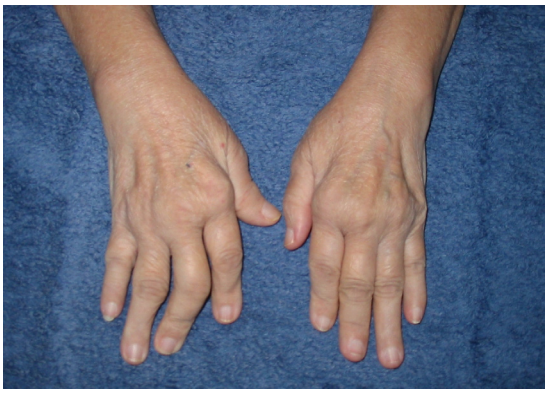

Figure 9. Zigzag deformity of the right hand (O'Dell 2005)

Entrapment neuropathy

Carpal tunnel syndrome

Entrapment neuropathy may result from synovitis about the flexor tendons. Entrapment of the median nerve as it passes through the carpal tunnel (carpal tunnel syndrome) leads to decreased sensation on the palmar aspect of the thumb index, and long fingers, and radial aspect of the ring finger, and later to weakness and atrophy of the muscles in the thenar eminence. These symptoms are often most prominent at night and frequently awaken patients from sleep. Patients generally report pain, numbness, and tingling in the hand. In RA patients, median nerve decompression should be considered before significant atrophy of the thenar eminence has occurred.

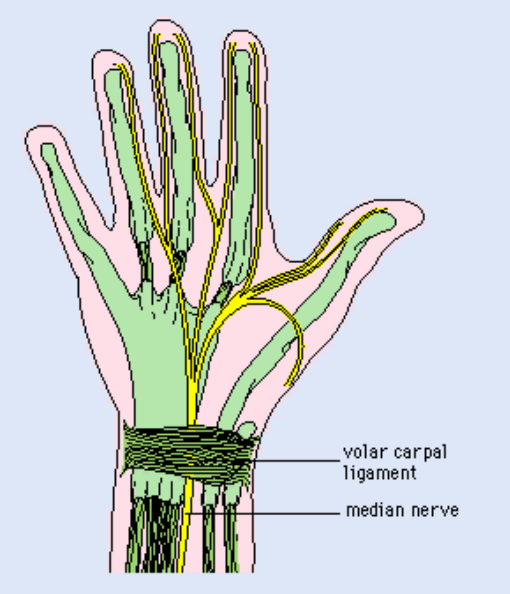

Figure 10. The Carpal tunnel and he course of median nerve (Gordon 1998)

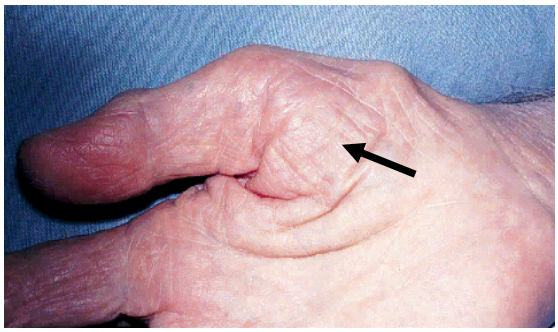

Figure 11. Atrophy of the muscles in the thenar eminence related to carpal tunnel syndrome (Gordon 1998).

Entrapment of the ulnar nerve

Less commonly, entrapment of the ulnar nerve at the wrist causes decreased sensation over the little finger and the ulnar aspect of the ring finger and decreased interosseous muscle strength and mass (Gordon 1998; O'Dell, 2005).

REFERENCES

Arnett, FC, Edworthy, SM & Bloch, DA 1988, 'The American Rheumatism Association 1987. Revised criteria for the classification of rheumatoid arthritis', *Arthritis Rheum*, vol. 1, pp. 315-320.

Choy, EHA & Panayi, GS 2001, 'Mechanisms of Disease: Cytokine pathways and joint inflammation in rheumatoid arthritis', *N Engl J Med,* vol. 344, no. 12, pp. 907-916.

Cutolo, M & Straub, R 2000, 'Recent aspects of gonadal hormone and neurotransmitter interactions with synovial and immune cells: implications in rheumatoid arthritis', *Ann Rheum Dis*, vol. 59, pp. 657-661.

Dinarello, CA & Moldawer, LL 2000, *Proinflammatory and anti Inflammatory cytokines in rheumatoid artrhritis*, Thousand Oaks, Amgen Inc., pp. 3-21.

Emery, P 2002, 'Evidence supporting the benefit of early intervention in rheumatoid arthritis', *J Rheumatol*, vol. 29, suppl. 66, pp. 3-8.

Goldring, SR 2000, **'**The final pathogenetic steps in focal bone erosions in rheumatoid arthritis', *Ann Rheum Dis*, vol. 59, pp. i72-i74.

Gordon, AD & Hastings, DE 1998, 'Rheumatoid arthritis. Clinical features of early, progressive and late disease' in JH Klippel & PA Dieppe (eds), *Rheumatology*, St. Louis Mosby Company, CD ROM.

Gordon, P, West, J, Jones, H & Gibson, T 2001, 'A 10 year prospective followup of patients with rheumatoid arthritis 1986-1996', *J Rheumatol*, vol. 28, pp. 2409-2415.

Hofbauer, LC & Heufelder, AE 2001, 'The role of osteoprotegerin in the and receptor activator of nuclear factor κB ligand in the pathogenesis and treatment rheumatoid arthritis', *Arthritis Rheum*, vol. 44, no. 2, pp. 253-259.

Jirholt, J, Lindqvist, AB & Holmdahl, R 2001, 'The genetics of rheumatoid arthritis and the need for animal models to find and understand the underlying genes', *Arthritis Res*, vol. 3, pp. 87-97.

Kalim, H 2000, 'Problems of rheumatic diseases in indonesia and the efforts to overcome'*, Scientific Meeting of Indonesian Rheumatology Association*, Jakarta 6-8 October, pp. 1-11 (in Indonesian).

McInnes, IB, Gracie, JA & Liew, FY 2001, 'Interleukin-18: A novel cytokine proinflammatory in rheumatoid arthhritis', *Arthritis Rheum*, vol. 44, no. 7, pp. 1481-1483.

Nanki, T & Lipsky, PE 2000, 'Cytokine, activation marker, and chemokine receptor expression by individual $CD4^+$ memory T cells in rheumatoid arthritis synovium', *Arthritis Res*, vol. 2, no. 5, pp. 415-429.

Neumeister, M, Nguyen, MD & Wilhelmi, BJ 2004, *Hand, Rheumatoid Hand*. e-Medicine. Retrieved from www.emedicine.com/plastic/topic475.htm

O'Dell, J 2005, 'Rheumatoid arthritis: the clinical picture' in WJ Koopman & LW Moreland (eds), *Arthritis and Allied Conditions, Textbook of Rheumatology*, 15th edn, William & Wilkins, Philadelphia, pp. 1165-1181.

Panayi, GS, Corrigall, VM & Ritzallis, C 2001, 'Pathogenesis of rheumatoid arthritis: the role of T cells and other beasts', *Rheum Dis Clin North Am*, vol. 27, pp. 317-334.

Scott, DL, Pugner, K, Kaarela, K, Doyle, DV, Woolf A, Holmes, J & Hieke, K 2000, 'The links between joint damage and disability in rheumatoid arthritis', *Rheumatology*, vol. 39, pp. 122-132.

Smolen, JS, Aletaha, D & Machold, KP 2005, 'Theurapeutic strategies in early rheumatoid arthritis', *Best Practice & Research Clinical Rheumatology*, vol. 19, no. 1, pp. 163-177.

Steiner, G, Tohidas-Akrad, M, Witzman G, Vesely, M, Studnicka-Benke A, Gal, A, Kunaver, M, Zenz, P & Smolen, JS 1999, 'Cytokine production by synovial T cells in rheumatoid arthritis', *Rheumatology*, vol. 38, pp. 202-213.

van Roon, JAG, Lafeber, FPJ & Bijlsma, JWJ 2001, 'Synergistic activity of interleukin-4 and interleukin 10 in suppression of inflammation and joint destruction', *Arthritis Rheum*, vol. 44, no. 1, pp. 3-12.

Wagner, U, Kaltenhäuser, S, Pierer, M, Seidel, W, Tröltzsch, M, Häntzschel, H, Kalden, JR & Wassmuth, R 2003, 'Prospective analysis of the impact of HLA-DR and -DQ on joint destruction in recent-onset rheumatoid arthritis', *Rheumatology*, vol. 42, pp. 553-562.