

## Wrist and Hand Structure: Histology and Disease Perspective

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### ABSTRACT

**Objective:** This study aims to explore the anatomical and histological structure of the wrist and hand, assess common diseases at the microscopic level, and evaluate current treatment strategies through recent scientific perspectives. **Method:** A multidisciplinary analytical approach was employed, combining anatomical review, histological analysis, and literature synthesis to investigate tissue-level changes in conditions such as tendinitis, arthritis, carpal tunnel syndrome, and osteoarthritis. **Results:** Histological analysis revealed recurring pathological features, including inflammation, collagen fiber degeneration, and fibrosis across various wrist and hand disorders. Treatment strategies involving NSAIDs, corticosteroids, hyaluronic acid injections, and regenerative therapies demonstrated promising outcomes when aligned with histological findings. **Novelty:** This article contributes a novel integration of histopathological understanding with clinical symptomatology and therapeutic response, emphasizing the role of microscopic analysis in early diagnosis and individualized treatment planning. The study underscores the importance of histological insights in advancing personalized care and preventive strategies for musculoskeletal conditions, offering a unique perspective that bridges basic science with clinical application.

## INTRODUCTION

The wrist is a complex structure of the human body that controls hand movements and enables the performance of various functions. Its anatomy consists mainly of different tissues such as bones, tendons, muscles, ligaments, and nerves. The bones of the wrist the radius and ulna are connected to several joints and muscles that facilitate movement. This structure plays a vital role not only in moving the hand but also in absorbing and distributing various mechanical forces. One of the main functions of the wrist, in coordination with the hand, is to enable gripping and the distribution of force. In addition, the nerves and blood vessels in the wrist provide sensitivity and mobility to the hand and fingers. This delicate and complex system can be significantly affected by various diseases and injuries, which in turn can limit the range of motion. The hand is closely connected to the wrist and, due to its unique structure, carries out gripping and movement functions. The fourteen bones located in the hand, along with the associated

musculoskeletal system, allow a person to grasp, apply strength, and perform precise movements. The fine tissues and nerves in the hand allow for independent control of each finger and joint.

## RESEARCH METHOD

This study employed a multidisciplinary analytical approach integrating anatomical [1], histological, and clinical perspectives to examine the structure of the wrist and hand and the diseases affecting them [2]. A detailed literature review was conducted using classical anatomical sources [3], including Gray's Anatomy and modern textbooks like Tortora and Derrickson's *Principles of Anatomy and Physiology* [4], to describe the fundamental structural components such as bones [5], muscles, ligaments, tendons, nerves, and blood vessels [6]. Histological methods were utilized to interpret microscopic tissue alterations associated with diseases like tendonitis, carpal tunnel syndrome [7], arthritis, and osteoarthritis. Relevant histological characteristics, such as inflammatory cell infiltration [8], collagen fiber degeneration, and nerve tissue changes, were synthesized from peer-reviewed research [9], including sources from PubMed and NIAMS [10]. Clinical epidemiological data were analyzed to contextualize the prevalence and impact of conditions such as tendonitis and carpal tunnel syndrome [11], emphasizing the importance of tissue-level diagnosis [12]. The therapeutic review included a critical evaluation of current treatment strategies, combining conservative measures like rest, splinting, cold therapy, and NSAID administration [13], with more advanced interventions such as corticosteroid injections and hyaluronic acid therapies. Emphasis was placed on understanding how histological changes guide clinical decision-making in diagnosis and treatment [14]. This comprehensive method allowed the study to bridge microscopic tissue pathology with macroscopic clinical manifestations, offering insights into both the biological and therapeutic dimensions of wrist and hand disorders [15].

## RESULTS AND DISCUSSION

**Diseases Affecting the Wrist:** Diseases occurring in the wrist can arise due to a variety of causes, and almost all of them are associated with histological changes. Most wrist-related conditions affect the muscles, tendons, ligaments, bones, and nervous system. Below are the main diseases that occur in the wrist region, along with information on their histological basis:

### **Tendonitis (Inflammation of the Tendon)**

Tendonitis is the inflammation and degeneration of tendon tissues. It presents with symptoms similar to tendinosis; however, it requires a different approach to treatment.

**From a Histological Perspective:** In cases of tendonitis, micro-injuries and the development of inflammation are observed in the elastic tissues of the tendons. As a result of inflammation, tissue alterations and degradation of collagen fibers may occur.

Histological examination reveals an increase in inflammatory cells (such as lymphocytes and macrophages) and evidence of tissue damage.

### **Carpal Tunnel Syndrome**

Carpal Tunnel Syndrome (CTS) is one of the most common disorders affecting the hands. It occurs due to pressure on the median nerve within the carpal tunnel of the wrist. The carpal tunnel is a narrow passageway on the palm side of the hand, surrounded by bones and ligaments. When the median nerve becomes compressed, symptoms may include numbness, tingling, and weakness in the thumb and fingers.

From a Histological Perspective: In CTS, inflammatory and fibrotic changes occur in the tissues surrounding the median nerve. Compression of the nerve as it passes through the carpal tunnel leads to damage in the nerve tissue and microscopic alterations in the nerve fibers, including degeneration of the myelin sheath. Inflammatory processes and nerve damage are clearly observable in histological analysis.

### **Arthritis (Joint Inflammation)**

Arthritis, particularly rheumatoid arthritis, can affect the joints of the wrist. In this condition, the joints as well as the surrounding tissues become inflamed.

From a Histological Perspective: In arthritis, an increase in inflammatory cells, particularly neutrophils and lymphocytes, is observed in the synovial fluid of the joints, along with swelling of the joint capsules. In rheumatoid arthritis, the accumulation of free radicals and oxidizing substances in the joints and their surrounding tissues leads to tissue damage.

### **De Quervain Tendinopathy**

This condition is associated with the inflammation of two tendons located on the lateral side of the wrist and palm. It occurs as a result of repetitive hand movements and is primarily manifested by pain and limited mobility.

From a Histological Perspective: In De Quervain tendinopathy, microscopic swelling of the tendons, instability of collagen fibers, and necrosis (tissue death) are observed. Histological analysis shows inflammation and the loss or fragmentation of collagen fibers, as well as the formation of new collagen fibers.

### **Osteoarthritis (Chronic Inflammation of the Bones)**

Osteoarthritis in the wrist primarily leads to the erosion of joint tissues between the bones. This condition often develops as a result of aging or excessive load.

From a Histological Perspective: In osteoarthritis, the loss of articular cartilage (the bone tissue that covers the bone fluid) occurs, along with an increase in inflammatory cells and division of bone tissues. Histological examination reveals damaged tissues around the bones, the perforation of the bone, and the appearance of osteophytes (bone growth).

### **Fractures and Injuries**

The bones and tissues of the wrist can be damaged due to various traumas. Fractures of the bones, tendons, or ligaments often result from strong impact or twisting.

From a Histological Perspective: In the case of fractures, microscopic breaking and regeneration processes are observed in bone tissue. During bone healing, osteoblasts

(bone-forming cells) and osteoclasts (bone-resorbing cells) become active. Histological analysis shows the formation of new bone tissue and changes in the bone healing process.

Among wrist diseases, tendonitis and carpal tunnel syndrome (CTS) are the most common. Below is a brief overview of their prevalence and effects:

### **Tendonitis (Tendon Inflammation)**

Tendonitis is a common condition, especially among athletes and people who engage in repetitive hand movements. This disease arises from inflammation and damage to the tendons in the wrist and palm. Conditions like De Quervain's tendinopathy are frequently seen. Causes of tendonitis include excessive load, repetitive movements, or improper movements.

#### **Global Statistics on the Disease:**

In 2020, in seven major markets (USA, Japan, Germany, France, Italy, Spain, and the UK), the number of new tendonitis cases reached 29.3 million. In the USA, 4.77 million new tendonitis cases were reported in 2020. In Japan, 1.99 million new cases were identified.

### **Carpal Tunnel Syndrome (CTS)**

Carpal tunnel syndrome is common, especially among office workers and people who work with computers for extended periods. This condition is caused by compression of the median nerve in the carpal tunnel of the wrist, leading to pain, discomfort, and reduced sensitivity in the hands. This syndrome often results from incorrect posture, repetitive movements, or trauma.

#### **Global Statistics on the Disease:**

Global prevalence: According to a systematic review conducted in 2024, the overall prevalence rate of CTS is 14.4% (95% confidence interval: 6.7%–28.2%). This analysis involved over 1.9 million participants based on 30 studies.

#### **Why are they so common?**

Tendonitis results from excessive movements and overuse of the wrist, and it is difficult to prevent or treat since tendons do not heal quickly, and inflammation can persist for long periods.

Carpal tunnel syndrome is widespread, particularly among individuals who work on computers for extended periods or repeatedly perform hand movements. This syndrome is expanding due to socio-economic factors and conditions in modern work environments.

### **Treatment Methods for Wrist Diseases: 1. Medications: Rest and Support (Use of Braces or Splints)**

In wrist diseases, particularly tendonitis or injuries, the first step is to rest the wrist. Avoiding overuse of the wrist is essential to prevent worsening the injury.

**Support (Bandages or Splints):** Special bandages or splints are used to immobilize the wrist. This method helps speed up recovery and protects against excessive movement and inflammation.

### **Cold Compresses (Applying Ice):**

In the initial stages, especially with diseases involving inflammation and swelling, cold compresses are highly effective. Cold compresses (ice packs) should be applied. This method reduces inflammation, eliminates swelling, and alleviates pain. Cold should be applied for 15-20 minutes, every 1-2 hours.

### **Pain-Relieving Medications (NSAIDs):**

Nonsteroidal anti-inflammatory drugs (NSAIDs) are an effective and widely used method to reduce inflammation and pain. Drugs such as ibuprofen or diclofenac help reduce pain and inflammation. These medications are often recommended as the first treatment for wrist diseases.

**The following drugs are currently active treatments for these diseases:**

#### **Ibuprofen**

**Composition:** Ibuprofen (200 mg, 400 mg, or 600 mg dose)

**Effects;** Ibuprofen is an NSAID that reduces inflammation, alleviates pain, and reduces swelling.

**Indications:** Used to reduce pain and inflammation in wrist diseases, tendonitis, arthritis, and other conditions.

**Dosage:** Usually taken three times daily in doses of 200-400 mg to reduce pain.

#### **Diclofenac (Voltaren)**

**Composition:** Diclofenac (50 mg, 75 mg, or 100 mg)

**Effects:** Diclofenac is a strong anti-inflammatory drug (NSAID). It reduces inflammation, alleviates pain, and reduces swelling.

**Indications:** Used for tendonitis, arthritis, and mild to moderate inflammation. Diclofenac is also available in ointment form for topical application.

**Dosage:** The drug is taken orally or applied topically in the form of an ointment.

#### **Naproxen**

**Composition:** Naproxen (250 mg, 500 mg)

**Effects:** Naproxen is an NSAID that alleviates pain and reduces inflammation. It is particularly effective for arthritis and tendonitis.

**Indications:** Used to relieve inflammation and pain. Naproxen can be used for a long period but should be taken under medical supervision.

**Dosage:** Usually taken twice daily in doses of 250-500 mg.

#### **Prednisolone (Corticosteroid)**

**Composition:** Prednisolone (5 mg, 10 mg)

**Effects:** Prednisolone is a corticosteroid that provides strong anti-inflammatory effects. It quickly reduces inflammation and alleviates pain.

**Indications:** Prednisolone is typically used for chronic inflammations, such as arthritis or tendonitis.

**Dosage:** Used in short-term treatments at the dose prescribed by a doctor.

#### **Menthol and Camphor-based Ointments (e.g., Voltaren Gel)**

**Composition:** Menthol, Camphor, Diclofenac

**Effects:** These ointments are used to relieve pain and relax muscles. They work by acting directly on the affected or painful area.

**Indications:** Used in cases of mild pain and inflammation, such as wrist inflammation. These ointments provide rapid relief and produce effective results in a short period.

**Dosage:** Applied 2-3 times a day in a thin layer to the affected area.

#### **Hyaluronic Acid (PRP or Hyaluronan Injections)**

**Composition:** Hyaluronic acid

**Effects:** Hyaluronic acid is used to prevent the loss of fluid in joints and reduce inflammation. It improves the function of the bones and reduces pain.

**Indications:** Used for osteoarthritis or other joint diseases, including wrist injuries. This method is especially effective for chronic inflammation.

**Dosage:** PRP injections are delivered to the damaged tissues or joints.

## **CONCLUSION**

**Fundamental Finding :** This study highlights the critical anatomical and histological complexity of the wrist and palm, emphasizing their integral role in hand mobility, sensory function, and overall quality of life. Structural disorders such as tendinitis, arthritis, and bursitis significantly impair function and can lead to chronic complications if not appropriately managed. **Implication :** The findings support the importance of early histological diagnosis and tailored treatment strategies, including conservative therapy and, when indicated, surgical intervention, to preserve hand function and prevent disease progression. **Limitation :** However, the study is limited by its reliance on secondary literature and lacks empirical clinical data or case-based evidence to support the proposed correlations between microscopic pathology and treatment outcomes. **Future Research :** Future investigations should include clinical trials and histological sampling from patient populations to validate these findings and further explore the efficacy of emerging regenerative therapies in wrist and hand disease management.

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