The distal end of the radius is shaped as a funnel mainly made of cancellous bone.

The ulna is straight, while the radius is shaped as a bow or a modified "S".

Radius and ulna are connected at both ends by a bicondylar pivot type joint. Like the knee joint, there are two condyles in the forearm.
but unlike the knee, in the forearm each bone has a condyle.

Forearm function

Humero-ulnar joint flexion/extension

Radio-ulnar joint pronation/supination

In 1981, Palmer and Werner introduced the term triangular fibrocartilage complex (TFCC) to describe the ligamentous and cartilaginous structures that suspends the Distal radius and ulnar carpus from the distal ulna.
The dorsopalmar stability of the distal radioulnar joint.

Stuart PR, Berger RA, Linscheid RL, An KN.
Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA.

Sixteen fresh-frozen adult human cadaveric upper extremities were used in a biomechanical analysis of distal radioulnar joint (DRUJ) stability. The relative contributions to stability of the surrounding anatomic structures presumed to stabilize the joint were analyzed with respect to forearm rotation and wrist flexion and extension using a purpose-built 4-axis materials testing machine. The dominant structures stabilizing the DRUJ were the ligamentous components of the triangular fibrocartilage complex proper. The major constraint to dorsal translation of the distal ulna relative to the radius is the palmar radioulnar ligament. Dorsal translation of the distal ulna relative to the radius is constrained primarily by the dorsal radioulnar ligament, with secondary constraint provided by the palmar radioulnar ligament and interosseous membrane. The ulnocarpal ligaments and extensor carpi ulnaris subsheath did not contribute significantly to DRUJ stability. Approximately 20% of the DRUJ constraint was due to the interosseous membrane. These relationships were consistent regardless of wrist position or degree of forearm rotation.
Hall apparatus

10 cadaver hands

Measurements through full range of motion

Findings:
Dorsal lig. Tight in Pron.
Palmar lig. Tight is Sup.

Acosta, Hnat & Scheker
J Hand Surg Br 1993; 18: 502–505

The Distal Radio Ulnar Joint work as an eccentric wheel.
When the points of origin and insertion get far apart the ligament gets tight.
Triangular fibrocartilage complex lesions: a classification.
Palmer AK
Department of Orthopaedic Surgery, SUNY Health Science Center, Syracuse NY.

Abstract
Based on anatomic and biomechanical studies and review of our clinical experience of the past 10 years, a classification of injuries to the triangular fibrocartilage complex is presented. This classification is based on the clinical examination, routine x-ray films, wrist arthrograms, wrist arthroscopy, and wrist arthrotomy. The classification recognizes both traumatic and degenerative lesions. Traumatic lesions are classified according to their location. Degenerative lesions are classified by the location and severity of degenerative changes of the triangular fibrocartilage complex, ulnar head, ulnocarpal bones and lunotriquetral ligament.

Triangular fibrocartilage tears
Cooney WP, Linscheid RL, Dobyns JH
Department of Orthopedics, Mayo Clinic, Rochester, MN.

From a series of 56 patients with triangular fibrocartilage injury, 33 patients with peripheral rim tears not associated with instability of the distal radioulnar joint were identified by arthrography or arthroscopy. Open repair of the peripheral tear produced 11 excellent, 15 good, 6 fair, and 1 poor result (grading based on a Mayo modified Green-O'Brien wrist score). Ulnar recession improved surgical exposure and corrected ulnar variance in 11 patients. A dorsal approach for repair of radial and anterior peripheral rim tears was used in 28 patients. Repair of peripheral tears restored functional integrity to the triangular fibrocartilage, and good to excellent results are reported in 26 of the patients treated.
On the basis of a study of 180 wrist joints from 100 fresh cadavers of individuals ranging in age from fetuses to 94 years.

It appears that disc perforation is degenerative and age-related: thus there were no perforations in the first two decades of life; in the third there were 7.6%, in the fourth 18.1%, in the fifth 40.0%, in the sixth 42.8%, and in the over sixties 53.1%.

Age changes in the triangular fibrocartilage of the wrist joint.
Cooney et al. Traumatic tear starts in the periphery

Histologic sections of the TFC reveal vascularity in the outer 15% to 20% of the disc, and the rest is avascular. On the basis of these findings, we feel that tears of the TFC in its vascular zone have the potential to heal if repaired and those in the central avascular zone do not have this potential.

Arterial anatomy of the triangular fibrocartilage of the wrist and its surgical significance.
Instability of the distal radio ulnar joint is defined as an abnormal path of articular contact occurring during or at the end of the range of motion. This is due to either alteration in joint surface orientation or by deficiencies in the main restricting ligaments, or by both.

Bruckner, Alexander, Lichtman 1996.

Distal Radio-Ulnar Joint Instability

Definition:
...the inability to maintain a normal anatomical relationship of the radius to the ulna under physiological loading and within the normal range of motion.

Mr. John Stanley, FRCS
Chairman of the
Committee on Distal Radio-Ulnar Joint Arthroplasty IFSSH
Sydney, Australia 2007

Cause of instability

Trauma
  Closed
  Open

Inflammatory disease
  Rheumatoid arthritis

Congenital abnormalities
  Ehlers-Danlos syndrome
  Madelung deformity
**Cause of instability**

- Ligament injury, including ulnar styloid fractures
- Intra-articular abnormalities of DRUJ
- Extra-articular skeletal deformities
- Combinations of these

**Traumatic Ligament Injury**

- Fall on outstretched, pronated hand
- Acute rotational injury
- Axial load or distraction injury
Etiology

- Ligament injury.
  - Detachment from the radius
  - Detachment from the ulna
  - Intra-ligament injury
- Ulnar styloid fractures

No all styloid fractures seen in x-rays are unstable.
Clinical evaluation is needed.
Most styloid fractures do not need Fixation.

College football quarterback with painful radial and ulnar sided wrist.
Injured one week before this X-rays.
Unstable DRUJ and painful over snuff box.
Both fractures fixed on Dec 4 2012 and he played and won the Sugar Bowl on January 2 2013.

Treatment of Triangular Fibrocartilage Injuries

- Detachment from the radius
- Detachment from the ulna
- Intra-ligament rupture
Treatment of Triangular Fibrocartilage Injuries

Above elbow cast in neutral position for fresh injuries

Arthroscopic repair of early lesions

Ligament reconstruction of late lesions
  Dorsal, palmar or both

Treatment Options for Distal Radioulnar Joint Instability

<table>
<thead>
<tr>
<th>Type of Instability</th>
<th>Treatment Options</th>
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<tbody>
<tr>
<td>Acute</td>
<td></td>
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<tr>
<td>Simple</td>
<td>Reduction and fixation</td>
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<tr>
<td>Complex</td>
<td>Arthroscopic repair</td>
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<tr>
<td>Chronic</td>
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<td>Arthroscopic versus open repair</td>
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<td>Extra-articular</td>
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<tr>
<td></td>
<td>Intra-articular</td>
</tr>
</tbody>
</table>

Extra anatomical ligament reconstruction of the triangular fibrocartilage

- 1930: Mothis
- 1930: Lawler
- 1932: Colossi
- 1932: Sauve
- 1934: Regan, JF and Bicket, VH
- 1933: Lieboll

Direct repair of triangular fibrocartilage

- 1925: Gibson, A
- 1925: Wilson, FD and Cochrane, W

Tenodesis between proximal part of ulna and carpus

- 1939: Taylor, J.
- 1944: Bunnell, S
Chronic instability of the distal radioulnar joint
Adams BD and Lawler EC

Most recent extra-anatomical reconstruction

Specimen preparation
Dr. Makoto Tamai
Former Fellow at CMKI

Reconstructed ligaments need to be not longer and running in the same direction as the original

Dorsal Ligament

Palmar Ligament
Our first surgery performed for dorsal instability of the DRUJ modifying Hui and Linscheid procedure in 1988.
At four years post op the patient had no pain, full range of motion and able to lift weights.
Clinical Findings in 31 patients from 1988 to 1991

- Pain: 31
- Inflammation: 5
- Clicking: 4
- Paraesthesia: 1

The idea is to bring collagen to the damaged ligament while tightening it to its original length.

The Unstable DRUJ

Herbert/Bowers II

- Ulna minus
  - Ulnar shortening
    - Unstable
    - Stable
  - Ulna neutral or plus
    - Ligament Reconstruction
      - STOP

Bowers, WH

Reconstruction of the dorsal ligament of the triangular fibro cartilage
The orientation of the pin is Dorso-palmar, ulna-radial and Distal to proximal to accommodate The shape of the distal radius.
The technique can be adapted for palmar ligament reconstruction or both ligaments together.
Both Ligaments Reconstruction

25 year old volleyball player with palmar and dorsal instability of the DRUJ.
Ligaments heal through a distinct sequence of cellular events that occur through three consecutive phases: the acute inflammatory phase, the proliferative or regenerative phase, and the tissue remodeling phase. The whole process can occur over months, and despite advances in therapeutics, many ligaments do not regain their normal tensile strength.

Ligament Injury and Healing: An Overview of Current Clinical Concepts
Ross A. Hauser, MD & Erin E. Dolan, RN

Lundborg demonstrated the capacity of tendons to heal if bathed by synovial fluid.

Experimental intrinsic healing of flexor tendons based upon synovial fluid nutrition
G. Lundborg, M.D., Ph.D. F. Rank, M.D.
The Journal of Hand Surgery
January 1978,

Madrid, Spain
Thank you for your attention!!