

Human ligaments classification: a new proposal

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A high concern exists among physicians about surgically important ligaments such as cruciate and collateral ligaments of the knee, patellar ligament, tibiofibular syndesmosis, collateral ligaments of the ankle, and coracoclavicular ligament. However, the classification of the ligaments is insufficient in the literature, due to their origin from connective tissue. A new classification is proposed, based on various parameters such as the macroscopic and microscopic features, the function and the nature of their attachment areas. (Folia Morphol 2011; 70, 2: 61–67)

Key words: ligaments, classification, Nomina Anatomica

INTRODUCTION

There was always some confusion concerning the classification of ligaments of the human body, presumably due to their origin from the connective tissue that is considered a low quality tissue compared to others. Moreover, orthopaedists are focused only on surgically important ligaments. For these reasons there is an absence of a well-designated classification system that subdivides the ligaments into subgroups according to various parameters such as their relation to the joint capsule, their morphology, histological structure, and the nature of the original anatomical structure.

DISCUSSION

In gross anatomy a ligament is considered an anatomical structure interconnecting two anatomical elements. We believe that the ligaments should be subdivided into *true* and *false ligaments*. *True ligaments* should be defined as those which are found in the structures of the musculoskeletal system and they should be named “motor or articular ligaments”, while *false ligaments* should be defined as those found apart from the musculoskeletal system. Pansky named the peritoneal folds “false ligaments” [8], while Healey et al. depicted the peritoneal reflections as “false ligaments” and certain thickenings of the subperitoneal

connective tissue surrounding neurovascular bundles or ducts as “true ligaments” [4].

The “false ligaments”, could be subdivided in the following categories:

- a) *Splachnic ligaments*, which are further subdivided into “peritoneal” (e.g. phrenocolic ligament), “pericardiac” (e.g. sternopericardial ligaments), “pleural” (e.g. suprapleural membrane), and “pure splachnic ligaments” (e.g. hyoglossus membrane and phrenoesophageal ligament).
- b) *Neuronic ligaments* that interconnect either symmetrical areas of the two halves of the central nervous system and consist of nerve fibres and bodies of neurons (e.g. corpus callosum, fornix, anterior and posterior cerebral commissure, and white and grey commissure of spinal cord), which represent thickenings of the dura mater of the spinal cord contributing to its support (e.g. dentate and coccygeal ligament).
- c) *Cutaneous ligaments* that are skin folds (e.g. anterior and posterior commissure of large labia of the pudendum).
- d) *Arterial ligaments* that form after transformation of embryonic vessels into connective tissue (e.g. ligament of Botallo, lateral umbilical ligaments, teres ligament of the liver).

Ligaments passing over joints or located adjacent to them are called "motor or articular ligaments". It is difficult to determine the total number of "motor ligaments", because of the inconsistent existence of most of them (e.g. the intra-articular sternocostal ligaments are usually located at the second sternocostal joint, the costotransverse ligaments of the eleventh and twelfth ribs are rudimentary, while the oblique chord may be duplicated or even absent). Furthermore, there are numerous bundles of connective tissue (ligaments) not listed in *Nomina Anatomica* [19]. We consider that it is more convenient to record the total number of motor ligaments which are found in *Nomina Anatomica*, and their number was estimated at approximately 745.

In classic anatomical textbooks, the "motor ligaments" are classified as:

A) Accessory ligaments. These ligaments are local thickenings of the fibrous capsule and contribute to the articular surface restraining. These ligaments are flexible enough to allow normal joint movement. Simultaneously, these ligaments are inflexible and they can be ruptured in extreme distension. In our opinion, the "accessory ligaments" may be further subdivided into extracapsular and intracapsular.

1) *Extracapsular ligaments.* There are two groups:

a) *Periarticular or distal extracapsular ligaments.*

These ligaments are cylindrical or strip-like thickenings of the fibrous capsule that in some way have been detached from the capsule, migrating into adjacent areas (e.g. coracohumeral ligament).

b) *Proximal extracapsular ligaments.* These ligaments are usually band-like thicknesses of the fibrous capsule, which are distinct from the fibrous capsule and are attached in close proximity to sites of capsule attachment (e.g. medial collateral ligament of the knee). Rogers subdivided the extracapsular ligaments into *extrinsic ligaments* that are not in contact with the joint capsule and *intrinsic ligaments* that are in contact with the capsule and are capsular thickenings [11]. In the 7th edition of *Nomina Anatomica* the ligaments are classified as: "Extracapsular ligaments" which are far apart from the capsule, "capsular ligaments" that are thickenings of the fibrous capsule, and "intracapsular ligaments" that are found interior to the joint capsule [19].

2) *Intracapsular ligaments.* In our opinion, these ligaments are divided into the following sub-categories:

a) *Intracapsular extra-articular ligaments.* These ligaments line the inner surface of the fibrous capsule without extending into the articular space. This group includes the three glenohumeral ligaments (superior, middle, inferior), which become most prominent when viewed from inside.

b) *Intracapsular intra-articular ligaments.* These ligaments are located within the articular cavity and are classified as follows: i) *Totally intra-articular ligaments*, totally surrounded by the articular synovial membrane. This group includes the round ligament of the femoral head, the intra-articular ligaments of the head of the ribs, and the intra-articular sternocostal ligaments. ii) *Partial intra-articular ligaments*, surrounded partially by articular synovial membrane, such as the cruciate ligaments.

B) Interosseous ligaments. These are short and strong ligaments, covering the narrow spaces formed between the opposite surfaces of adjacent bones, thus greatly reducing their mobility. These ligaments are located in synovial joints (wrist and tarsal joints), synarthroses (inferior tibiofibular syndesmosis, interosseal membranes of the forearm and tibia), and amphiarthroses (sacroiliac joint).

C) Independent ligaments. These ligaments, may be subdivided into the following two categories:

1) *Motor ligaments not participating in joint function.* These ligaments belong mainly to the periarticular ligaments (e.g. lumbocostal ligaments), the interosseous ligaments (e.g. interspinal ligaments), and the syndesmoses (e.g. interosseous membrane of forearm). The most prominent feature of these ligaments is that they do not participate, or participate to a lesser extent, in the movements of the neighbouring joint. The term "independent ligament" is used with respect to the joint capsule, not the joint function [3, 11].

2) *Ligaments forming fibro-osseal foramina or obstructing foramina.* These ligaments are subdivided into two categories:

a) *Proper ligaments* that connect two different areas of the same bone (usually bridge bony notches). This category includes the thyroid membrane, the inguinal ligament, the iliopectineal ligament, the superior and inferior transverse ligaments of the scapula, the transverse ligament of the acetabulum, the trans-

verse humeral ligament, the transverse ligament of the atlas, and the pterygospinous ligament. It is possible for a "proper ligament" to participate in the formation and function of a synovial joint, like the transverse ligament of the atlas and the acetabulum.

- b) *Ligaments interconnecting two or more bones.* These ligaments are extended between two or more bones, bridging various bony notches, thus transforming them into foramina or canals containing vessels and nerves. Examples of this category include the transverse ligament of the wrist joint, the ischiospinal and ischiotuberal ligaments, the posterior atlanto-occipital membrane, and the transverse perineal ligament.

Classification of the motor ligaments according to their morphology

According to their shape the "motor ligaments" are classified as follows:

- a) *Band-like ligaments:* Most "motor ligaments" belong here (e.g. lateral collateral ligament of the knee joint).
- b) *Cylindrical ligaments* (e.g. teres ligament of the femoral head).
- c) *Quadrangular ligaments:* These ligaments may be confused with the band-like ligaments; in band-like ligaments one dimension is larger than the other (e.g. sternoclavicular ligaments).
- d) *Triangular ligaments* (e.g. deltoid ligament of the ankle joint).
- e) *Trapezoid ligaments* (e.g. trapezoid ligament of the acromioclavicular joint).
- f) *Rhomboid ligaments* (e.g. costoclavicular ligament).
- g) *Conoid ligaments* (e.g. conoid ligament of the acromioclavicular joint).
- h) *Radiate ligaments* (e.g. radiate sternocostal ligaments).
- i) *Bifurcated ligaments,* are bifurcated to small ligamentous bands (e.g. lateral collateral ligament of the elbow joint).
- j) *Annular ligaments,* which are circular (e.g. annular ligament of the radius).
- k) *Cruciate ligaments,* that correspond to ligaments from which perpendicular fibrous bands arise forming a cross-like shape (e.g. cruciate ligament of the atlas).
- l) *Ellipsoid or circular ligaments* are usually membranes which obliterate foramina (e.g. thyroid membrane).
- m) *Arcuate ligaments* (e.g. arcuate popliteal ligament).

The distinction between ligaments and membranes

There is a great deal of confusion in anatomical literature regarding the determination of an anatomical structure either as a ligament or as a membrane. The following report of the famous Canadian anatomist J. Grant is characteristic "...this structure is a membrane, called cricothyroid ligament" [1]. Searching for the "motor membranes", referring to the last edition of *Nomina Anatomica* [19], we estimated there to be 34 in number. The following criteria have been established in the present work in order to classify a "ligamentous structure" as a membrane: 1) A thin and broad lamina of connective tissue. 2) Covering the interosseal spaces, in which one dimension is longer than the other. 3) Obstruction of a circular or oval foramen by a lamina of connective tissue. 4) Exclusion of the various above-mentioned "morphological" types of ligaments with the exception of oval and a few quadrangular ligaments. At this point it is worthwhile reporting that both the flava ligaments and the nuchal ligaments are membranes and not ligaments.

Functions of ligaments

Despite the great interest of anatomists and surgeons regarding ligament functions, limited attention has been paid in classical anatomical textbooks regarding this issue. The chapters concerning such an issue are, according to our considerations, inadequately organised and designated [1, 3, 6, 7, 12, 20]. Here we attempt to provide a more organised classification of the ligament functions.

- a) *Joint capsule reinforcement,* resulting in greater stability of articular surfaces. This function is mostly performed by "accessory ligaments". The following ligaments beyond their "reinforcement action" appear to have purely "supportive action" as well: the annular ligament of the radius, the intra-articular ligaments of the heads of the ribs, the intra-articular sternocostal ligaments, the teres ligament of the femoral head, the cruciate ligaments, Lisfranc's ligament, and the interosseal membranes of the forearm and tibia.
- b) *Reduction of the extreme mobility of articulating bones in synovial joints* (e.g. the anterior cruciate ligament prevents the extreme anterior displacement of the tibia in the knee joint).
- c) *Maintenance of the track of movement in synovial joints* (e.g. the collateral ligaments in the elbow joint and in the phalangophalangeal joints restrain the

- movement occurring around the joints securing the movement around the transverse axis of the joint).
- d) *Saving of muscular energy* (e.g. the anterior ligaments of the hip joint, which stretch passively during pelvis extension, maintaining the body weight, thus reducing the expended energy of the corresponding muscles). This group includes the nuchal ligament and the flavae ligaments, which save "muscular energy" due to their elastic fibres. These ligaments reveal their "muscular energy" during vertebral column extension.
 - e) *Attachment area for the muscles*. Typical examples are the nuchal ligament, the interossei membranes of the forearm and the tibia, and the stylohyoid ligament [6].
 - f) *Transmission of muscular energy* an example being the case of the interosseous membrane of the forearm and the thyrohyoid membrane [16].
 - g) *Harmonisation and control of mobility of the connected anatomical structures*, as happens in the case of the transverse ligament of the knee joint, the deep portion of the medial collateral ligament of the knee joint, the anterior and posterior meniscofemoral ligaments, and the interclavicular ligament.
 - h) *Protection of the adjacent structures*, as occurs in the case of the intervertebral discs which are protected by the posterior longitudinal ligament, the radiate ligament, and the intra-articular ligament of the head of the rib. Similarly, the spinal cord is protected (from the dens of axis in case of fracture) by the cruciate ligament, while the flexor tendons are protected (reduce of friction) from the underneath located palmar ligaments of the metacarpophalangeal and phalangophalangeal joints [3]. Finally, the subclavian vessels and the brachial plexus are protected from the stronger (compared to the anterior) posterior sternoclavicular ligament, and the heart is protected from the stronger (compared to the anterior) posterior sternal membrane [12].
 - i) *Support of tendons track*, as happens in the case of the retinacular ligaments of the wrist and ankle joints, the transverse humeral ligament, the deep transverse metacarpal ligaments, and the short and long vincula of the flexor tendons of digits.
 - j) *Formation of foramina, canals, or spaces* for the passage of vessels and/or nerves. That is achieved not only with the presence of the "proper ligaments" but with the presence of other "accessory ligaments" as well, such as the sphenomandibular ligament that creates (with the mandibular condyle) a space for the passage of the maxillary artery and the poste-

rior atlanto-occipital membrane that forms (with the groove for the vertebral artery) a foramen for the passage of that artery.

- k) *Carrier of a nutrient artery for an articulated bone* such as the teres ligament of the femoral head (that contains the acetabular artery for the vascular supply of the femoral head) and the scapholunate ligaments (that contain arteries for the vascular supply of the lunate).
- l) *Diffusion of the articular fluid in articular surfaces*, as happens with the intra-articular ligaments and especially with the teres ligament of the femoral head [14].

Classification based on ligament histological structure

- a) *Collagen fibres*. The majority of ligaments and especially those of the musculoskeletal system consist of dense fibrous connective tissue. This fact makes these ligaments soft, inelastic and flexible. Only if they are subject to continuous tension may the collagen fibres be lengthened. Their direction, however, in the joint fibrous capsule and capsular ligaments is such that inhibition of collagen fibre distension is possible. Exceptions are the sacroiliac ligaments and the intervertebral discs that lie under continuous bodyweight tension.
- b) *Collagen and elastic fibres*. In this group of ligaments the elastic fibres dominate providing the ligaments with an ability of elastic restoration to the initial length after distension. These ligaments are yellowish, a fact that explains the term "ligamenta flava" which are located between the vertebral arches. Other examples of "elastic ligaments" belonging to the group of "splanchnic ligaments" are the following: the cricothyroid ligament or elastic cone, the posterior cricoarytenoid ligament, the ligaments of tympanic ossicles [6], and the thyroepiglottic and the hyoepiglottic ligament [20].
- c) *Collagen and smooth muscular fibres*. This group of ligaments includes mainly the "splanchnic ligaments", such as the teres ligament of the uterus that contains smooth muscular fibres derived from the outer and middle layers of the muscular coat of the uterus, the proper ligament of the ovary, and the cremaster ligament-muscle of the duodenum.
- d) *Collagen and striated muscular fibres*. These ligaments are also splanchnic ligaments. Basic representatives of the category include the median cremaster ligament of the pharynx and the cremaster ligament of the duodenum.

- e) *Fatty tissue*. This group includes ligaments that contain either lobuli of fatty tissue or organised fatty masses as fat pads. The first sub-group includes the interosseous sacroiliac ligament, while the second sub-group the fat pad of the larynx.
- f) *Bursa elements*. This category, also, includes the “splachnic ligaments”, such as the thyrohyoid membrane in which the infrahyoid bursa is enclosed. However, a “motor ligament”, the costoclavicular ligament, also belongs to that category. An interposing bursa is presented between the two component layers of that ligament [2].
- g) *Collagen fibres and cartilaginous elements*. This group includes all ligaments consisting of collagen fibres and cartilaginous elements, which form an articular cartilage in contact with a bony surface. Examples are the transverse ligament of the atlas, the annular ligament of the radius, the plantar calcaneonavicular ligament, the interosseal ligaments of the upper row of carpal bones, and the annular ligament of the stapedius.

Classification concerning origins from remnant or atrophic organs

- a) *Apical or cremaster ligament of the atlas*. This ligament, which arises from the tip of the axis dens and is inserted into the middle third of the anterior border of magnum foramen, is either a remnant of an intervertebral disc or a remnant of a whole vertebra called the pre-axis. This is supported by the fact that this ligament is crossed by notochords and in its middle portion cartilaginous elements are found. These elements are thought to be an intervertebral disc remnant.
- b) *External internal intercostal membranes*. These membranes represent the anterior edge of the external intercostal muscles and the posterior edge of the internal intercostal muscles, correspondingly, that have become atrophic.
- c) *Preurethral ligament*. This ligament is considered to be a remnant of the ischiopubic muscle.
- d) *Ligament of the coccyx*. This ligament is considered to be a remnant anatomical structure from the phylogenetic development [5].
- e) *Ligamentum teres of the femoral head*. This is considered either to be a remnant of the pubofemoral muscle, which in reptiles is located outside the joint cavity [15], or a remnant of the pectineus muscle [13].
- f) *Intertransverse ligaments*. These ligaments are considered as atrophic portions of the intertransverse muscles [9].
- g) *Interclavicular ligament*. This ligament is considered to be a homologous structure with the wish-bones of birds [1].

Classification according to original anatomical structure

- a) *Capsular ligaments*. This category includes the majority of the ligaments of the musculoskeletal system. These ligaments are thickenings of the fibrous capsule making it strong enough to better stabilise the articular surfaces. These ligaments, which are inelastic and inflexible and can rupture easily on great distension, are called “accessory ligaments” [7].
- b) *Bursal ligaments*. Some retinacular ligaments, such as the dorsal ligament of the wrist joint and the lacinate ligament, are expansions of the underlying fibrous tendon sheath [15].
- c) *Tendinous ligaments*. Some ligaments are formed by the tendinous fibre expansions of adjacent muscles. Basic representatives of that group are the following ligaments: 1) *Patellar ligament*. This ligament is an expansion of the tendon of the quadriceps femoris muscle. 2) *Retinacular ligaments of the patella*. Similarly, these bearing ligaments of the patella are formed by expansions of the quadriceps tendon. 3) *Transverse humeral ligament*. This ligament, which transforms the bicipital groove into a fibrous canal, is formed by the convergence and fusion of the tendinous fibres of the subscapular muscle or, in the rare cases in which this muscle is absent, the transverse humeral ligament is constituted from the tendinous fibres of the latissimus dorsi and major pectoral muscle [14]. It has been suggested that the transverse humeral ligament constitutes a capsular thickness [6]. 4) *Coracohumeral ligament*. This is thought to be an expansion of the tendon of the minor pectoral muscle [14].
- d) *Periosteal ligaments*. These ligaments are thickenings of the periosteum. Typical examples of such ligaments are the anterior and posterior pubic ligament formed by the periosteum of the pubic bones, and the lacunar ligament, which is a thickening of the pectineal periosteum [10].
- e) *Fascial ligaments*. These ligaments are thickenings of the fascia, as occurs in the case of the oblique chord that is thought to be a thickening of the supinator fascia [1]. Similarly, the retinacular ligaments of the wrist and ankle joint are thickenings of the fascia of the forearm and tibia or parts of the intermuscular septa, as occurs in the case of the nuchal ligament.

Classification based on the number of joints which a ligament passes through

- a) *Ligaments passing over one joint.* The majority of the "motor ligaments" belong to this group.
- b) *Ligaments passing over two joints.* This group includes the following 15 ligaments: the lateral collateral ligament of the knee joint (knee and proximal tibiofibular joint), the calcaneotibial ligament (ankle and subtalar joint), the calcaneofibular ligament (ankle and subtalar joint), the palmar and dorsal radiocarpal ligament (wrist and midcarpal joint), the palmar ulnocarpal ligament (wrist and midcarpal joint), the interclavicular ligament (both the sternoclavicular joints), the lateral collateral ligament of the elbow joint (humeroradial and proximal radioulnar joint), the apical ligament of the atlas (atlantoccipital and atlantoaxial joint), the alar ligaments (atlantoccipital and atlantoaxial joint), the cruciate ligament of the atlas (atlanto-occipital and atlantoaxial joint), the tectorial membrane (atlanto-occipital and atlantoaxial joint), the iliolumbar ligament (lumbosacral and sacroiliac joint), the lumbocostal ligament (intervertebral and costovertebral joint), and the arcuate popliteal ligament (knee and proximal tibiofibular joint).
- c) *Ligaments passing over more than two joints.* In this group four ligaments can be distinguished: the anterior longitudinal ligament (intervertebral joints), the posterior longitudinal ligament (intervertebral joints), the supraspinal ligament (interspinal syndesmoses), and the nuchal ligament (flava syndesmoses).

Classification according to the histological structure of the attachment areas of the ligaments

- a) *Bone–bone.* This group includes the majority of "motor ligaments" (e.g. iliofemoral ligament).
- b) *Bone–ligament.* This group includes the iliopectineal ligament (extending between the iliopectineal tuberosity and the inguinal ligament) and the lacunar ligament (extending between the superior ramus of the pubic bone and the inguinal ligament).
- c) *Bone–cartilage.* This group includes the anterior and posterior radiate sternocostal ligaments (sternum–costal cartilage), the intra-articular sternocostal ligaments (sternum–ostal cartilage), the costoclavicular ligament (clavicle–costal cartilage), the glenohumeral ligaments (humeral tubercles–glenoid labrum), and the meniscofemoral ligaments (intercondylar notch–lateral meniscus).

- d) *Bone–skin.* These ligaments are the homologues of the mimic muscles. This group includes the anococcygeal ligament (tip of coccyx–skin of anus), the coccygeal ligament (tip of coccyx–skin of coccygeal fovea), and the cutaneous ligaments of the digits of Cleland (lateral sides of phalanx–skin over the phalangophalangeal joint) [18].
- e) *Cartilage–cartilage.* This group includes the intercartilaginous ligaments (costal cartilage–costal cartilage), the transverse ligament of the acetabulum (bridges the edges of the acetabular labrum), and the transverse ligament of the knee joint (interconnecting the anterior edges of the lateral and medial meniscus).
- f) *Ligament–ligament.* This group includes the reflected ligament (extending between inguinal ligament–linea alba), the superficial transverse metacarpal (or metatarsal) ligaments (interconnect the longitudinal fascicles of the palmar or plantar aponeurosis), and the orbicular zone (attached to the fibrous capsule of the hip joint).

Classification based on various parameters

- a) *Simple or double ligaments.* The majority of "motor ligaments" are double ligaments. The single ligaments found in the last edition of Nomina Anatomica [19] are the following (33 in number): anterior and posterior atlanto-occipital membrane, anterior atlanto-occipital ligament, supraspinal ligament, nuchal ligament, anterior and posterior longitudinal ligament, anterior sacrococcygeal ligament, superficial and deep posterior sacrococcygeal ligament, cruciate ligament of the atlas, apical ligament of the atlas, tectorial membrane, interspinal ligaments (16 in number), anterior and posterior sternal membrane, interclavicular ligament, and the superior and inferior pubic ligaments.
- b) *Ligaments "acting" on vessels and nerves.* Such an action occurs in pathologic conditions in which ligaments are thickened, compressing the underlying vessel or nerve. This group includes the superior and inferior ligament of the scapula, the transverse ligament of the wrist, and the paraterminal ligaments that bridge the edges of the distal phalanx permitting the passage of the proper palmar digital arteries and nerves [17]. This group also includes the venosus ligament of the liver, which maintains the inferior vena cava within a groove of the posterior surface of the liver and ligament of Hey (superior margin of the oval fossa), and the ligament of Burns (inferior margin of the oval fossa) that protect the

- great saphenous vein from occlusion during flexion of the thigh [4].
- c) *Ligaments and membranes perforated by vessels and nerves.* The interclavicular ligament, the sacrotuberal ligament, the interosseous membrane of the forearm and tibia, and the thyrohyoid membrane are classified in this group.
- d) *Ligaments altering their morphology with respect to age.* There is probably only one ligament in this group: the annular ligament of the radius. This ligament, before the age of seven years old, has a cylindrical shape, but after this age forms the shape of a frustrum with the larger basis directed superiorly, which explains the higher incidence of proximal radioulnar joint dislocation in children [1].
- e) *Ligaments affected by hormonal factors.* A typical example is the influence of oestrogens on the ligaments of the genital system of females and in the "motor ligaments" of the female pelvis (pubic and sacrococcygeal ligaments).
- f) *Ligaments changing their strength with respect to sex.* It is worth mentioning that the sacroiliac and sacrococcygeal ligaments are more powerful in males than females [6].
- g) *Ligaments constituting thickenings of other ligaments.* Regarding the "motor ligaments", the anterior atlanto-occipital ligament being a thickening of the anterior atlanto-occipital membrane. The majority of these ligaments belong to the group of "splanchnic ligaments". A typical example is the median cricothyroid ligament, which is a thickening of the elastic cone and the thyrohyoid ligaments (median and lateral) that are thyrohyoid membrane densations.
- h) *Ligaments constituting expansions of other ligaments.* Typical examples of this group are the nuchal ligament, which is an expansion of the supraspinal ligament, and the tectorial membrane, which is an expansion of the posterior longitudinal ligament.
- i) *Ligaments with multiple layers.* The anterior and posterior longitudinal ligaments that consist of a superficial and a deep layer, the medial collateral ligament of the knee and ankle joint consisting of a superficial and a deep layer, and the costoclavicular or rhomboid ligament consisting of two cruciate bands; the anterior and posterior band, belong to this group.
- j) *Ligaments belonging to the same ligamentous category but having a different term.* Typical exam-

ples of this group are the costoxiphoid ligament belonging to the radiate sternocostal ligament group, the posterior atlanto-occipital membrane belonging to the flava ligament group, and the lumbocostal ligament belonging to the anterior costotransversal ligament group.

- k) *Ligaments consisting of distinct bands.* This group includes a great number of "motor ligaments" such as the arcuate ligament of the wrist, the medial collateral ligament of the elbow, the coracoclavicular ligament, and the lateral collateral ligament of the ankle, which are composed of uni-layer bands of different directions.

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