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Terms Used to Describe Abnormalities of Joint Kinematics: An Overview

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ABSTRACT

Background: *In the joints, the movements, active or passive, occur normally in certain physiological planes: axes or directions, and within certain limits. In certain pathologies, the joint kinematics may be affected in one of the following ways: limitation of the normal movements, movement beyond the normal limits, or movement in the non-physiological planes. Different terms were used to describe the abnormalities of the joint kinematics. Nowadays, terms like joint hypermobility, joint laxity, joint instability, and ligamentous laxity are, synonymously or not, still used in some literature in their correct place. The current article aimed to review the abnormalities of joint kinematics and the new concepts of optimum application of the terms used to describe them. It has reached to some conclusions like: limitation of joint movement is the term used to describe any incomplete joint movement within a physiological plane and standard limits; Joint hypermobility is the term used to describe the ability to do a joint movement in a physiological plane but beyond the usual limits. Joint instability is the term used to describe the liability of a joint to move in non-physiological planes.*

Keywords: Abnormalities, Joint hypermobility, Joint instability Kinematics, Joint movement, Stiffness.

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INTRODUCTION

A joint is a site where the bones are connected together [(1)]. Synovial joints usually have a range of movement (ROM) more than that of cartilaginous ones. Kinematics is the branch of mechanics concerned with the motion of objects without reference to the forces that cause the motion [(2)]; in the human being, it deals with the possible motions of a whole body or its parts [(3)]. In the joints, the movements, whether active or passive, normally occur in certain physiological planes: axes, or directions, and within certain limits. Every joint has its specific movement(s) that occur(s) within a specific plane(s) and range(s). The ROM of each movement has its limits usually determined by certain anatomical structures or otherwise by the tightness of the restraining ligaments. Age, gender, and ethnic differences tend to make different capabilities of joint mobility [(4,5)].

In certain pathologies, the joint kinematics may be affected in one of the following ways: limitation of the normal movements, movement beyond the normal limits, or movement in the non-physiological planes. The abnormalities of joint kinematics had been described in the literature separately. Different terms are used to describe abnormalities of movements. Previously these terms had been used with some ambiguity. Recently, each term gained its special meaning with a specific definition for the medical field. Nowadays, terms like joint

hypermobility, joint laxity, joint instability, and ligamentous laxity still are used in some literature as synonymous or not in their correct place. Thus, the current article aimed to review the abnormalities of joint kinematics, the terms used to describe them, and the current concepts of optimum use of the terms used to describe the different types of joint kinematic abnormalities.

METHODS

The study design and registration protocol

The study was done according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [6,7]. A review protocol was prepared and registered with the Open Science Framework website on December 18. 2023. Available from: https://osf.io/28rey

Information sources

Electronic databases such as PubMed, Europe PMC, and Google Scholar were used to search for relevant articles. The keywords or phrases in the search process were: joint kinematics, limitation of movement, joint stiffness, joint hypermobility, and joint instability. Specific regions were excluded from the search process; In addition to the electronic database search, six books were also involved in the search for the relevant data.

Eligibility criteria

The inclusion criteria here were journal articles discussing joint movement abnormalities and those related to the human species. The search process was further restricted to those articles published in English only. The exclusion criteria, however, were literature discussing non-musculoskeletal, locomotor, joint abnormalities, and those concerning the treatment of joint movement abnormalities.

Search period and strategy

The search process was done to find the relevant articles during the period December 18, 2023, till December 22, 2023. It was done by the author and the peer review of the electronic search strategies (PRESS); a checklist was taken into consideration during the search process [8].

Data extraction

The extracted data from the articles were collected and then sorted by using a Microsoft Office Word software sheet (Microsoft Corporation, Microsoft Office Word, 2019. Redmond, Washington, USA). According to the scoping review methodology, an assessment of the quality, risk of bias, of the included studies was not performed [6,7].

RESULTS

A total of 560 articles were found at the onset of the search process but finally, only 34 were included in this review. The detail of the search process was summarized in the figure below. The included articles were 30 from journals and four books. Twenty-eight of the journal articles were original and two were systematic reviews. Three books specialized in orthopedic disorders and the fourth was on the physiology.

The retrieved data were divided into three parts: limitation of the normal movements, movement beyond the normal limits, and movement in the non-physiological planes:

Limitation of the normal movements

Limitation of joint movement is a general term used to describe any incomplete joint movement within a physiological plane and standard limits for that specific joint. It is the inability to complete the usual movement within the usual plane and the usual limits. It may be

due to pain from any cause of inflammation, trauma, infection, …, or loss of the ability to actively do a movement by any of the neuro-muscular-tendinous disorders. There are other terms used to describe the limitation of joint movement but in specific conditions. Paralysis is the term used to describe the inability to perform the movement(actively) from a neurological cause [9]. Stiffness is the term used to describe the inability to complete a particle joint movement both actively and passively. It may be due to congenital problems such as arthrogryposis and synostosis, or acquired from a post-traumatic and post-operative sequel, chronic inflammatory disorders, degenerative disorders, or tumors. Locking is the term applied to the sudden inability to complete a particular movement from a mechanical block [9].

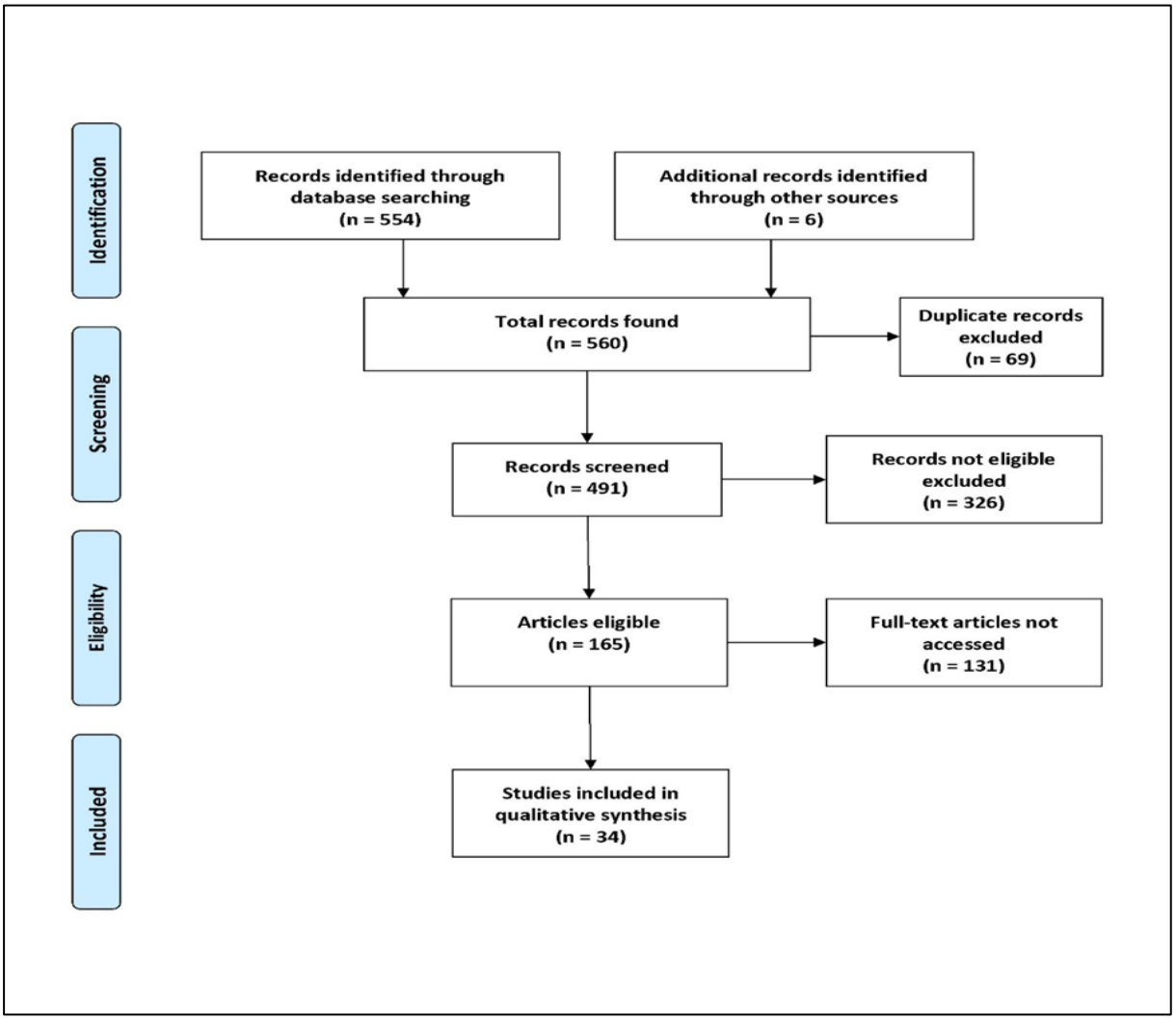

Figure (1): The flow diagram for the search process.

The ROM is recorded in degrees of a circle, with the joint as its center. It starts from the neutral or the extended anatomical position of the joint, a starting position, which is designated to be the zero degree, rather than the 180 degrees. Then the degrees are added in the direction in which the joint moves and finishes where movement stops due to anatomical limitation [10]. For accuracy, it is ideal to measure the ROM objectively with a goniometer. For example, 'knee flexion 0–140 degrees mean that the range of flexion is from zero, the straight knee, through an arc of 140 degrees, the leg making an acute angle with the thigh [10].

Movements beyond the normal limits

Joint hypermobility (JH) is a term commonly used to describe the ability to move a joint, passively and/or actively, in a physiological plane but beyond the usual limits of the age, gender, and race. Hence, it is a descriptive term for the increased ROM rather than a diagnostic term for a disease or a syndrome. It may exist as a separate diagnostic result but often a feature of a larger syndromic diagnosis [11,12]. Synonyms of JH include joint hyperlaxity, joint hyperextensibility, loose joints, and double-jointedness [11]. It occurs due to excessive laxity of the constraining soft tissues especially the capsule-ligamental structures [5,13,14]. This excessive laxity occurs due to either a congenital disorder, or genetic defect affecting connective tissue matrix proteins which may occur as an isolated defect or part of an inherited disorder like Ehler-Danlos' syndrome, Marfan's syndrome, Down's syndrome, osteogenesis imperfecta, skeletal dysplasia as achondroplasia, … [11]. It, however, could occur as an acquired one from training with stretching physical exercises [5,15], widespread inflammatory or degenerative diseases of the joints [11,16], neuromuscular disorders as Ullrich congenital muscular dystrophy, congenital muscular dystrophy with joint hyperlaxity [17,18], or endocrinal as hypothyroidism [11].

Joint hypermobility may be localized, observed in less than five joints [11], generalized, in five or more joints, usually symmetrical in four limbs and axial skeleton, peripheral, observed in hands and/or feet of infants and children, or historical in adults who lost their JH [19,20].

Movement in the non-physiological planes

Joint instability is a term used to describe the liability of a joint to move in an unusual plane, subluxation or dislocation, during usual life activities. It is mainly used as a patient's complaint or symptom when feeling the joint to be insecure, such as the give way of the knee joint. The term joint laxity is used during the clinical examination (sign) when a joint is found to be liable for a movement passively in an unusual plane by performing special tests [11]. It occurs due to a deficiency in one of the supporting structures of the joint, like bones, ligaments, and muscles. It may result from congenital, developmental, and hereditary disorders (a primary bone defect like glenoid dysplasia in shoulder instability, trochlear dysplasia in patellofemoral instability, and generalized JH from excessive ligamentous laxity) [21-24], or acquired sequel of trauma (limb bone malalignment, torn ligament, tendon insufficiency, …), repeated movement or overuse over time, and sequel of neuromuscular disorders [25,26]. It is localized in most of the cases but may be generalized (only in generalized JH cases).

DISCUSSION

Unawareness of the different abnormalities that occur in joint kinematics and the terms used to describe them may lead to misunderstanding among the medical personnel. The current study aims to increase awareness about these terms, which are used ambiguously nowadays, and the current agreement on their applications.

Limitation of joint movements

Patients often have difficulty in distinguishing the type and cause of limitation of movement. They may use the term stiffness for all kinds of limitations of joint movements. Stiffness should never be assumed until verified by examination. Using the goniometer is essential for the ideal estimate of the ROM angle of a joint. However, with practice, it may be possible to estimate the angles, to an acceptable extent, by eyeballing [9]. Furthermore, the goniometer may not be available nearby all the time. Describing the range of movement accurately may be difficult. Although it is ideal to cite or span the ROM, since the beginning till

the end, in degrees [9] , it may be difficult to interpret the degree of limitation by degrees for all persons. For example, if there was a limitation of elbow flexion and the ROM was 115 degrees, it may be difficult to imagine the magnitude of the present limitation by everyone, even if it was supplemented by the normal range reference. Terms such as 'full', 'good', 'limited', and 'poor' may be misleading. Hence, there is a need for a grading system for the limitation of joint movement. The author of the present study suggests a subjective grading based on objective measurements depending on how much the normal ROM is deficient: mild (less than 25%), moderate (25-75%), severe (more than 75%) permitting for little movement, and complete (100%), no movement occurs.

Since most of the human body joints are working together in a synchronized manner, the functional sequel of a single joint stiffness may be buffered by the others. Therefore, a single joint stiffness, even if it is severe or ankylosed or fused, might not have a serious impact on daily life activities provided the nearby surrounding joints are normal or have a considerable ROM. If multiple joints are affected, the additive effect, even of a mild degree, subsequently may cause a significant impact on the function of an extremity or a body region.

Joint hypermobility

The abnormality of joint kinematics can be diagnosed when the obtained ROM is compared with the normal parameters for that joint, sex, age, and race. In general, the joints have higher angular values in females than males, young especially children, and adolescents more than in old adults [27]. Negros and Asian backgrounds are generally more hypermobile than Caucasians [12,28]. Some synonymous terms were used for JH like joint hyperlaxity and joint hyperextensibility. The first one cannot be used for pure clinical description because it gives a clue about the nature of pathology which is the excessive ligamentous laxity, and the second one gives a clinical description for one direct of JH which is hyperextension which may not be true for all the joints. The terms like loose joints and double jointedness seem to be non-academic.

Joint hypermobility and joint hypermobility syndrome

The term joint hypermobility syndrome (JHS) is used to describe connective tissue disorder involving mainly the joint capsule-ligamental structure and characterized by chronic musculoskeletal clinical features, symptoms and signs, due to JH [29]. It may be in a localized, generalized, peripheral, or historical form. It is sometimes referred to by different other terms like hypermobility spectrum disorder (HSD), benign joint hypermobility syndrome (BJHS), and benign hypermobility syndrome (BHS) [5,13,19,20,28,30]. The Beighton Scoring System measures joint hypermobility on a 9-point scale, while the Brighton diagnostic criteria, major and minor, is used to diagnose JH syndrome [31-35]. The term syndromic JH is used when at least a second tissue/structure other than the joint capsule-ligamental structure is involved like connective tissue disorders, such as Ehlers-Danlos syndrome, Marfan's Syndrome, osteogenesis imperfecta, skeletal dysplasia, such as Larsen syndrome, spondyloepimetaphyseal dysplasia, hereditary myopathies, such as Bethlem myopathy, chromosomal and genomic disorders, (such as Down's syndrome [5,11,35].

Joint instability, joint hypermobility, and joint laxity

Joint instability and JH have been used in the past as synonyms. However, by inference, they prelude to different forms of joint kinematics abnormalities. Hypermobile joints may also be unstable and lax, but not all unstable/lax joints are hypermobile [11,12]. Clinical symptoms and signs are the first clues to differentiate between

them. Joint instability usually presents with certain characteristic symptoms like recurrent attacks of a particular joint dislocation, such as shoulder and patella-femoral joint, recurrent attacks of pain around the affected joint with certain activities [35], abnormal sounds as clunks or crepitations may be heard or felt [25,35,37], and decrease joint, and limb, function also known as activity-limiting symptoms as in shoulder , dead arm syndrome [35,38]. Abnormal signs may be found during the clinical examination of a joint by performing drawer or stress tests, such as of elbow and knee. The term joint laxity is used to describe these abnormal clinical findings [11]. Investigations like imaging by doing radiological stress views and MRI are usually valuable and diagnostic. Arthroscopy may also be valuable in some cases of joint instability [39,40]. Joint instability usually disturbs the usual life and ends with early degenerative changes and osteoarthrosis due to biomechanical disturbance in the joint [11,41-43].

CONCLUSION

Limitation of joint movement is the term used to describe any incomplete joint movement within a physiological plane and standard limits. Joint hypermobility is the term used to describe the ability to do a movement joint in a physiological plane but beyond the usual limits. Joint instability is the term used to describe the liability of a joint to move in non-physiological planes.

REFERENCES

1. Snell RS. Clinical anatomy by regions, 9th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2012. pp 1-33.
2. Beggs JS. Kinematics. New York: Hemisphere Publishing Corp;1983. pp 1-18.
3. Dorland's illustrated medical dictionary, 32nd edition. Philadelphia, PA: Elsevier-Saunders; 2012.
4. Chung M, Wang M. The effect of age and gender on joint range of motion of worker population in Taiwan. International Journal of Industrial Ergonomics 2009;39(4):596-600. DOI: 10.1016/j.ergon.2007.11.004
5. Grahame R. Joint hypermobility and genetic collagen disorders: are they related? Arch Dis Child 1999;80:188-191.
6. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467-473. doi:10.7326/M18-0850
7. Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. Int J Evid Based Healthc. 2015;13(3):141-146. doi:10.1097/XEB.0000000000000050
8. McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS Peer Review of Electronic Search Strategies: 2015 Guideline Statement. J Clin Epidemiol. 2016;75:40-46. doi:10.1016/j.jclinepi.2016.01.021
9. Solomon L, Wakeley C. T. Orthopaedic diagnosis. In: Solomon L, Warwick D, Nayagam S, editors. Apley's System of Orthopedics and Fractures, 9th edition. London: Hodder Arnold; 2010. pp 3-28.
10. Herring JA. Developmental dysplasia of the hip. Chapter 16 in Tachdjian's Pediatric Orthopaedics: From the Texas Scottish Rite Hospital for Children, 5th Edition. Philadelphia, PA: Elsevier Saunders; 2014. pp 483-535.
11. Castori M, Tinkle B, Levy H, Grahame R, Malfait F, Hakim A. A framework for the classification of joint hypermobility and related conditions. Am J Med Genet C Semin Med Genet. 2017;175(1):148-157. doi:10.1002/ajmg.c.31539
12. Tofts LJ, Elliott EJ, Munns C, Pacey V, Sillence DO. The differential diagnosis of

children with joint hypermobility: a review of the literature. Pediatr Rheumatol Online J. 2009;7:1. Published 2009 Jan 5. doi:10.1186/1546-0096-7-1
13. Everman DB, Robin NH. Hypermobility syndrome. Pediatr Rev. 1998;19(4):111-117. doi:10.1542/pir.19-4-111
14. Bird HA. Joint hypermobility in children. Rheumatology (Oxford) 2005;44:703–704.
15. Tinkle BT. Symptomatic joint hypermobility. Best Pract Res Clin Rheumatol. 2020;34(3):101508. doi:10.1016/j.berh.2020.101508
16. Punzi L, Pozzuoli A, Pianon M, Bertazzolo N, Oliviero F, Scapinelli R. Pro-inflammatory interleukins in the synovial fluid of rheumatoid arthritis associated with joint hypermobility. Rheumatology (Oxford). 2001;40(2):202-204. doi:10.1093/rheumatology/40.2.202
17. Voermans NC, Bonnemann CG, Hamel BC, Jungbluth H, van Engelen BG. Joint hypermobility as a distinctive feature in the differential diagnosis of myopathies. J Neurol. 2009;256(1):13-27. doi:10.1007/s00415-009-0105-1
18. Donkervoort S, Bonnemann CG, Loeys B, Jungbluth H, Voermans NC. The neuromuscular differential diagnosis of joint hypermobility [published correction appears in Am J Med Genet C Semin Med Genet. 2016 Jan;170A(1):285-6]. Am J Med Genet C Semin Med Genet. 2015;169C(1):23-42. doi:10.1002/ajmg.c.31433
19. Juul-Kristensen B, Røgind H, Jensen DV, Remvig L. Inter-examiner reproducibility of tests and criteria for generalized joint hypermobility and benign joint hypermobility syndrome. Rheumatology (Oxford). 2007;46(12):1835-1841. doi:10.1093/rheumatology/kem290
20. Hakim A, Grahame R. Joint hypermobility. Best Pract Res Clin Rheumatol. 2003;17(6):989-1004. doi:10.1016/j.berh.2003.08.001
21. Abboud JA, Bateman DK, Barlow J. Glenoid Dysplasia. J Am Acad Orthop Surg. 2016;24(5):327-336. doi:10.5435/JAAOS-D-15-00032
22. Bollier M, Fulkerson JP. The role of trochlear dysplasia in patellofemoral instability. J Am Acad Orthop Surg. 2011;19(1):8-16. doi:10.5435/00124635-201101000-00002
23. Schenk TJ, Brems JJ. Multidirectional instability of the shoulder: pathophysiology, diagnosis, and management. J Am Acad Orthop Surg. 1998;6(1):65-72. doi:10.5435/00124635-199801000-00007
24. Wolfe S, Varacallo M, Thomas JD, Carroll JJ, Kahwaji CI. Patellar Instability. In: StatPearls. Treasure Island (FL): StatPearls Publishing; August 16, 2020. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482427/
25. Solomon L, Karachalios T. The knee. In: Solomon L, Warwick D, Nayagam S, editors. Apley's System of Orthopedics and Fractures, 9th edition. London: Hodder Arnold; 2010. pp 547-585.
26. Wilder RP, Sethi S. Overuse injuries: tendinopathies, stress fractures, compartment syndrome, and shin splints. Clin Sports Med. 2004;23(1):55-vi. doi:10.1016/S0278-5919(03)00085-1
27. Clinch J, Deere K, Sayers A, et al. Epidemiology of generalized joint laxity (hypermobility) in fourteen-year-old children from the UK: a population-based evaluation. Arthritis Rheum. 2011;63(9):2819-2827. doi:10.1002/art.30435
28. Ahlberg A, Moussa M, Al-Nahdi M. On geographical variations in the normal range of joint motion. Clin Orthop Relat Res. 1988;(234):229-231.

29. Kumar B, Lenert P. Joint Hypermobility Syndrome: Recognizing a Commonly Overlooked Cause of Chronic Pain. Am J Med. 2017;130(6):640-647. doi:10.1016/j.amjmed.2017.02.013
30. Engelbert RH, Bank RA, Sakkers RJ, Helders PJ, Beemer FA, Uiterwaal CS. Pediatric generalized joint hypermobility with and without musculoskeletal complaints: a localized or systemic disorder?. Pediatrics. 2003;111(3):e248-e254. doi:10.1542/peds.111.3.e248
31. Czaprowski D, Sitarski D. Generalized Joint Hypermobility – Diagnosis and Physiotherapy. J Nov Physiother. 2016;6:302. doi:10.4172/2165-7025.1000302
32. Grahame R, Bird HA, Child A. The revised (Brighton 1998) criteria for the diagnosis of benign joint hypermobility syndrome (BJHS). J Rheumatol. 2000;27(7):1777-1779.
33. Beighton P, Solomon L, Soskolne CL. Articular mobility in an African population. Ann Rheum Dis. 1973;32(5):413-418. doi:10.1136/ard.32.5.413
34. Beighton P, De Paepe A, Steinmann B, Tsipouras P, Wenstrup RJ. Ehlers-Danlos syndromes: revised nosology, Villefranche, 1997. Ehlers-Danlos National Foundation (USA) and Ehlers-Danlos Support Group (UK). Am J Med Genet. 1998;77(1):31-37. doi:10.1002/(sici)1096-8628(19980428)77:1<31::aid-ajmg8>3.0.co;2-o
35. Juul-Kristensen B, Schmedling K, Rombaut L, Lund H, Engelbert RH. Measurement properties of clinical assessment methods for classifying generalized joint hypermobility - A systematic review. Am J Med Genet C Semin Med Genet. 2017;175(1):116-147. doi:10.1002/ajmg.c.31540
36. Cole A, Pavlou P. The shoulder and pectoral girdle. In: Solomon L, Warwick D, Nayagam S, editors. Apley's System of Orthopedics and Fractures, 9th edition. London: Hodder Arnold; 2010. pp 337-368.
37. Warwick D. The elbow and forearm. In: Solomon L, Warwick D, Nayagam S, editors. Apley's System of Orthopedics and Fractures, 9th edition. London: Hodder Arnold; 2010. pp 369-381.
38. Garcia JA, Arguello AM, Momaya AM, Ponce BA. Sternoclavicular Joint Instability: Symptoms, Diagnosis And Management. Orthop Res Rev. 2020;12:75-87. Published 2020 Jul 28. doi:10.2147/ORR.S170964
39. Goodwin D, Dynin M, Macdonnell JR, Kessler MW. The role of arthroscopy in chronic elbow instability. Arthroscopy. 2013;29(12):2029-2036. doi:10.1016/j.arthro.2013.08.016
40. Bari AA, Kashikar SV, Lakhkar BN, Ahsan MS. Evaluation of MRI versus arthroscopy in anterior cruciate ligament and meniscal injuries. J Clin Diagn Res. 2014;8(12):RC14-RC18. doi:10.7860/JCDR/2014/10980.5331
41. Blalock D, Miller A, Tilley M, Wang J. Joint instability and osteoarthritis. Clin Med Insights Arthritis Musculoskelet Disord. 2015;8:15-23. Published 2015 Feb 19. doi:10.4137/CMAMD.S22147
42. Nayagam S. Injuries of the knee and leg. In: Solomon L, Warwick D, Nayagam S, editors. Apley's System of Orthopedics and Fractures, 9th edition. London: Hodder Arnold; 2010. pp 875-905.
43. Delincé P, Ghafil D. Anterior cruciate ligament tears: conservative or surgical treatment? A critical review of the literature. Knee Surg Sports Traumatol Arthrosc. 2012;20(1):48-61. doi:10.1007/s00167-011-1614-x.