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Orthopedics and Sports Medicine:
Open Access Journal

Research Article

To the Morphology of Spiral Fractures of Long Tubular Bones

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Received: June 02, 2018; **Published:** July 10, 2018

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Abstract

Aim: Determination of the course of rotation of the free end of the long tubular bone in helical fractures on the localization and direction of the line of spiral bone rupture.

Material and methods: On the models of long tubular bones of the chicken, 360 spiral fractures were studied. The localization and direction of the spiral fracture line in different rotation modes-clockwise and counterclockwise are determined.

Results: In case of rotation of any free epiphysis in both directions with a fixed other one, the specified line is equally often located both on the front surface of the bone and on the back one and always passes from left to right. When the free upper epiphysis is rotated clockwise, this spiral line goes from the bottom up, when rotating in the opposite direction-from the top down. In contrast, when the lower end of the bone rotates relative to the fixed upper one, direction of the spiral fracture line, depending on the type of rotation, is directly opposite.

Conclusion: The obtained data and the revealed regularities allow solving the expert questions concerning the mechanism of injury formation and clarification of the circumstances of the incident quite accurately.

Keywords: Long Tubular Bones; Spiral Fracture; Rotation Type; Localization and Direction of Spiral Fracture Line

Introduction

Spiral (helical) fractures of long tubular bones (SFLTB) (Figure 1) occur due to the rotation of one of the ends of the bone with a fixed other [1-5]. In this case, the bone is formed stress, passing respectively helical line, which initially breaks the bone. Due to the bending of the bone cylinder on the opposite helical line, a compression occurs on the side and a straight line of bone fracture is formed, connecting the ends of the spiral part of the fracture (Figure 2-4) [1,3,5]. SPDTC are not particularly rare. For example, according to S Salminen [6], among all hip fractures, the helical character is 36.7%, and according to the study of F Madadi with co-authors [7], the spiral fracture of the tibia was 13.4% of bone injuries of this localization.Anything that puts a lot of twisting stress or force on a long bone can cause a spiral fracture. But a few specific motions, activities, and circumstances tend to be associated with the injury.Causes of spiral fractures include [2,8-15].

Figure 1: Spiral fracture of the middle third of the femoral shaft [6].

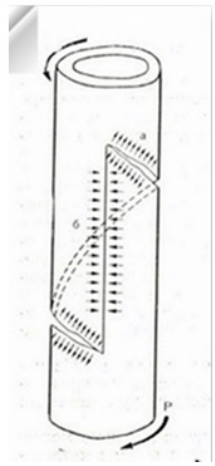

Figure 2: Deformity of the long bones in torsion: P-direction of the external impact; a-tension forming a helical fracture line; b-tension forming a direct line of fracture [1].

Figure 3: Tibia, front view: spiral line of primary bone rupture (own observation).

Figure 4: Tibia, back view: straight line of bone fracture (own observation).

a) skiing, snowboarding or skating injuries, when the leg is twisted by being stuck in a ski, snowboarding or skating boot while the rest of the leg continues to move.

b) soccer injuries, especially when two players run into one another and become entangled or twisted.

c) American football injuries, especially when one player runs into another, one player is held or restrained by another, or a player twists to get free.

d) wrestling injuries to the legs or arms caused by twists.

e) motor vehicle and motorcycle accidents.

f) when a pedestrian is tangentially hit by a car.

g) bicycle accidents, typically those involving a motor vehicle as well.

h) falling after trying to compensate for a loss in balance by putting out an arm or quickly repositioning the leg.

i) child abuse, if a child's arm or leg has been jerked aggressively.

j) falling down the stairs or a slope with fixed obstacles, such as rocks or trees that can twist an arm or leg away from the rest of the body.

k) physical violence, when a person's arm or leg has been twisted forcibly.

l) machinery injuries that involve someone's limbs.

In the aspect of forensic fractology is of great practical interest is the question about the peculiarities of the topography of the helical line of the primary break bones depending on the direction of rotation of its free epiphysis. The correct answer to this question is often extremely important for determining the mechanism of injury, clarifying the circumstances of the incident and making a reasonable expert opinion [5].However, there is very little research in this direction. No such information was found in the Medline database, only one publication relating to 1983 was found in the Google Scholar database [16]. Its author, the Finnish specialist O. Böstman, found that in 78% of cases the spiral component of the fracture line was located in the anterior quadrant of the tibia circumference, and the vertical element of the fracture - in the poster medial.In the Russian-language literature, almost only the work of scientists of the Altai medical Institute V.E. Yankovsky and V.N. Kryukov devoted to this topic.

The research of the first author [4,5] was carried out more than 40 years ago, published in relatively little-known publications and now represent to a certain extent a bibliographic rarity. According to the data generalized in VE Yankovsky's doctoral dissertation [5], with external rotation of the femoral shaft or tibia, the helical fracture line goes in the direction from top to bottom and inside. This line has the opposite direction in case of internal rotation.

Such a conclusion raises a number of questions. First, it is not clear on what surface of the bone is this helical line of bone rupture. Secondly, the rotation of the shaft of the mentioned bones, both external and internal, will have a different direction relative to the clockwise direction at the right and left feet. Therefore, the presented conclusion is not complete and generalized.The author also offers a method of determining the direction of rotation of the bone by restoring the perpendicular to the helical fracture line, which corresponds to the direction of stretching forces and, consequently, the direction of rotation of this part of the bone (Figure 5).In some cases, this method can be useful. However, it requires a certain imagination and is not always convenient for practical use.Two later monographs by VN Kryukov[1,8] also do not bring much clarity in this direction. In modern publications on forensic medicine, for example, in the textbook of NN Tagaev [3], this question is given just a few lines without any specifics. Even the National manual of forensic medicine [17] does not contain any information of this kind. Thus, there are almost no specific and sufficiently clear criteria to accurately assess the direction of rotation of a free end of a long tubular bone in appearance and localization of the line of spiral rupture of bone tissue. Therefore, the aim of this study was to attempt to fill at least a partial existing gap.

Figure 5: Fracture of the tibia during rotation; determination of the direction of rotation [1, 5].

Material and methods

As a model for the experiment, long tubular bones of the chicken were used: radius - 100, ulna - 120, humerus - 120, tibia - 20 (Table1). From a purely technical point of view, this is a very convenient object for studying the morphology of fractures. In addition, what is important is not a problem to obtain any necessary amount of experimental material.So, in general, 360 SFLTB received by the fixed lower epiphysis and the rotate top clockwise and in the opposite direction are studied-for 180 observations in each case. (The direction of rotation of the free end of the bone, whether it is upper or lower, with respect to the movement of the hour hand is determined by the mental view of the bone from above that is, as we usually look at the clock, lying face up).To evaluate the obtained quantitative results, the method of nonparametric statistics - calculation of the Mann-Whitney U-test was used.

Table 1: Quantitative characteristics of the studied material and the results of the study.

The form	In the course clockwise		In the course Counterclockwise		Number of fractures
of rotation Side of the bone. The course of Thespiralfracture Bone	Front. Left to right. Bottom-up.	Back. Left to right. Bottom-up.	Front. Left to right. From the top down.	Back. Left to right. From the top down.	
Radius	28	22	40	10	100
Ulna	29	31	24	36	120
Humerus	29	31	16	44	120
Tibia	6	4	2	8	20
In total	92 (51,1%)	88 (48,9%)	82 (45,6%)	98 (54,4%)	360

Results and discussion

The results of the study are presented in the Table 1. Analysis of the data reveals certain patterns.First, in the case of rotation, all types of tubular bones used in the experiment are damaged equally. In other words, the morphology of the spiral fracture does not depend on the anatomical belonging of the bone, that is, its place in the skeleton.Secondly, the rotation of the free upper end of the bone by the fixed lower epiphysis both in a clockwise direction and against can arise two types SFLTB, differing from each other by the localization of the helical line of the primary rupture of the bone tissue.In one form of fracture, this line is located on the front surface of the bone, in the other - on the back one. The frequency of one and the other species is about the same - about half of all fractures of the same mechanism of injury. In this case, the spiral fracture line in the horizontal direction always goes from one side edge of the bone to another one (say, from left to right), which is quite natural.

The observed noticeable differences in the frequency of one or another localization of the spiral part of the fracture of some bones (for example, radius, ulna, tibia, when rotating counterclockwise) are associated not so with the design features of the latter, much as with a relatively small number of observations. In General, the differences in the respective percentages are statistically insignificant in the entire sample.The described phenomenon serves as a significant refinement of existing in the literature very brief and insufficiently certain information in this regard.The difference of the studied SFLTB determined by the type of rotation of the free end of the bone is the orientation of the helical part of fracture in the vertical direction (Figure 6).

Figure 6: Localization and direction of the spiral line of fracture depending on the type of rotation: I, II, III-radius, ulna, humerus respectively; clockwise rotation-front (A) and back (B) view; Counterclockwise rotation-front (C) and back (D) view (own observation).

Figure 6 Localization and direction of the spiral line of fracture depending on the type of rotation: I, II, III - radius, ulna, humerus respectively; clockwise rotation - front (A) and back (B) view; Counterclockwise rotation - front (C) and back (D) view (own observation).So, if you look at the spiral fracture line directly from the side of its localization, the direction of this line when the upper epiphysis is rotated clockwise will always be oriented from the bottom up. On the contrary, in the case of a reverse rotation, the break line runs from top to bottom.In the opposite situation, that is, when the lower end of the bone rotates relative to the fixed upper one, the course of the spiral fracture line in a vertical direction will be directly opposite to the described one, namely: when the free lower epiphysis is rotated clockwise, the line goes from top to bottom, counterclockwise - from bottom to top (Table 2).The revealed regularities of localization and direction of the helical part of the SFLTB as a whole confirm the correctness of the method of determining the course of the free end of the bone rotation proposed by VE Yankovsky [5]. However, in my opinion, the new approach to this issue is quite simple and quite convenient in practical terms.

Table 2: Localization and direction of the spiral fracture line depending on the type of rotation.

The fixed epiphysis	The form of rotation	Side of the bone	The direction of the spiral line of fracture	
			Horizontal	Vertical
Lower	clockwise	Front, back	Left to right	Bottom-up
Lower	Counter- clockwise	Front, back	Left to right	From the top down
Top	clockwise	Front, back	Left to right	From the top down
Top	Counter- clockwise	Front, back	Left to right	Bottom-up

Conclusion

The study of the SFLTB morphology depending on the direction of rotation of the free epiphysis revealed clear patterns that allow solving expert questions concerning the mechanism of injury and clarification of the circumstances of the incident quite accurately.

Acknowledgement

I thank my numerous voracious family for providing my experiment with enough material to explore. Special thanks to my daughter Lydia Denisova for making photos to illustrate the article.

References

1. Kryukov VN (1986) Mechanics and morphology of fractures. Moscow, Russia.
2. Pigolkin YuI, Dubrovin IA, Leonov SV (2014) Blunt force trauma. In: Sudebnayamedicinal sudebno-medicinskaya ehkspertiza: nacionalnoerukovodstvo/pod red, YuIPigolkina, Moscow, Russia. GEHOTARMedia Publ4: 70-99.
3. Tagaev NN (2003) Forensic medicine: a textbook/pod obshchredAM, Bandurki, Harkov: Fakt Publ.
4. Yankovskij VEH (1972) The topography of stresses and the mechanism of fractures of the tibia in certain types of deformations. In: VoprosymorfologiiIpatologiiopornyhtkanej: materialynauchKonf, Altajskogogos medinstituta, Barnaul.
5. Yankovskij VEh (1974) Materials on biomechanical features of long tubular bones of the lower extremities (substantiation of forensic criteria of damage examination): disdra med, Nauk, Moscow, Russia.
6. Salminen S (2005) Femoral shaft fractures in adults: epidemiology, fracture patterns, nonunion, and fatigue fractures. A clinical study: acad. dis. Helsinki, University of Helsinki, Europe.
7. Madadi F, Eajazi A, Madadi F (2011) Adult tibial shaft fractures-different patterns, various treatments and complications. Med Sci Monit17 (11): 640-645.
8. Kryukov VN (1995) Fundamentals of mechano-and morphogenesis of fractures, Moscow, Russia.
9. Huizen J (2017) What is a spiral fracture? Causes and treatment.
10. Stenroos A, Pakarinen H, Jalkanen J (2016) Tibial fractures in alpine skiing and snowboarding in finland: a retrospective study on fracture types and injury mechanisms in 363 patients. Scand J Surg 105 (3): 191-619.
11. Yakunin SA, Leonov SV (2014) Car injury. In: Sudebnayamedicinal sudebno-medicinskaya ehkspertiza: nacionalnoerukovodstvo / pod red. YuI Pigolkina. Moscow: GEhOTAR-Media Publ 7: 148-85.
12. Deryagin GB, Agafonov VV (2008) Land transport injury: Uch-methodpossible.MosU MVD,RossiiPubl,Moscow, Russia.
13. Solohin AA (1968) Forensic medical examination in cases of automobile injury.Medicine Publ, Moscow, Russia.
14. Yankovskij VEh (2005) Some features of the formation of fractures. In: Mater. VI Vseross. sezdasud. medikov. Moscow, Russia 312-313.
15. Leonov SV, Dubrovin IA, Tolmachev IA (2014) Damage caused by unarmed man and animals. In: Sudebnayamedicinal sudebno-medicinskaya ehkspertiza: nacionalnoerukovodstvo/pod red. YuI Pigolkina5: 100-128.
16. Böstman O (1983) Morphological observations of torsional fractures of the adult tibial shaft. Acta OrthopScand 54 (4): 627-633.
17. (2014) Forensic medicine and forensic-medical examination: national guidelines/pod red. YuI Pigolkina.