

Wilson (H. Aug)



A STUDY  
OF  
TRANSVERSE FRACTURE OF THE PATELLA,  
BY

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TRANSVERSE fracture of the patella would seem to be of comparatively modern recognition for Hippocrates, Celsus and Galen are absolutely silent upon the subject, Sorannus being the first to give a description of it. Whether the occurrence of fracture of the patella at the present day is owing to advance in civilization or deterioration of the human economy, or both, will not be discussed in this paper. Even at the present time, however, fractures of the patella from whatever causes are not very common, for they comprised only 45 of the 2,328 cases of fractures treated in the Hotel Dieu, Paris; at most one in fifty, or an average of 4 yearly.

*Anatomy.* The patella is a sesamoid bone situated in the anterior part of the femoro-tibial articulation. It is enveloped in the substance of the tendon common to the extensor muscles of the thigh. It is cellular within and covered by very thin but firm plates, so that in proportion to its bulk there is scarcely a stronger bone in the body. (*Anat. Phys. and Diseases of Bones and Joints, S. D. Gross, M.D., p. 137.*)

The anterior surface is convex and is perforated by small apertures for the passage of the nutrient vessels and marked by rough vertical striæ, which

give the fibres of the tendon of the quadriceps a remarkably firm hold.

The posterior surface is divided by a ridge into two facets united angularly, each of which articulates by a trochlear surface with one of the condyles of the femur. The outer one for articulation with the outer condyle being broader and deeper serves to indicate the leg to which the bone belongs.

The patella is held firmly in place by the quadriceps tendon from above and the ligamentum patellæ from below, and in the act of flexion and extension the patella glides over the condyles of the femur, giving an example of a lever of the first order. The extensor muscles are the power, the leg the weight, and the patella resting on the condyles of the femur the fulcrum placed between the power and the weight.

The predisposing causes of this lesion may be age, sex, scurvy, gout, cancer, syphilis, rachitis, occupation, attempts at muscular feats. The study of age and sex and their influence in the causation of any disease or deformity is always of interest, and I think it particularly so in fractures of the patella.

In the following table I have collated from the annual reports all the cases of transverse fractures of the patella from

whatever cause, that were treated in St. Bartholomew's Hospital, London, during a period of eleven years, from 1866 to 1877, inclusive, omitting 1869, for which year I was unable to find a report:

Between the ages of 15 and 25 there were	20, or one-fourth of the total number.
" " " " 25 and 35 " "	70, " one-fourth " " "
" " " " 35 and 45 " "	98, " one-third " " "
" " " " 45 and 55 " "	63, " one-fourth " " "
" " " " 55 and 65 " "	22, " one-fourth " " "
" " " " 65 and 75 " "	9, " one-thirtieth " " "
" " " " 75 and 85 " "	2, " one-140th " " "

Thus it will be seen that 98 cases, or about one-third of entire number, occurred in persons between the ages of 35 and 45. The study of sex is likewise of considerable importance and none the less interesting. From the same source I found that

Between 15 and 25 there were 16 males and	4 females, the proportion being as 4 to 1.
" 25 and 35 " " 54 " "	16 " " " " 3½ to 1.
" 35 and 45 " " 62 " "	36 " " " " 1¾ to 1.
" 45 and 55 " " 36 " "	27 " " " " 1¾ to 1.
" 55 and 65 " " 13 " "	9 " " " " 1½ to 1.
" 65 and 75 " " 7 " "	2 " " " " 3½ to 1.
" 75 and 85 " " " "	2 " " " " " "
Total,	188 " " 96 " " 2 to 1.

Transverse fracture when due alone to muscular action takes place always when the leg is *flexed* upon the thigh and *sudden* muscular contraction takes place.

To illustrate the first, suppose that I should wish to break a pen holder, I certainly would not direct my force in the line of the fibres of the wood, but would place my thumb near the middle (a fulcrum) and apply the force required to break the stick at the two ends, using the force against the fulcrum, thus illustrating power and resistance.

So it is with the patella, which would require an immense force to break if the leg was extended and the power was exerted in a line with fulcrum and resistance, but when the patella is held against the condyles of the femur and the leg is flexed a tremendous force, the character of which is a cross breaking strain is being exerted upon the patella.

The second element required is sudden muscular contraction. A delicate

silk cord may be made to sustain a certain weight if the power is exerted gradually, but if the same cord and the weight are submitted to elevation suddenly applied the cord will break.

A few cases due entirely to muscular action may be studied with benefit.

Cases 1, 2.—Bichat (Packard's Malgaigne, p. 602), and Sir A. Cooper (Cooper's *Surg. Essays*, Part II, p. 85), each saw a case where the fracture took place in aiming a kick, the motion of the foot being suddenly impeded, fracture took place.

Case 3.—Hevin saw the case of a dancer who received a fracture in making a great effort in leaping. (Packard's Malgaigne, p. 602.)

Case 4.—In the operating theatre of the Hotel Dieu both patellae of a patient were broken by the violent spasms of the muscles which followed an operation for stone. (Cooper's *Surg. Dict.*, p. 752.)

Case 5.—Bichat (Packard's Malgaigne, p. 602) mentions the case of a man who was cut for stone and who in a *subse-*

quent convulsion broke both patellæ at the same time.

Case 6.—Desault (*Gross System Surg.*, 5th Edit., Vol. I, p. 1,001) met a case in which a man broke both patellæ simultaneously by a violent effort of the muscles to disengage the limbs from the constrained position in which they were placed during the operation of lithotomy. Before the use of anæsthetics, the patients who were to undergo this operation were placed upon their backs and the wrists and ankles of corresponding sides were securely fastened together.

Case 7.—Boyer (*London Med. Repos.*, 1823, Vol. XIX, p. 174) speaks of a coachman who, being in danger of falling from his box, made an effort to save himself and heard the crack produced by the fracture.

Case 8.—Dr. Kirkbride (*Am. Journal Med. Sci.*, Aug., 1835, Vol. XVI, p. 330) records an instance in a man who attempted to jump into a cart and broke his patella.

Case 9.—Fielding (*London Med. Repos.*, Vol. XIX., 1823, p. 174) met a case in a woman caused by attempting to lift a heavy basket.

Case 10.—A sailor (Hamilton, *Fractures and Disloc.*, Ed? p. 434) caught the heel of his boot in a knot hole, in the floor, which threw him backward, and in the effort to save himself from falling the patella was fractured.

Case 11.—Jno. C—k was admitted to Dr. R. J. Levis' ward at the Pennsylvania Hospital January 7th, 1878, and said that he had slipped upon the ice, and in the effort to save himself from falling felt the patella snap. There had been a fracture of a similar nature of the opposite patella seven years before. The fragments on the side of the old fracture were separated four inches. The patient stated that there had been close apposition when

he was discharged, but that the separation had gradually taken place.

Case 12.—About the same time Mary Mc— was admitted into the same Hospital and under the care of Dr. Levis. The fracture was also caused by a slip upon the ice and an attempt to prevent falling.

Case 13.—Sands (*Med. Rec.*, Feb. 2, 1878, p. 87) reports a case where the fracture was caused by the effort to prevent falling on being roughly assaulted.

Case 14.—A gentleman (Sir A. Cooper, *Surg. Essays*, vol. I, p. 350) in jumping a ditch fractured his patella in his effort to prevent falling upon reaching the opposite side.

Case 15.—Sir Wm. Blizard (*Lancet*, Aug. 17, 1833, p. 673) reports the case of Wm. A—, who, while walking on the curbstone slipped off, and in the effort to prevent falling, fractured his patella.

Case 16.—A man (*Am. Journal Med. Sci.*, July, 1848, p. 220) was tripped by the rope of a canal boat, and before reaching the ground felt the snap accompanying the fracture.

Case 17.—M. Sallemont (*Cyclopæd. Anat. and Phys.*, Todd, vol. iii., p. 70; *Boyer's Surg.*, vol. iii., p. 358) reports the case of Louis M—, who was thrown by a comrade with whom he was struggling, and in the effort to prevent falling broke his patella.

Case 18.—Mr. Liston (*Lancet*, Oct. 14, 1873, p. 81) reports the case of Eliz— S—, who fractured her right patella in leaping from an embankment.

Case 20.—Dr. Kirkbride (*Am. Jnl. Med. Sci.*, Aug., 1835, vol. xvi., p. 330) has reported a case in which both patellæ were broken in a similar manner, but at different periods. The girl, aged 29, was admitted into the Penna. Hospital, Oct. 16, 1833. In falling

backwards and in making an effort to save herself the right patella gave way. She was dismissed on Dec. 2d.

On April 20th following she was re-admitted with a fracture of the left patella, produced in the same manner as before.

Case 21.—M. De Beauvois (*Med. Times and Gazette*, Oct. 9, 1880, and *Med. News*, Jan., 1881) related at the Paris Société de Médecine an example of this rare occurrence. A man, thirty years of age, and apparently in good health, was engaged in the game of leap-frog, and having struck the ground with his feet, when on the point of springing forwards he felt as if he had received a blow on the legs and heard a crackling sound. He fell on the ground, believing that some one had struck him. On his being carried to the hospital, a transverse fracture of each patella, with a separation of not more than two centimetres, was found to exist.

9 Cases.—There are nine cases where the fracture was caused by a mis-step in going down-stairs, and falling backwards, the patients made powerful efforts to prevent falling :

Lancet, Feb. 15, 1840, p. 770.

St. George Hosp. Reports for 1870.

Am. Jnl. Med. Sci., July, 1848, p. 220.

Lancet, Sept. 5, 1835, p. 748.

Am. Jnl. Med. Sci., vol. xxx. (Haywood).

New Eng. Quart. Journal, July, 1842.

Packard's Malgaigne, p. 600.

Hamilton Fracts. and Disl., 4th Edit. p. 434.

#### ANALYSIS OF THIRTY CASES.

In aiming a kick, . . . . .	2
In leaping, . . . . .	3
In leaping (double), . . . . .	1
During lithotomy (double), . . . . .	1
In convulsions subsequent to lithotomy (double), . . . . .	2
Effort to prevent falling, . . . . .	11

Lifting heavy weights, . . . . .	1
Efforts to prevent falling, threatened by a misstep in going down-stairs, . . . . .	9
	—
	30

I believe that muscular exertion is the cause of the vast majority of the cases that are set down as due to traumatism. When a person falls on his knees, the patellæ very rarely touch the ground, the force of the fall is received by the tuberosities of the tibia, and if a fracture of the patella should take place it would be undoubtedly due to muscular action alone. That this must be the case is abundantly proved by the fact that there is, as a rule, no abrasion or contusion of the skin over the patella.

In cases where the fracture is due to direct violence and no muscular force is exerted, the fracture is apt to be in any other than a transverse direction, the skin in many cases being severely pulped. I have, upon several occasions, in the anatomical rooms of the Philadelphia School of Anatomy, tried to produce a transverse fracture of the patella upon the cadaver. I have comminuted it, but I have never without using a chisel or similar instrument, been able, to produce a transverse fracture of the patella, because the essential of that fracture the muscular exertion was absent.

Transverse fractures of the patella are very rarely united by osseous tissue, and the reasons for this are sufficiently simple, and may be briefly stated as follows :

- The intervention of synovial fluid between the fragments.
- The blood supply of one or both fragments being cut off.
- Muscular action prevents perfect coaptation.
- The synovial fluid, when exces-

sive, may be drawn off by an aspirator, or its absorption may be promoted by stimulating lotions applied externally, but if complete coaptation is accomplished and maintained this will not interfere to a very marked extent.

b. The blood supply of the upper fragment is largely cut off, owing to the rupture of the nutrient arteries which come from the anastomoses of the internal and external articular branches of the popliteal artery. The principal blood supply of the upper fragment is derived from the periosteum and from the lower fragment, if it is kept firmly in apposition. As strange as it may seem, this fact is often ignored by surgeons who are called to treat such cases, for by their very treatment they frequently tend still further to diminish the blood supply, by tight bandages, adhesive strips, in fact by nearly all the appliances which make pressure upon the skin over the bone. Thus they defeat the very object which they are endeavoring to bring about.

c. The principal cause in the prevention of ossific union in transverse fracture of the patella is the muscular action. If this be properly overcome and the bone held firmly in position, I cannot understand why the transverse fracture should not unite by bone just as well as the vertical fracture, for the latter certainly must contend against the presence of the synovial fluid, and the probable ruptured nutrient artery, but it has in its favor the absence of muscular action.

I believe it is now an undisputed fact that in transverse fractures uniting by ligamentous bands, the ends of both fragments are very often covered by a bony deposit.—*Edinburg Med. and Surg. Jul.*, 1837, No. 130, Chelius's Surgery, p. 630, vol. 1.

This ossific deposit would in most

cases have been sufficient to hold the fragments firmly together. This seems to me to indicate that the method of treatment to be adopted is that which holds the fragments in perfect apposition, and, therefore, excludes all synovial fluid from between the fragments, and does not interfere with the blood supply of the affected part.

Some surgeons raise the very serious objection to bony union, that it will form a ridge of callus on the articulating surface, which will be sure to cause serious impediment to the use of the limb. I have been unable to find authentic records of a single pathological specimen of transverse fracture where bony union was claimed by the originators of the various appliances for the treatment of this lesion. Their claims are based upon the examination of living specimens, and it therefore seems to me as though the theory of the ridge of callus was raising an objection not founded upon fact, but merely a possibility.

The same may be said of the surgeons who claim that ligamentous is far superior to any other union after this fracture. The fact that the extensor quadriceps muscle has the *bony* patella to glide over the condyles of the femur, seems to me to indicate that *bone* is the correct substance for the purpose and in case of fracture to secure bony union if possible, and I believe it possible. I can not say that I ever saw bony union, because I did not see the cases after death, but I certainly have seen cases under the care of Dr. R. J. Levis, of this city, that were treated by his modification of Malgaigne's hooks, that so simulated osseous union that no one seemed able to define any separation, and the two patellæ measured very nearly the same.

It is certainly remarkable that patients seem to be able to walk quite

well when there is a separation of a considerable distance between the fragments. Benj. Bell makes one inch the limit of separation, allowing of firmness of the knee. Velpeau asserts that he has seen the functions of the joint *completely re-established* with an interval of two or three inches between the fragments. Malgaigne says that such assertions are in his opinion only accounted for by some inaccuracy in examination. He said he never saw the function of the limb completely restored even when the separation was limited to one-third of an inch.

Among the many disadvantages of ligamentous union is its tendency to stretch, an elongation is most certain to follow the fibrous union, and especially is this the case if the patient is allowed to use his limb too soon.

There is a case quoted by Hamilton in his excellent work on Fractures and Dislocations, in whom after three months' treatment by splint the separation was one-half to three-quarters of an inch. The knee was much ankylosed. Soon after this the upper fragment began to draw up and at the end of a year the separation was three inches.

Kirkbride (*American Journal Medical Sciences*, Vol. XVI), has reported a case in which the ligament had stretched two and a half inches.

Dr. Watson (*Watson Four. Med. and Surg.*, Vol. III, p. 366), refers to a case in which the ligamentous band of union measured three and a half inches.

In case No. 11, of the 30 previously mentioned the ligamentous band measured four inches after seven years. It was supposed to be a case of bony union and the case was noted as such upon the books.

The liability of the new formed ligament to rupture, is a serious objection to this form of union.

Hamilton speaks of two cases (*Hamilton, Fracts. and Dislocations* 4th Edit., p. 436).

Morgagni saw two cases, and others have been recorded by Richter, Ortalli, Dupuytren, Roux, Velpeau and others. I have seen but one case.

Sir Chas. Bell saw a case where the skin gave way at the same time that the ligament ruptured, thus laying open the joint. Subsequently it became necessary to amputate the limb.

The most serious sequella of ligamentous union is the great liability to a fracture of a similar nature of the opposite patella. This is occasioned by the increased strain placed upon the sound side by the presence of defective union of the side first fractured.

In case No. 11 the second fracture occurred seven years after the first one.

In case No. 20 the left patella was fractured six months after the right one.

The great necessity of striving, by all honest means, after bony union in cases of this kind of fracture is evident, for even though osseous union be not attained, the shorter the bond of union the better. "For it is found that the joint will always be weak and unprotected precisely in proportion to its length and thinness."—*Gross, System Surgery*, 5th Edit., p. 946.

As I have previously said the reasons why this fracture does not unite by osseous tissue are :

- a. Presence of synovial fluid between the fragments.
- b. Faulty nutrition, due to rupture of the nutrient vessels or compression.
- c. Difficulty of maintaining complete coaptation.

It therefore follows that the treatment to be adopted is that which overcomes these difficulties best, and at the same time does not endanger the patient's life.

It is stated (*Med. and Surg. Reporter*, Nov., 1874), that at the Hospital Laribosière, the surgeons becoming convinced that bony union cannot be attained, "dispense with all apparatus "to coöptate the fragments, which is "perfectly useless, as whatever is done "the surgeon can hardly expect any "thing more than a fibrous union which "after all does not interfere with locomotion."

"Dr. R. J. Levis, of Philadelphia, (*Med. Times*, Dec. 5, 1874), says he "has seen three instances in which fracture of the patella was left without "further treatment than a state of rest, "no attempt being made to secure "mechanically the coaptation of the "fragments. In one case the fracture "was associated with other injuries almost necessarily of a fatal character, "but the patient survived for nearly "three months. In another instance "the fracture was complicated with "severe injuries of the limb which "were attended with such great swelling that the fracture was not recognized until after the lapse of more "than two months.

"In the third case the fracture was "treated as a simple *sprain* with rest "alone by a Homœopathic surgeon and "the patient came ultimately under my "care on account of permanent disability of the limb, due to a separation "of the fragments of not less than *five* "inches. In each of these cases the "separation of the fragments remained "far greater than I have ever seen it "as the result of ordinary treatment, in "which approximation is effected as "thoroughly as possible."

The serious objection to the various appliances which aim to maintain coöption through the medium of the skin is that they tend still further to reduce the blood supply of the fragments, and do not keep the fragments in that per-

fect state of approximation which is absolutely essential for the production of osseous union—therefore it seems to me that they should be discontinued as unscientific.

The above objections cannot be raised against those appliances which act directly upon the bone, and these appliances are hooks originated by Malgaigne and modified by Levis and Morton, and the wiring together of the fragments.

Malgaigne was the first to use the patella hooks, and his uniform good results caused other surgeons to resort to this form of apparatus.

About 1877 (*Med. and Surg. Reporter*, Aug. 31st, 1878), Dr. R. J. Levis of Philadelphia, while using Malgaigne's double hooks in a case of fracture of the patella was impressed by the fact that the double hooks implied that the patella was a symmetrical bone, but as it was known not to be so, it occurred to him that single hooks would be much preferable, and he had made an instrument with two hooks instead of four. The general principle of the hooks has remained the same, but the attachments have been somewhat changed, until now the hooks are held together with a ratchet on a pinion, greatly facilitating the application, and removal.

M. Nelaton (*Clin. Surg.*, Translated by Atlee, p. 171), used the hooks a "number of times, but never found any "of those inconveniences to result from "its use which have been so singularly "exaggerated."

Campbell De Morgan (*Am. Jnl. Med. Sci.*, July, 1863, *Brit. Med. Journ.*, May 24th, 1862), mentions the fact that a large number of cases have been treated by means of Malgaigne hooks in the Middlesex Hospital and the results were most satisfactory.

Mr. Mitchell Henry, (*Lancet*, Aug.,

1860, p. 146), saw the hooks in use for many years in Malgaigne's wards in Paris without any serious inconveniences.

I have had opportunities of seeing quite a large number of cases in the Pennsylvania Hospital treated in Dr. Levis' wards by his modified hooks, and am convinced that if bony union was not attained, it was impossible to determine the space between the fragments, and I cannot remember one instance of serious difficulty arising from the hooks.

Cases when admitted to that institution are usually allowed to remain quietly in bed for a week, the leg and thigh being bandaged to control muscular action. Attention is paid to the inflammatory condition of the parts, which is reduced as speedily as possible with solutions of acetate of lead, etc.

The hooks are applied generally about one week after the receipt of the injury, and are permitted to remain for about four weeks, when very gentle passive motion is indulged in. The patient is not allowed to rest his weight on the affected side for at least two months after the accident.

Sir Astley Cooper, (Sir A. Cooper, *Surg. Essays*, Vol. II., p. 350), performed a series of experiments upon rabbits with reference to the solution of the question,—Why does not the patella unite by bone? In experiment VI, having divided the bone by means of a chisel, he sewed the two portions together, the suture being passed through the tendinous covering of the bone, but the ligatures separated and the bone united by ligament.

It is quite evident that Sir Astley Cooper had grasped the thought of wiring the fracture in the human subject, but it does not seem to have made much impression, either because of its failure in the experiment or because his

mind was occupied in watching intently the phenomena of repair. I am not aware of any application of this principal to the human subject made by Cooper.

But Mr. Lister (*Med. and Surg. Reporter*, Jan. 12, 1878), cut down upon the fragments in a case and drilled the two portions of the patella and tied them together with silver wire. Six weeks after the operation the wound was completely healed, the ends of the wire projecting through the scar. There was in this case no constitutional disturbance and the patient obtained excellent use of his limb. Dr. John Rhea Barton performed a similar operation, but lost his patient—*Gross, System Surgery*, 5th Edit., vol. I, p. 1,004.

Dr. T. M. Logan performed this operation once. (*Pac. Med. and Surg. Journ.*, Dec., 1866), (*Agnew's Surgery*, Vol. I., p. 781). The fracture had existed for nine weeks when the wiring was done. The wire remained six weeks, the patient being kept under treatment for four months and a cure is recorded.

Dr. J. E. Van der Meulin, of the University of Utrecht Cameron of Glasgow (*Hamilton Fracts. and Dislocations*, Edit. 1880, p. 516), Mr. Rose of London (*N. Y. Med. Journal*, May, 1876, page 463, *Med. Rec.*, April 3, 1880, p. 384), G. McClelland (*N. Y. Med. Journal*, May, 1876) have recorded cases, but I believe the procedure to be such a dangerous one, presenting no superiority over the hooks when properly applied, that I believe it should be resorted to only after every other known method has failed; and even then only after a deliberate study of the cases previously operated upon.

In closing I would say that it is my conviction that the hooks are the only scientific method of treating transverse fracture of the patella.