CASES
OF
RE-FRACTURE OF BONE;
WITH OBSERVATIONS.

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Received Nov. 10th, 1858.—Read Jan. 11th, 1859.

I VENTURE to bring before the Society the report of a few cases of more or less interest to the surgeon, viz., of re-fracture of bone, to which I have added some explanatory observations.

The subject of re-fracture of bone as a curative process in surgery has, perhaps, not sufficiently occupied the attention of the profession. Although it is true that, by virtue of a higher-classed surgery, the necessary resort to re-fracture must be comparatively rare, we have yet no exemption from liabilities to failure, the result of eccentric varieties of fracture, and constitutional peculiarities both of a moral and physical character. The difficulties incidental to the management of such cases can hardly be adequately tested by the statistics of our hospital practice, whether metropolitan or provincial; because such institutions, from the abundance of their resources, may be supposed to possess all required appliances essential to treatment under

every circumstance of difficulty and complication. Notwithstanding the ample supply possessed by our hospitals and other large institutions, the varieties and complication of splints, and other agents employed for the purpose of maintaining exact apposition between the broken ends of a bone, it will not be denied by men of even moderate experience, that cases of extreme difficulty are not of very infrequent occurrence, which tax to the utmost the ingenuity and the perseverance of the surgeon. We occasionally meet with combinations, in the same case, of oblique fracture of the shaft of a long bone, large muscular power, and more than ordinary irritability of the nervous system—three conditions which collectively set at defiance every attempt to maintain the entire apposition of the broken ends of the bone, coupled with that perfect immobility of the limb, on which alone complete success must depend. Another element of difficulty is occasionally found in extreme irritability of the integuments. In such cases, the subject of fracture is unable to bear with impunity the requisite pressure caused by the splints, and ulceration follows with remarkable rapidity on one or more projecting or salient points of the limb, compelling a change of apparatus, generally from a perfect to a less efficient form of mechanism.

Of this difficulty I had a remarkable example in St. Bartholomew's Hospital, during last summer, in a man, æt. 40, who sustained a fracture of the middle of the thigh-bone. The bones being adjusted, a long splint was applied to the limb by means of the ordinary bandages; but, in the course of a few days, he complained of such severe pain, caused by the pressure both of the splint and bandage, that I was compelled to order their entire removal. The parts subject to pressure were found to be congested with blood, and extensive ulceration followed in the region of the hip, groin, and foot; all restraint was rendered nugatory, and the man recovered with an overlapping bone and a short limb. Nor is this the only case of this peculiarity of constitution that has come under my observation. I may

allude, among other examples of the evil results of intolerance of pressure on the skin, to a case of popliteal aneurism, which I essayed to cure by means of the pressure of a tourniquet. Before commencing the *permanent* resort to the instrument, I applied the tourniquet over the femoral artery, in what is termed Scarpa's triangle, with a slight tension only of the screw; but, within forty-eight hours, the whole surface became erythematous, the limb swelled, and I was compelled to tie the artery. Moral wilfulness also is no very infrequent obstacle to complete recovery from a fractured bone. In the summer of 1857, I had a man with this attribute under my charge in St. Bartholomew's Hospital. He had broken his thigh-bone about the middle. He also was treated with a long splint. Finding the perineal bandage disagreeably tight, he relaxed it during the night. The house-surgeon remonstrated with him, but in vain. On the following day he untied the bandage, and set the splint loose. In vain I assured him that his recovery depended absolutely on his tractability, and that without implicit obedience he would become a cripple for life, but he persevered in the management of his own case, the bone united with the limb three inches short of its original length, and he left the hospital.

In some examples where the fracture takes place by a long obliquity, and the fractured surface is more than usually smooth, there remains nothing but the force of the extending splint, combined with its lateral pressure, to maintain the broken surfaces in apposition. But an extending splint, unless applied with unusual tension, contends imperfectly against the persistent influences of muscular contraction. The consequence is that the contraction of the bones, especially in persons in whom the ossific reparation is more than usually slow, continues to increase, while the altered relation of the bones is so insidious as to escape observation, and the final union may exhibit the bone abridged to the extent of one or two inches of its normal length. However perfect may be the measurement of the limb at the date of the first application

of the splints, the retraction to the above extent is complete, and the union is firm.

I do not mention these cases of imperfect recovery from fracture with a view to the appropriateness for re-fracture, but rather with that to their rejection. I would select such examples of failure as are attributable to causes, incidental to the first fracture, but avoidable on the second; and inasmuch as both constitutional irritability and moral unfitness for personal restraint would be rather aggravated than mitigated by protracted physical suffering, it must be obvious that such are not cases to sustain a repetition of similar and possibly even more critical restraint than appeared to be required by the former injury. The case may be one of inherent difficulty founded on the combination I have alluded to, in the form of great obliquity of fracture, occurring between the ages of twenty-five and forty-five, a large muscular development with a natural intolerance of restraint; the extension may be inadequately made; the mechanism, though sufficient to the end of maintaining complete apposition of the broken surfaces for ordinary occasions, is insufficient for this. The measurement of the limb made by coarse tape, or by any material at hand, however unsuitable, to determine the exact adjustment of the bone, finds a defect of apposition of half an inch or more, which, it may be argued, if not increased by further retraction during the treatment, may be expected to restore a good, serviceable limb without apparent lameness in the future gait of the patient. If to these conditions be added inexperience in the application of splints, coupled with imperfect mechanical knowledge, we have the elements of a permanent retraction of the bone to any amount, whether in the case of fracture of the bones of the lower extremity so slight as not to affect the gait in walking in any appreciable degree, or sufficiently great to cause permanent and injurious lameness for life. In the instance of the upper extremity, I have been led to resort to re-fracture of the bones of the forearm in cases, in which retraction of both bones (itself an evil, if taken alone,

of no great moment) has been accompanied with loss of muscular power, whether of flexion or extension, of inability to rotate the arm, or of permanent pain resulting either from pressure on or displacement of one or other of the nerves of the forearm, or, possibly, from some entanglement of muscular or fibrous tissues in the uniting medium of the fractured bones. Surely on such conditions it is warrantable to retrace our steps towards the condition of the patient at the date of the first fracture, provided that object be attained without *difficulty*, and its almost necessary concomitant, *danger*.

That actual re-fracture may be attained without the presence of either of these objectionable elements I think I shall be able to show. It does appear that the uniting material of a bone, at the expiration of three, four, or even five months, is capable of being separated by lateral pressure with a comparatively small effort. The results of the experiments on animals instituted by the great French surgeon, Baron Dupuytren, led him to the inference that a greater quantity of hard matter, whether bone or not, was deposited about the broken ends of the bone than was required for ultimate use; and the examination of the evidence obtainable from preparations of the uniting bones of animals, undoubtedly exhibits, on all occasions, solid masses of firm substance around them. It has yet probably to be determined whether the process first described by Dupuytren may not apply as the rule in those cases, in which the attempt at motion between the bones prevails, or whenever we fail to effect that entire and absolute rest of a broken limb, which the moral restraint as well as the higher sensibility of man will commonly, if not invariably, command. It is almost impossible to ensure perfect immobility of the broken limb of a dog even from the hour of the fracture, and the consequence is that under the best management the deposit of bone around the fractured ends is large in quantity, as if coarsely thrown down in the neighbourhood of the fracture rather than in a direct line between the fragments. Very commonly the bones, not-

withstanding the superfluous amount of bony deposit, fail to unite, and a permanent false joint is the result.

The practice by Dupuytren of attempting the readjusting of fractured bones imperfectly united at a considerable term after union was completed, is no doubt in the recollection of the surgical members of the Society. Many cases are cited as examples of resetting bone by means of gradual and permanent extension and lateral pressure, while direct rupture of the uniting medium is strongly deprecated. No one will doubt the greater appropriateness of simple and gentle means employed in disuniting a bone surrounded by soft parts, if the simple means suggested will effect the disunion; but if gentle efforts will not attain the end, the question arises, are we justified in resorting to more powerful agency in order to obtain separation of the bones? I believe we are. The means resorted to by Baron Dupuytren were gradual extension and lateral pressure. If we examine a preparation of a broken femur at the expiration from the fracture of seven or eight weeks, in which overlapping of the bones has occurred to such an extent as to require, or even to justify, an attempt at separation, supposing the limb be shortened to the extent of an inch and a half or two inches, it is obvious that lateral pressure must be perfectly inefficacious, and that any attempt to lengthen the limb by permanent extension must be nearly equally so, because, as the bone has at that time acquired sufficient strength to support the weight of the body without separation of the uniting medium, we may reasonably infer that no less powerful extension than the equivalent to that weight could effect any change in the new structure, and probably a great deal more than this force would be required to elongate it. M. Dupuytren assigns a period of sixty days, at the expiration of which it would be imprudent, he considers, to attempt the separation. At the same time he publishes cases of successful treatment applied to fractures considerably exceeding the above term. These examples, however, refer either to cases of imperfect union, or to such deviations from perfect recovery as are

characterised by deformity caused by lateral distortion, rather than by deficiency in the normal length of the affected limb. These are not cases of overlapping, but merely of union of the broken extremities in an indirect line ; the points of contact, being limited to the extremities only, are capable of separation by very slight force.

But I am the advocate of a proceeding of a larger kind. I believe bones which have united to any length by lateral apposition of the entire diameter of the shaft, and in which the spaces formed by the contact of the two cylinders are filled with fibro-osseous matter possessing firmness sufficient to support the superincumbent weight of the body, are susceptible of disintegration by a judiciously applied force to the advantage of their replacement to their natural relations prior to fracture, and without injury to the soft structures around them.

I place the warrant for re-fracture of bones imperfectly united, with overlapping to any moderate extent, on the grounds of its practicability, of its safety as an operative proceeding, and of its indispensability to the perfect utility of the limb involved.

First, with respect to its practicability. We are not to gauge the density of the uniting medium of a fractured bone, or to infer its absolute osseous nature by its power of resistance to the superincumbent weight. If this material be examined at the expiration of even four or five months, when, under the slight protection of the pressure of a bandage, a man has resumed, in a limited degree, his daily occupations, it will often be found to be composed of fibrous tissue, in which the deposit of bone is yet limited. My observation leads me to believe that the perfect process of reunion is greatly protracted in examples of imperfect adaptation of surfaces, and that we are not justified in calculating on an exact rate of progress in cases presenting various and dissimilar conditions, including every variety of fracture of which bone is the subject. The difference of time may extend over a period of several weeks. Again, in examples of overlapping in the long cylindrical bones,

it would appear that the two portions, though laterally united, fail somewhat in nutrition, and become more or less atrophied; the walls become reduced in thickness, and the medullary cavity in diameter. The extremity of each portion is closed, and presents the appearance of a truncated cone. It may be perfectly true that the union of such a fracture is compatible with moderate exercise, and that the limb will support the weight of the body without pain or discomfort of any kind, beyond that arising from the defect of gait which is dependant on the inequality in the length of the two limbs. But it does not follow from this, that it will yield to lateral force. In the upright position the resistance is made by the whole length of the uniting medium. By bending the limb at the line of union we have the resistance only of the transverse diameter. If this union be susceptible of rupture, it is effected without great difficulty on the part of the surgeon. The practicability of re-fracture of a bone in any given case can only be brought to the test of experiment. It is impossible to lay down any inflexible rule of conduct. We may be confident of our ability to effect separation in some cases, and our inability in others. We cannot define the exact line on which success and failure meet. The power to re-fracture is obtainable on different conditions in different cases. It depends on age, possibly on sex, on the extent of surface involved, on the duration of the healing or uniting process, and finally on the tact as well as the force of hand employed in the operation; but that, on ordinary conditions, it may be effected for many weeks, or even months, after the restoration of the limb to careful exercise, there appears to me no good reason to doubt.

Secondly, with respect to the question of safety, two points are involved. 1st. The reasonable probability that the bone will break at the site of the original fracture, and at no other part. 2dly. That the separation may be effected at the site of the original fracture, without injury to the soft parts around. I know but of one bone in the human body coming within the required conditions, which

can be broken, even in its dried state, by the hand of man employed with all its muscular force, viz., the fibula. I have seen a powerful man entirely fail to break a single radius, on which his muscular force was immediately directed. Is it possible to apply a similar force to a bone surrounded with soft structures on every side? Long before such a force could reach the bone, the skin would give palpable evidence of violence by laceration. In a case in which, after the most vigorous efforts, I failed to re-fracture a femur which had united for nine months, the man sustained no injury beyond a bruising of the skin, from which he entirely recovered in two or three days. Moreover, the broken ends of the bone become rounded off, and there remain no sharp or prominent angles, or spicula, which our natural apprehension of danger might point to, as fruitful sources of injury to surrounding vessels or nerves, and the separation is, of course, made with due consideration to their possible proximity. The effort made, and the force applied, are gradual and deliberate, and it is better, should the bone yield by pressure upon it *in one direction*, to break down the connecting medium by slight extension *in all*, and that the broken bone be carried around the circumference of a small circle rather than forced in the single radius of a larger one. It should also be rotated on its axis in the case of a single bone, as the femur or humerus.

The experiments of M. Dupuytren in this path of surgical science obviously refer to cases of deformity arising from a defect in the direction of the broken bone, or in which an angle is formed at the point of union. He recommends the employment of "a graduated force," to be maintained, and gradually augmented. Now, as my experience proves the practicability of the re-fracture of bone many weeks after the imperfect union has proved sufficient to support the weight of the body, it is obvious that no application of an extending force of less amount than one hundredweight and a half could be available to any useful purpose. How is such a force to be applied? Could it be resorted to for even a brief period without suffering and danger? M.

Dupuytren quotes the authority of Dr. Jacquemin in favour of the extension of the limit of sixty days, beyond which he would deem the attempt unwarrantable. But I have endeavoured to show that it is impossible to fix a limit; that the nature of the uniting material is dependant on age, on sex, on health, on immobility, and on the mechanical relation of one fragment to the other; and I have broken a femur, firmly united, and without danger, at a date the double of that which M. Dupuytren has named as the utmost limit at which the attempt would be justifiable, and I have broken it by the very means which he has deprecated as dangerous.

Thirdly, with respect to the question of interference in these cases, it can only be determined by the requirements of any given example. If, the fracture having occurred in the upper extremity, the imperfect union of the bones have compromised the movements of the arm in pronation and supination, or materially impaired the actions of the fingers or hands, or if in the lower extremity a considerable degree of lameness is the result, whether consequent on obliquity of the bone or abridgement of the length of the limb,—in either case, be the interval from the accident long or short, be it one month, or four, five, or six, I can find no objection under ordinary conditions to the attempt at re-fracture with a view to readjustment. The limit as to time must, as I have said, be indefinite; the practicability to accomplish the separation of the united bones without injury to the soft structures of the limb constitutes the sole, but as I think the sufficient, guide to its warrant. Short of such an occurrence, any degree of force may be applied, in the full assurance that should the bone break, it will break at the point of fracture, and in no other part. I would suggest, if common discretion did not otherwise dictate it, that the force be applied with all requisite care, gentleness, and deliberation. Its direction would be determined rather by the relation of the bones to each other, than by that of the vessels of the limb. We have, in the attempt to reduce old dislocations, sufficient evidence that

the large vessels of a limb may be made liable to a good deal of violence with impunity, that they may be subjected to considerable displacement, to retraction, and again after the expiration of several months to elongation, without damage to their structure or function. In the case of old dislocations of the femur on the dorsum ilii, we elongate the femoral artery to the extent of its abnormal retraction. This would probably be equivalent to from one to two inches; and, in the case of the humerus in dislocation under the pectoral muscle, to that of one inch. But I know of no example of injury sustained by the main artery of either limb in the attempt at restoration of the dislocated bone to its normal relations. It will hardly then be asserted that the liability to injury of the arterial system of a limb from the required elongation presents any obstacle to the operation of re-fracture; while, if we reflect on the nature of the union of overlapped bones, and recollect how completely the rough projecting surfaces of bone are rounded off by time, we can scarcely admit the liability to injury to the vessels from their cautious separation.

The act of disuniting the bone is effected by slow laceration rather than by a snap or fracture. It is not a sudden but a gradual process, requiring persistent rather than sudden force. It is the act of tearing rather than breaking, the name of which implies the fracture of hard material, whereas I have endeavoured to show that the uniting medium, though sufficient for the purposes of locomotion, is yet soft and lacerable.

With respect to the requisite elongation, on all accounts it should be effected by a great power gradually applied, and that of the compound pulleys is desirable in cases in which the retracting force of the muscles is considerable. In children, or in the emaciated limb of an adult, pulleys are not essential. The extension, however, should suffice to restore the limb to its normal length, and every appliance required to maintain the bones in exact apposition should be within reach, and prepared for instant application.

CASES.

The first case to which I shall refer is recorded in a paper by Mr. Wiblin, of Southampton.¹ The bone involved was the right femur. The man's age, 23. Eleven weeks had elapsed since the fracture. The bone was firmly united, as may be inferred from the above interval. The limb was two inches short of its natural length. The man's gait was very imperfect. Having placed him at the end of his bed, laid the thigh over a firm piece of board, and made every requisite preparation for retaining the bones in the natural situation, chloroform was administered. The patient being rendered perfectly insensible, I gradually leant my weight on the knee, and the separation was audible to persons around. I then rotated the bone in all directions, until the separation was complete. Pulleys were applied by means of a strap fixed round the ankle-joint, and gradual extension made for three quarters of an hour, before the normal length of the limb was restored. His recovery was complete.

CASE 2.—A man, æt. 40, was treated in the Casualty Ward of St. Bartholomew's Hospital for oblique fracture of both bones of the right forearm, about halfway down. He declined admission as an in-patient. In consequence of his negligent attendance at the hospital, the bones overlapped, and were fixed in partial supination. He lost the power of closing his hand, and he suffered severe and continuous pain at the seat of fracture. I gave him an opiate liniment to apply frequently. The bones had apparently united by the thirtieth day, but both the local pain and the distortion of the limb increased, and at the expiration of the eighth week I proposed to him the readjustment of the fracture under chloroform. He declined this offer, and I saw nothing more of him for several weeks. However, the pain continued, and he determined to submit to the opera-

¹ 'Lancet,' July 21st, 1855, p. 49.

tion. This I performed at the expiration of the seventeenth week, either on or about the 120th day. The patient having been put under the influence of chloroform, I drew the arm over the corner of the operating-table, and carefully applied a portion only of my weight. The bones separated without any difficulty. Extension was made slowly but efficiently, and the forearm fixed by lateral splints in slight pronation. The pain subsided immediately, the movements of the arm were fully restored, and the man's recovery was perfect.

CASE 3.—I relate the following case, in which my attempt to break the bone failed, for the purpose of showing that great muscular power may be employed on the surface of a limb without injury to the soft structures beneath.

In this example, one of fractured thigh, the overlapping was very great, and the obliquity considerable. I have alluded to this man's case as that of imperfect union of bone from wilful interference and great intolerance of restraint during the treatment. He applied to me at St. Bartholomew's Hospital, after an absence of several months, intreating me to give him some relief. He consented to my proposition of the attempt to break the bone, which, considering that more than nine months had elapsed since the accident, did not promise a very favorable issue. Long as was the period since union had been completed, it did not appear probable that injury would arise from the attempt, and he was placed under the influence of chloroform. I employed the full force of pressure in every direction, by every warrantable means, but could make no impression on the fractured bone. He sustained, however, no injury through the attempt, and he left the hospital on the fourth day.

CASE 4.—My attention was called to the case of a gentleman, æt. 46, who had broken his thigh, about the middle, by a fall. By some mismanagement in the placing of the bone at the time, the length of the limb, when union was completed, was found reduced to the extent of an inch and

three quarters. The lower fragment rode forwards, and its projection remained very prominent under the quadriceps muscle. I saw him on the twenty-fourth day from the date of his first supporting the weight of his body on his limb. To all sensation the union was perfectly firm, and he moved upon the limb without apprehension or pain; but the inequality in the length of the two limbs rendered his gait very unsightly to others and irksome to himself, which was further increased by the circumstance of the bone being distorted by the obliquity of the union. Another evil arose from the present condition of the limb, viz., inability to flex the thigh to its fullest extent on the pelvis, in consequence of the rectus muscle being implicated in the fracture.

On the seventy-fifth day from the fracture I separated the bones at the point of fracture. The operation, if it merit the name, performed of course under the influence of chloroform, was effected, as in the former thigh-case, by bringing the fractured part to the edge of a thickly padded board of wood placed on the end of the bed. I leant my weight on the front of the knee, pressing the lower fragment backwards. The force was not very great, at least was greatly within what I retained the power to exercise, had it been necessary. The separation was completed by the rotation of the leg in the entire circle. Pulleys were employed to elongate the limb to its normal length, which was not accomplished within a period of forty minutes. A long splint, a front and inner splint, were applied with all requisite severity of tension, and were retained in that condition for a fortnight, and finally removed at the expiration of the seventh week. The bone had now fully united at its broken surfaces, and the normal length of the limb was restored. The result fully justified the treatment adopted, and rewarded the patient for his long period of confinement and deprivation.

CASE 5.—A young man, æt. 22, sustained a fracture of both bones of the leg. On the final removal of the splints

on the forty-sixth day, a gum and chalk bandage was applied, which was retained on the leg for a period of two weeks. Up to this date no measurement had been made, and no suspicion arose that the union was imperfect. I saw the patient in the eleventh week from the accident. The leg was shortened to the extent of an inch and a half, the upper end of the tibia projected forwards, and the lower end extended obliquely outwards so much as to render it difficult to throw the weight of his body on the flat sole of his foot. I had the patient placed under the influence of chloroform, broke the bones, extended the leg by the force of the pulleys, applied a long splint, and a second splint on the inner side of the leg. The union of the bones is firm; and at the expiration of two months from the date of the operation, the man walks firmly and well on the affected leg.

CASE 6.—A child, *æt.* 6, sustained a fracture of both bones of the leg. The management of the case was undertaken by a female friend of the child's mother, who, having performed the functions of a nurse in a large hospital at a former period of her life, undertook the charge of the child. She applied splints, or the substitute for splints, on each side of the leg, and retained them in position for thirty-eight days. On the forty-fifth day I examined the leg, and found the tibia greatly bent backwards, forming an angle at the point of fracture, and the fibula overlapped to the extent of nearly an inch. The opposite limb was well formed, healthy, and thoroughly developed. When the child had been brought under the influence of chloroform, I broke the uniting medium, and extended the leg to its primary length. Two side splints appeared all that was required, and at the present date of three weeks from the re-fracture the child is progressing favorably towards its recovery.

CASE 7.—A boy, *æt.* 15, was sent to me, whose right leg was fractured at about one third of its length from the ankle-joint. The fracture, which was caused by a cart-wheel passing over the leg on ploughed land, was very

oblique, and involved both of the bones. He was placed in bed, and lay, without any attempt being made to adjust the bones, for several weeks, during which his diet was restricted, with a view to avert the evils attendant on inflammation. Splints were then applied, and the leg "put up;" but the muscles had retracted, the bones overlapped, the foot came in contact with the ground on its outer edge only, and the limb was deficient in length to the extent of upwards of two inches.

The boy came under my observation at the expiration of thirteen months from the date of the accident, at which time he was unable to throw the slightest weight on the affected side. It did not appear, on careful examination, that the union of the bones was perfectly firm, and, having had the boy brought under the influence of chloroform, I separated the uniting medium, although not without difficulty. Extension by means of pulleys was made for three quarters of an hour. The distortion of the limb became greatly reduced, although still retracted in length to the extent of one inch. Splints were applied with more than ordinary care, the pressure of which produced extensive ulceration of the leg below the knee and about each ankle, and thus three weeks' time was lost. I then divided the tendo Achillis, and renewed the attempt to extend the leg by means of pulleys. This object was accomplished with some success. The natural form of the limb was restored, the bones united firmly, and the boy recovered the entire use of the foot. He places it fearlessly on the ground, and walks with an almost imperceptible limp, consequent on a retraction of the limb that does not exceed three quarters of an inch.