

Anatomy and Piano Teaching

I must, first of all, explain my presumptuousness in attempting to discuss such a huge and complex subject as anatomy, when I have had no formal medical training.

Why, then, am I giving this talk?

I have had an interest in anatomy for many years and have believed for a long time that we should be relating its knowledge to the art of piano teaching. In spite of my little knowledge, I hope that, if I 'start the ball rolling', someone better trained than myself will take up this idea, and pursue the subject further. I believe very strongly in interdisciplinary study, and feel that, today, with so much specialised knowledge available, many productive 'collisions' of traditionally isolated fields must now be possible.

With this idea in mind, I should like to quote from the most recent edition of Gray's Anatomy, published in 1989:

"Human Anatomy is a part, not merely of medical science, but also, beyond that, of biological knowledge, and beyond that also a part of the totality of mankind's understanding of his universe. But it has been customarily isolated, and usually still is in many schools and texts... it is stultifying to confine enquiry or description to the artificially bounded 'subjects' of 'education'. Anatomy has been a particular sufferer in this compartmentalisation... There are, in fact, no real boundaries between 'anatomy' and all other fields of human enquiry..."

"...the human individual has not only applied himself to the creation of innumerable skills and crafts for mere survival, but has, in the unceasing development of mind, evolved the arts — painting, literature, poetry, music, sculpture and drama — to enrich our culture."

"Human Anatomy is, therefore, a crucial feature of mankind's unending study of man, which embraces the arts, sciences, mathematics, politics, religions, ergonomics and environmental manipulation — all percepts of human cerebration."

I believe that knowledge of how things work can help us to use them more effectively, whether cars, computers, bicycles, vacuum cleaners, lawn mowers, sewing machines, pianos or ourselves.

It is exciting to see an increasing interest in the use of ourselves. In early times, the practitioners of Zen, Yoga and Tai-Chi brought knowledge of the dynamics of physical movement to a high development. F. Matthias Alexander, with his book, "The Use of the Self", was a pioneer of this way of thinking in the West, and it is encouraging to see not only Alexander Technique lessons becoming widely available throughout the world and being used in music, dance and drama colleges, and in sports coaching; but that there is also a great revival of interest in Yoga, as well as in Tai-Chi, along with other martial arts. I can not hope to touch on the mental training that all these disciplines involve, beyond saying that they are also of crucial importance to us.

From a slightly different angle, the science of ergonomics — the science of fitting the task to the body, rather than (as is still all too often the case) forcing the body to adapt to the task, is attracting an increasing amount of interest. Unfortunately, one only has to look at a modern class room to see how children are still obliged to distort themselves in order to fit unergonomically designed desks and chairs, and to see how little time is being spent on good posture and efficient pen holds in handwriting. The current fashion seems to be to make children produce vertical strokes on paper placed squarely in front of them. It takes only a few moments thought to see that this does not take into account the way the arm and wrist are designed. That such an obvious fault remains generally unnoticed raises some worrying questions :— Have we become accustomed not to notice? And are we making similar mistakes elsewhere?

One of the most exciting areas in understanding the use of the body is in the field of sport, where the latest technology is being brought to bear to improve the performance of athletes in the endless race to break international records. There seems always to be plenty of money available when national prestige is at stake! Unfortunately, it often seems that athletes are being pushed beyond what is natural or healthy for them. Nevertheless we can take advantage of the books being written about the

technological approach to sport even if they are not primarily being written for us. Many of the principles are the same.

Among the very few who have applied anatomical knowledge to the teaching of musical instruments are; Otto Ortmann (piano), in the 1920's, Josef Gat (piano), 1960's, and Paul Rolland (strings), 1970's. Rolland is perhaps the greatest pedagogue of them all, working from the broadest base, with a well co-ordinated team of experts behind him, covering subjects such as mechanics, anatomy, neurology, kinesiology, psychology and teaching technique.

I have often wondered why it is that string teachers have for so long been in agreement on the basics of how their instruments should be played, with the works of Flesch and Galamian still being widely used today, whereas there is no similar consensus of opinion about works of piano pedagogy, whether they are by Matthay, Breithaupt, or Ching — who were working at about the same time as Flesch and Galamian — or by present day writers. I believe that the reason for this is that the mechanics of playing the violin are largely out in the open. You can see the strings and the bow, and most of the problems are fairly obvious. It is clear that bowing can be categorised into types such as *sautier*, *martelé*, *spiccato* etc, that a straight bow produces a better sound than a crooked one, and that a stiff left hand can't vibrate effectively, etc. On the piano, everything is under cover. The action of the instrument is inside a case — the workings of the hand and arm are hidden — and all one can see is the point of contact between the finger and the key. As there must be an infinite number of ways to set a piano key in motion, there can be no consensus about the *best* ways of doing this until the workings of the hand and arm — and, indeed, of the piano itself — are understood.

I sometimes meet with opposition to the idea of applying the analysis of body movement to making music. People seem to fear that analysis will take away some of the magic, and that, if a pupil is set up with generally good posture, the movements and muscular co-ordination will look after themselves.

In answer to the first objection, I can only say that the more I look at the way the body works, the more magical and wonderful the whole process seems; and in response to those who believe that 'the muscles will look after themselves', I can agree that this is true of those who have an instinctive physical gift; but would point out that there are many potentially fine musicians who are not so lucky, and who find themselves muscularly 'tied in knots' and intensely frustrated in their desire to realise their artistic aims. In any case, are we not, as teachers, committed to helping everyone to achieve their fullest potential, regardless of talent?

There does, however, seem to me to be a danger in making deductions based on a limited knowledge of anatomy, and then applying these as if they were unshakeable facts. I am not interested in finding 'rules of thumb' but rather, in finding new ways to ask questions about technical problems and to find more ways of experimenting in order to solve them. Pupils differ from each other anatomically, not only in the lengths of their bones, but also in the number of muscles and tendons they have, so the solution of a problem for one pupil will not necessarily be the same as that for another.

Here I would like to quote once more from Gray's Anatomy:

"Rote repetition of 'acceptable' answers to specific questions, although engrained in many vocational examinations, is an actual impediment to progress. Uncertainty, in the face of insufficient soundly based data, should be stated and will only lessen as these accumulate".

This would, perhaps, be a good place to assure you that all my ideas expressed in this talk are being subjected to constant re-evaluation as my knowledge and experience (hopefully) increase, and that any conclusions I draw represent only the present 'state of play'.

Even having limited my subject to the skeleton and muscles of the hand and arm, I will be doing well to get beyond the 'bare bones' of my talk, but I will attempt to put some 'flesh' on them before the end of this session.

Useless Fact No 3,019: There are 30 bones in the upper limb, and 39 muscles that control the movements of the hand. So, where to begin?

Let's start with the bones.

Please stop me if I talk too quickly — and *do* ask questions as we go along.

— *Diagram* —

There are already some observations we can make, just from knowing about the bones.

Let's look at the way we can turn the hand either palm up, or palm down. What we piano teachers usually call 'rotation' and anatomists call '*pronation*' and '*supination*'.

Pronation is, of course, the normal position for piano playing, and problems often arise when pupils have a limited amount of pronation. They may not be able to compensate for the different angles of articulation at the first knuckle of each of the fingers, (which is due mainly to the concave shape of the palm) — *demonstration* — ,they may not be able to put the thumb under the hand far enough to connect the notes of, for example, arpeggios, and they may also have difficulty in playing rapidly alternating notes.

— *Description of forearm rotation showing the bones of the arm in the anatomical position and how they cross over in pronation.*

- *The limits of pronation, and how the angle of the hand can be increased by raising the upper arm (elbows out).*
- *Demonstration of the way the thumb moves on a wide arc from its saddle-shaped joint (optimum angle of function), and how pronation can help it to reach further. The thumb as an extension of the radius. (Radius - scaphoid - trapezium - 1st metacarpal).*
- *Other thumb under problems; fear of not seeing the thumb — pronation of the thumb (joint at a right angle to those of the other digits)— playing on the nail.*
- *Getting thumb away from the keyboard to allow for optimum angle of function, and comfort of fingers.*
- *Warning about pronation not being the only way to play arpeggios. Description of use of rotation in high speed arpeggios. "The technique changes as the speed changes".*
- *Discussion of radial and ulnar deviation in arpeggios etc. — exercises for developing these movements.*

Rotation can also be used for the rapid alternation of notes, in trills, tremolandi, alberti figures etc. and it is, in fact, one of the fastest movements we can make, being preferred by the best tympani players when speed is important.

— *Demonstration, incl. showing how rapid alternation can be improved by moving the elbows away from the sides.*

The superior strength of supination over pronation, due to the powerful biceps brachii muscle in the upper arm assisting in supination. Why weight lifters lift in supination — the design of taps, screws etc. Discrimination against the left handed!

Upper arm rotation is frequently used for more powerful playing and where endurance is important, and is usually used along with some degree of forearm rotation, either consciously or sub-

consciously in varying proportions depending on the musical effect required. [In fact, all this apparent isolating of movements from each other is a gross over-simplification. There are always more or less complex chains of movements and synergys (*explanation?*) supporting each action throughout the body.]

Upper arm rotation, being initiated primarily by the big muscles in the shoulder is very powerful, and you can keep it up for a long time.

—*Demonstration of upper arm rotation.*

- *Balanced arm movements — and how to practice them.*
- *Use of balanced arm movements to help in pronation-biased rotation (Because of relative weakness compared to supination).*

We can also play alternating notes very softly and sensitively by articulating mainly from the fingers alone, and can make an effective crescendo starting at the first knuckles, moving to forearm rotation and finally adding the weight and strength of the upper arm.

—*Demonstration.*

There is another important use of rotation, and that is the one suggested by Tobias Matthay in “The Visible and Invisible in Piano Technique”, where he uses rotary movements to accustom pupils to supporting each side of the hand with minimal tension. When these movements have been learned, the pupil can play without *visible* rotation, but all the while supporting the hand with the same muscles that were used to create the rotation.

Players who have not learned to do this often support the hand by flexing both the supinator and pronator muscles in antagonism thereby making the forearm behave like a solid block which is insensitive to the contours of the keyboard, the needs of each individual finger and to fine adjustments of tone, all the while contributing to a build up of tension in the hand and arm.

I have often noted how easily a ‘difficult’ passage can be mastered by studying the rotation patterns. Such passages frequently have complex rotation patterns, and until these are learned, the muscles are confused and tend to tighten antagonistically.

There is often confusion as to which way we should rotate when putting the thumb under:

— *Demonstration: Chopin’s “Fantasie Impromptu”? — trills, etc.*

Otto Ortmann, already mentioned, produced two books; “The Physical Basis of Piano Touch and Tone” (1925) and “The Physiological Mechanics of Piano Technique” (1929) which are both important pioneering works of piano pedagogy, and whose experimental methods still stand up well to modern scrutiny. From a detailed analysis of the skeleton of the hand and arm, he arrives at what he calls ‘the normal arm-wrist-hand position’ in the following way, and I quote:

p 30, from “A piano technique,...” to “This can be determined for each joint.” on p 31.

I won’t read the full passage as it is rather arduous and full of degrees and clever compromises, but it is here if any of you want to read it afterwards.

He finishes by saying: *p 32, from “By dividing the excess curvature among the various joints...” to p33 “... is movement, not position”.*

Although I am supposed to be talking mainly about bones at the moment — I cannot resist quoting Raoul Tubiana, Director of the Hand Institute (Paris) and Former President of the International

Societies for Surgery of the Hand, who, in a book published in 1984, would seem to agree with Ortmann, although for different reasons.

p 35, from "Neither the flexors nor the extensors" to "automatic opening of the fingers."

Lets now look at the sideways, or lateral movements of the fingers ('*adduction*' and '*abduction*', as the anatomists call them).

It can be seen that the fingers can play wider intervals when the fingers are extended (straight) than when they are flexed (curled up).

There are two main reasons for this: First, there are ligaments that go across the sides of the first knuckles and help to hold the fingers on, called collateral ligaments. These are loose when the fingers are extended, allowing sideways movement, and tight when the fingers are flexed, locking the fingers firmly in position and allowing little, if any sideways movement. You can test this for yourselves.

—*Diagram.*

Secondly, the fingers follow the arched shape of the palm, and, when flexed all follow a line which travels to a point near the centre of the wrist. (To the *scaphoid tubercle*, to be precise!)

—*Diagram.*

Try them one by one. However opened out your hand is to start with, the fingers all zoom in towards the centre as you flex them. That means that, even if you extend your fingers at the first knuckles but keep them flexed at the second knuckles, the first knuckles open out O.K. but the finger tips remain quite close together. So, don't be inhibited by advice about keeping your fingers curved. If you need to stretch a big interval, flatten your fingers!

Fact No 3,020: Did you know that each finger resembles the equiangular spiral discovered by Fibonacci, in 1202, when he was studying the numerical sequence 0, 1,1,2,3,5,8,13,21, etc, where each number is the sum of the two previous? Biologists have since discovered that this spiral corresponds to all the spirals seen in flowers and seashells.

I couldn't bring myself to call this a 'useless fact', because I find it such an awe inspiring thought, and it makes me feel more closely related to all other living things.

And now for the muscles.

But first, a few necessary anatomical terms:

In the anatomical position, the two bones of the forearm, the *radius* and the *ulna*, are parallel to each other, so that this—is the front of the arm, and this—the back. This is easy to remember, because the back of the hand is in line with the back of the arm.

Muscles are described as being either '*flexors*' or '*extensors*'. Flexors are those that close joints, and are generally on the front of the arm, while extensors open joints out, and are generally along the back of the arm. In the hand, the situation is not quite so straight forward, because there are muscles that flex some joints while they extend others; and one set of muscles — the *lumbricals* (we shall hear more of them later) — which are attached at one end to a flexor tendon, and at the other end to an extensor tendon.

This brings me to some more terms: '*tendon*', '*origin*' and '*insertion*'. A tendon is the tough, white cord which grows out of one end—or sometimes both ends—of a muscle. and is usually attached to a bone at the other end. The tendons are the 'strings' that work the human 'puppet', and the muscles are the 'engines' that pull the strings. The *origin* is the place where the end of the muscle

nearest the shoulder is attached (normally to a bone), and *insertion* is where the tendon from the end nearest the fingers is attached (also normally to a bone). The origin is usually regarded as fixed, and when the muscle contracts, the insertion—always near a joint, but on the opposite side of it from the muscle—has to move closer to the origin, thus moving the joint. The *flexor digitorum* muscle, which originates in the forearm, sends tendons, which travel across four different joints, to each of the four finger tips, and these tendons can slide a distance of up to 85mm in the adult arm, as recorded by Verdan in 1976. There are, of course, large differences from person to person.

So, to recap; When a muscle contracts—or gets shorter—it pulls on its origin and its insertion equally. The origin is normally a fixed point, which can not be moved by the muscle in question, so the bone where the muscle has its insertion has to move, thus flexion or extension at either just one or at a series of joints takes place.

Lets take the flexor digitorum profundus (or deep finger flexor) again as an example. It has a large and extremely secure origin in the forearm, mostly from the upper two thirds of the ulna, and ends in four tendons which insert into each of the four finger tips. When the muscle contracts, it can be seen that—as the tendons traverse four different joint—flexion at the wrist and also at the first, second and third knuckles can take place.

If we want to flex only the three knuckles, we have to prevent the wrist joint from moving by stabilising it with its extensors (the *extensors carpi radialis longus* and *brevis*, and the *extensor carpi ulnaris*), which lie along the back of the forearm.

If we want to flex only the last two knuckles, we have to stabilise both the wrist and the first knuckle. That this is possible is due to a fascinating arrangement. The *extensor digitorum* (or general finger extensor) originates mainly from the common extensor tendon, which is attached to the outside prominence, or *lateral epicondyle*, of the elbow, divides into four tendons which travel across the back of the hand and insert into each of the four finger tips (on the opposite side from those of the profundus muscle). Now you would think that, when this muscle contracted, it would lift the fingers up straight, like this. But, in fact, at the first knuckle, its tendons are attached to strips of fibre called *sagittal bands*, which curve round the fingers and are attached to the *volar plates*, here, in front of the knuckles. These volar plates are all connected together by the *transverse metacarpal ligament* which goes right across from one side of the palm to the other.

So— the arrangement looks something like this. — *diagrams*—

The end result of all this tying down of the extensor tendon is this: The extensor tendon can lift the fingers only a limited amount, before the sagittal bands prevent it from sliding any further, and this happens before the last two knuckles have been extended. Consequently, the flexor can pull these two joints of the finger down while the first knuckle remains fully extended. The last two joints of the fingers can be fully extended only by muscles in the hand itself— the ‘intrinsic’ muscles.

I will from time to time talk about ‘intrinsic’ muscles—meaning muscles *in* the hand, and ‘extrinsic’ muscles—meaning muscles which are in the forearm, but which control finger movements.

Now, let’s look at a simplified plan of the main flexors and extensors in the arm and hand.

First, the flexors.

There are four groups of muscles which can flex the fingers— two in the forearm (extrinsic), and two in the hand (intrinsic).

The flexor digitorum profundus is by now something of an old friend. You know that it originates in the forearm and sends tendons to the four finger tips. But there are more features, which should be of interest to piano teachers. Where the tendons begin—just before the wrist—there is a network of areolar tissue and tendinous slips which bind the tendons together and extend as far as the palm. The

tendon acting on the index finger usually escapes most, if not all, of these connections, but the other three are always bound together, whether looser or tighter, depending on the individual. Some people, myself included, have the index tendon connected along with the other three. The links between some of the tendons (usually the middle and ring fingers, but sometimes the index and middle fingers as well) are further reinforced by the *lumbrical* muscles (mentioned earlier), which often have their origins in *two adjacent* profundus tendons in the palm of the hand.

What can we learn about piano playing just from this one muscle?

It is a big muscle, and, out of the 39 muscles which control the hand, second only in strength to its colleague, the *flexor digitorum superficialis*. It is useful for carrying heavy loads, scratching, pinching and, perhaps surprisingly, for making the gentlest finger movements. In piano playing, because of the way its tendons are interconnected, it tends to unify the fingers, encouraging the hand to work as a single unit. It therefore helps us to play loud chords and repeated chords and octaves, where it not only helps to unify the hand, but assists the wrist flexors. It is not helpful when we need to use the fingers more independently, especially in rapid playing or in double notes, as it tends to make the fingers work as a unit— although it can be used in very gentle slow playing, and to add intensity to melodies.

If you were to have the misfortune to have a severed profundus tendon in your finger, the surgeon would probably set your hand in plaster in a shape something like this; with the damaged finger bent, and the other three straight out. Try this yourselves with the middle finger. Now, if you test with the other hand, you will find that your finger tip is completely floppy. (Just wiggle it with the other hand to feel.) This is because your profundus tendons are so connected that it is impossible to have one of them pulled up while the others are stretched out. So this position forces you to leave the damaged tendon loose while it is mending. Clever!

Now, starting with your hand in this position, and keeping the ‘damaged’ finger bent, try to get your fingertip to wiggle by itself without any help from the other hand. You will find that this is impossible unless you allow the other fingers to curl up in sympathy with the bent finger. This proves that the profundus muscle tends to move all the finger tips *together*.

Because we all differ as to the amount of connection we have between the various tendons, some of you will probably have found that you didn’t have to let your ‘undamaged’ fingers come up very far before you had control over the ‘damaged’ finger tip, while others will have had to curl them quite a long way.

Whatever degree of connection you may have had, I’m sure you can see that this tendency of the fingers to move together can have a very deleterious effect on piano playing—and to some people almost cripplingly so. I always make a point of testing each pupil, taking the fingers one by one, so that I can find out just what they are capable of, and how I might need to design a technique to suit them personally.

I can not make this point strongly enough. There can be many anatomical differences between one person and another, and **NO TWO PUPILS SHOULD BE EXPECTED TO PLAY IN THE SAME WAY**. In order to enlarge on this point, I can not resist quoting from the description of the *palmaris longus* muscle, in Gray’s Anatomy:

...Often absent on one or both sides, the muscle is very variable. It may have a proximal tendon or be reduced to a tendinous strand. It may be digastric or reduplicated. It may end in antebrachial fascia, tendon of flexor carpi ulnaris, pisiform, scaphoid, etc. Reimann et al (1944) found the muscle absent in 281 out of 2205 specimens; fifteen muscles had accessory slips and four were double.

Let’s move on to the other big finger flexor in the forearm; the *flexor digitorum superficialis*, or superficial finger flexor. ‘Superficial’ because it is closer to the surface of the forearm than the ‘profundus’, or ‘profound’ muscle, which is deeper than it, and close to the bones. The superficialis

arises from two heads or origins, one from both the ulna and the humerus, and the other from the radius, these two heads helping to centre the pull of the muscle down the middle of the forearm. Like the profundus, it divides into four tendons, but these insert into the *middle* phalanges of the fingers. These tendons have far greater independence than the profundus tendons, and can flex each finger independently at the second knuckle.

But, once again, we are not all alike, and not all of us are equipped with four tendons from this muscle. Frequently, the tendon that should go to the little finger is missing. So— let's find out which of us has it, and which do not. I have it in my left hand, but not in my right.

Hold all your fingers flat, palm upwards (in the anatomical position!), and flex your little finger from the second knuckle only, making sure you keep all the other fingers flat. If you can't do it, don't force. It simply means that you don't have the superficialis tendon to that finger, and in order to make up for that, you are trying to use the profundus muscle to flex the little finger— but can't, because, as you now know, the profundus muscle is trying to flex the other fingers as well!

I remember one of my teachers getting impatient with me because I couldn't curl my right hand little finger under the fourth finger to make a join in a melodic passage. The frustration I felt could have been avoided had I been aware of this particular anatomical detail— and that it was a normal difference.

Here is the very passage in question: *Chopin's Scherzo in B Flat Minor, middle section*.

I'll explain how I solved the problem later.

O.K. So, how can we best use this muscle in piano playing?

It is a big muscle, the strongest of the flexors, and works together with the profundus in carrying heavy loads—particularly in what is known as the 'hook grip'. It is ideal for hanging from a fortieth-storey window ledge, because we can keep the finger tips flat, giving us more pulp grip! Together with the profundus, it helps to flex and stabilise the wrist and adds power to octaves and chords. It is not ideally suited to finger technique, because, unless we play with an extremely low wrist, it moves the fingers at right angles to the keys; and, not only is that wasteful of effort, it also causes tiredness because of the friction of the fingers sliding on the keys. In order to correct that fault, we would have to fixate the second knuckles by using extensors antagonistically to the superficialis, and that, I feel, introduces an unacceptable amount of stiffness in the hand and wrist.

This is an observable fault once you know what to look for, and here, I would like to labour the point that if you do know how the hands work, you can more easily spot problems and find solutions to them. I have spent many happy hours in the Usher Hall, analysing the techniques of great players, and then trying to apply the knowledge in my teaching—having first used myself as a guinea pig!

But, back to the superficialis muscle:

Its over use is actually the cause of the finger tip collapse that so many of us worry about. Pupils who become aware (subconsciously, of course) of the difficulties of using the profundus— and, I repeat, this muscle can have a crippling effect on the playing of some pupils—often automatically substitute the superficialis. What happens then is a *pulling in* of the third knuckle. If we try to correct this by insisting on curved finger tips, we compound the problem by forcing the use of the profundus muscle. We then get a hand position which, on the surface, looks satisfactory, but we find that the pupil can not play quickly, or with a loose hand and wrist. The teacher should therefore carefully observe whether the finger is flexing at the second knuckle when finger tip collapse occurs, and, if instead, it is slightly *extending* at that joint, then the collapse is not a serious fault, and is best left untampered with for the time being.

Superficialis is, however, useful for repetition touch, and for a kind of very short staccato, where you play the note and release it in one movement; and for these effects, it is often worth the extra fatigue.

If you want to repeat notes using the pattern 4321 repeating, proceed as follows:

Flex the fourth finger at the second knuckle, keeping the second and third fingers straight. (Note that using the profundus muscle would bring down the third finger, at least a little way, as well, making a clean repetition more difficult). Continue by flexing the third finger at the second knuckle, keeping the second finger straight—and so on. Finally, straighten the fingers in preparation for another round while you play the thumb.

I shall move on to the finger extensors now, because I want to discuss further, the problem of stiffness.

The *extensor digitorum* has, as I've already mentioned, its origin mainly at the elbow, and sends four tendons which insert at about the middle of the middle bone of each finger. But here the picture becomes rather more complicated, because—as you may remember—they are also attached to the *sagittal bands*, at the first knuckles, and, just before they join onto the middle bones of the fingers, two slips of tendons come out from the side, and, in a roundabout way, finally insert into the finger tips.

I hope to cover some aspects of the finger extensor mechanism; but it really deserves a whole talk to itself.

In the back of the hand, these extensors are linked together by the *tendineus interconnexus*, or connecting tendons — Something like this:

— *Chart*.

The index finger occasionally escapes this connection. You can find out if you have it by making a fist, and then extending your index finger as far as possible. If you see a tendon in the back of your hand—in line with the index finger—move sideways, you have the connection.

Some pianists have, in the early 20th Century, had connecting tendons between the middle and ring fingers removed by surgery, but there is a high price to pay for the independence gained, for all this connecting and binding together of the various parts of the hand give structural strength, and help to fine-tune its co-ordination.

Description of extensor indicis and extensor digiti minimi — how little finger can help to raise the ring finger etc.

We can now construct a picture of what is happening to the pupil who is actively curving his finger tips. He is playing, shall we say, his third finger, and as he has normal connection between his profundus tendons, his fourth finger is trying to play as well. Instinctively, he tries to keep his fourth finger raised by using the extensor muscle. Unfortunately, as the four tendons of the extensor muscle are joined together by the tendineus interconnexus, he is actually trying to raise the other three fingers as well. This means that he is trying to play his third finger and raise it at the same time, resulting in stiffness in the hand and wrist.

Now, in the hope that you are not already lost in this mass of verbiage and strange sounding words, what have I been saying?

Put simply; the flexor digitorum profundus does not help us to use the fingers independently, and the flexor digitorum superficialis makes the fingers slide on the keys, causing friction and fatigue.

So, you might be excused for asking which muscles I consider to be ideal for finger work.

Before I answer that, I would like to discuss a purely mechanical problem.

Let us regard the finger as a simple lever, whose fulcrum is at the first knuckle. This would mean that all movements of the finger tip must follow a line which is part of a circle around its fulcrum. Now, if we look at the piano key, which is also a simple lever, with its fulcrum somewhere near its

middle, we can see a big problem. The circles of the key and of the finger must always be in opposition. It is impossible so to align their fulcra, that their circles follow the same path.

This, as you can see results in friction between the finger tip and the surface of the key, with consequent waste of energy.

—*Diagram.*

It is possible to align the two fulcra so that there is a part in each of their circles that *almost* coincides, but that requires an extremely low wrist position which is not always comfortable. Nor is it desirable in every case. Nevertheless, a lowish position is helpful in minimising the problem and making the finger stroke more effective.

Fortunately for us, the finger is not a simple lever, but a complex one with three joints. So the ideal solution from the mechanical point of view would be to flex the finger at the first joint and let one or both of the other joints extend to compensate for the divergence in the two circles.

Like this:

—*Diagram.*

Is this kind of touch possible? And is it not too complicated to have part of the finger flexing while another part is extending?

The French anatomist, Duchenne wrote , in 1867:

"It would be impossible to imagine a more ingenious mechanism favourable to simultaneous flexion of the proximal phalanx and extension of the two distal phalanges than presented in the anatomic arrangement of the terminal tendons of the (interosseus muscles) and lumbricals."

G.J. Romanes, in 1986:

"Thus these muscles flex the metacarpophalangeal joints of the fingers and extend the interphalangeal joints — the position of the fingers in writing."

The lumbricals and interossei, are *intrinsic* muscles. That is, they are in the hand itself.

These two sets of muscles, which all have the advantage of being completely separate from each other, flex at the first knuckle because of their attachments to the base of the first phalange at the same time as extending at the second and third knuckles due to the way that they are inserted into the dorsal digital expansion, which is — put very simply — a triangular sheet of tendinous matter covering the back (dorsal surface) of each finger. Some anatomists have pointed out that, in flexing at the first knuckle, these muscles change the balance between the flexors and the extensors to the point where the second and third knuckles are extended by the muscle tone of the extensors rather than by active work on the part of the lumbricals and interossei.

—*Diagram.*

The lumbricals and interossei are agile, independent and well suited to precise movements, whereas the long finger flexors arising in the forearm, although more powerful, are relatively clumsy and slow acting, both because of the way the parts of the muscles and tendons are interconnected, and also because they are so far away from the fingers.

As Romanes says:

“In precision movements, flexion of the metacarpophalangeal joints of the medial four digits is produced mainly by the interossei and lumbricals, the long finger tendons acting in powerful movements.”

And Tubiana:

“The intrinsic muscles assume increased importance when agility and precision are necessary; when stress is on power, the extrinsic muscles become more important.”

Gray's Anatomy:

“In the finest work...most skilled manipulations employ the lumbricals and interossei, with metacarpophalangeal flexion and interphalangeal extension, and vice versa.”

These muscles are particularly sensitive to changes of position and pressure.

J.R.Napier, in 1966:

“these short muscles are extremely well endowed with special nerve endings which provide them with a positional sense which has no equal elsewhere in the body.”

And Tubiana again:

“Rabischong (1963) demonstrated the richness of the sensory receptors at their level, ...” And p88: “Regulation of the force of grip is essential. The force must be varied according to the weight, fragility, surface characteristics, and utilisation of the object. Precise and continuous sensory information is indispensable for safety in preventing premature release or excess pressure.”

Their stretch receptors are extremely important to us in gauging the weight of the key and regulating precisely the amount of muscle activity needed to produce the sound we require for each note.

- *Stretch receptors—spinal loops.*
- *Similarity to toes—automatic adjustments—Chopin: Etude in A Flat, Op 25, No1.*
- *Description of how interossei and lumbricals work.*
- *Ways of learning to use them.*
- *‘Intrinsic plus’ position.*
- *Advantage of using finger pads—pulp contact—proprioceptive feedback.*
- *Playing loud chords on fingertips — bad.*
- *Using profundus muscle to set limits on finger movement.*
- *Curled little finger.*
- *‘Sequencing’ of fingers.*
- *Less pronation when playing chords and octaves.*
- ***The hand and speech.***