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Basic Physics of Conventional Exercise Methods

Almost all conventional exercises are based upon resistance provided by gravity; but even when springs are used as a form of resistance, the result is much the same – such resistance is uni-directional. And while it is possible, with the use of pulleys, to control the direction of resistance –it still remains almost impossible to provide resistance in more than one direction while using conventional training equipment.

There are a few exercises involving conventional equipment that can be performed in such a manner that this limitation regarding the direction of resistance can be overcome – at least for all practical purposes; but since these exercises form the subject of a later chapter, I will ignore them for the moment.

This limitation in direction of resistance is probably the greatest limiting factor affecting most exercises; since it thus becomes impossible to involve more than a small percentage of the total number of fibers contained in a particular muscular structure in any conventional exercise.

Because, while the resistance is provided in only one direction, the involved body parts are rotating; in effect, you are trying to oppose a rotational form of movement with a reciprocal form of resistance – an obvious impossibility. Impossible, at least, with conventional training equipment.

While performing a curl, for example, the movement is rotational throughout a range-of-movement of approximately 160 degrees; at the start of the curl, the movement is almost perfectly horizontal, straight forward – at about the midpoint, the movement is vertical, straight up – at the end, the movement is approximately horizontal again, but in the opposite direction.

Yet, during the entire movement, the resistance was always vertical, straight down. Thus, in practice, although the resistance remains constant, it seems to become heavier as the movement progresses from the starting position to the midpoint – and after the midpoint, seems to become lighter. In the normal finishing position of the curl, there is literally no resistance – having reached that point, it is then possible to hold that position almost indefinitely, with absolutely no work being demanded on the part of the bending muscles of the upper arms.

This occurs because during a curl the moment-arm of the weight is constantly changing as the movement progresses; DIRECT resistance is provided only at the infinitely-small point where resistance is being moved vertically.

A careful scrutiny of conventional exercises will clearly show that this is almost always the case; direct resistance is provided only within an extremely limited range-of-movement, literally an infinitely small range of movement – and in many conventionally exercises, there is no direct resistance at any point.

If the normal strength curve of human muscles exactly matched the apparently changing resistance provided by an exercise like the curl, then the movement would feel perfectly even; that is to say, no point in the movement would seem to be any heavier than any other point. But since, in fact, the strength curve does not match the change in resistance, some points do feel heavier than other points; so-called "sticking points" are encountered, where the weight feels very heavy, as well as points where there is little or no resistance.

Just as jumping is not the best means of moving forward, since it involves the expenditure of effort in a vertical as well as a horizontal direction, trying to provide a rotary movement with constant resistance by using a uni-directional form of resistance is impractical at the very least. In such a case, resistance will only be – can only be – provided during part of the movement.

And even a casual thought should make it obvious that the maximum range-of-movement during which an increasing rate of resistance is even possible is a rotary movement of 90 degrees; after 90 degrees of rotary movement, the resistance must start decreasing. During the first 90 degrees of movement in a curl, for example, the direction of movement is constantly changing from horizontal to vertical, and the weight will thus seem to get heavier – but after 90 degrees of movement, the direction of movement starts changing from vertical to horizontal, and the weight will seem to grow lighter.

Direct resistance will be provided only at the point where the involved body parts (the hands, in a curl) are moving directly upwards, meeting resistance coming from an exactly opposite direction.

If, at that point of direct resistance, the weight is too heavy, then you cannot progress to that point in the movement; but if the weight is light enough to permit a full-range movement – even though heavy enough to require an all-out effort at the point of direct resistance – then you have provided balanced resistance only at one point in the curl. Thus you will be working the muscles properly during a range-of-movement of something less than 1 degree, out of a possible range-of-movement of about 160 degrees.

However, for all practical purposes, the situation is not quite that bad; in fact, you will be providing useful resistance during a range-of-movement of approximately 20 degrees. But still, what about the other 140 degrees of movement?

Now, regardless of the position you assume for the exercise, it remains impossible to produce more than 90 degrees of worthwhile movement; but it is possible to select "which" 90 degrees of movement you choose to exercise. But that subject also comes up in more detail in a later chapter, so I will skip it at this point; except to point out that some positions are far more advantageous than others, since they involve working the muscles in their strongest positions rather than in their weakest positions.

Now – it should not be assumed that the apparent change of resistance that is encountered in conventional exercises such as the curl is always a disadvantage; on the contrary, in many cases it is a distinct advantage.

Returning to the example of the curl, it should be noted that the bending muscles of the upper arms are in their weakest position at the start of the movement, when the arms are straight; and as the arms start to bend, the level of strength increases rapidly. Thus, in this instance the apparently increasing resistance is a very decided advantage; because the resistance is increasing at the same time that the strength of the working muscle is increasing – even if, as happens to be the case, not in proportion.

But still, any increase is better than none; since the muscles need more resistance as the arms are bent – and an incorrect rate of increase is better than no increase.

"But," you might ask, "why do the muscles need more resistance as they contract?"

Because of the shape of the muscles – and because of the manner in which they function.

The well-known "all or nothing" principle of muscular-fiber function states that individual muscle-fibers perform work by contracting, by reducing their length – and that they are incapable of performing various degrees of work; that is to say, they are either working as hard as possible, or not at all. When a light movement is performed, it does not involve a slight effort on the part of a large number of muscular fibers; instead, only the exact number of fibers that are required to perform that particular movement will be involved at all – and they will be working to the limit of their momentary ability. The other, nonworking fibers may get pushed, pulled, or moved about by the movement – but they will contribute absolutely nothing to the work being performed.

Thus, as should be obvious, in order to involve all of the muscle fibers in the work, the resistance must be so heavy that all of the fibers are required to move it.

However, in practice, this is extremely difficult to do; because all of the individual muscle fibers cannot be involved in the work unless the muscle is in a position of full contraction.

It should be plain that the muscle could be in no position except its shortest, fully-contracted position if all of the muscle fibers were contracted at the same time; the individual fibers must grow shorter in order to perform work, and if all of the fibers were shortened at the same time, then the muscle as a whole would have to be in a position of full contraction – no other position is even possible with full muscular contraction. Not, at least, unless the muscle is torn loose from its attachments.

But it does not follow that even a position of full contraction will involve the working of all of the individual fibers; because only the actual number of fibers that are required to meet a momentarily imposed load will be called into play.

Thus, in order to involve 100% of the fibers in a particular movement, two conditions are prerequisites; the muscle (and its related body part) must be in a position of full contraction – and a load must be imposed in that position that is heavy enough to require the work of all of the individual fibers.

And in almost all conventional exercises, there is literally no resistance in the fully contracted position – at the very point in the exercise where the greatest amount of resistance is required, literally none is provided.

In the top position of the squat, when the leg muscles are fully contracted, there is no resistance on these muscles – in the top position of the curl, when the bending muscles of the arm are in a position of full contraction, there is no resistance – in the top position of the bench press, when the triceps are in a position of full contraction and the pectorals and deltoids are as close to a position of full contraction as they get in that movement, there is no resistance. Dozens of other examples could be given, but those three should be enough.

But what does the shape of a muscle have to do with this?

While I have never been able to find anything in scientific journals regarding the order-of-involvement of individual muscular fibers in the performance of work (although my being unaware of such studies does not indicate that they have not been done), the very shape of a muscle seems to make this point clear; or, at least, when the shape is considered in connection with other, easily proven, factors.

If a muscle is exposed to rotary, perfectly direct resistance, then it is immediately obvious that the strength of the muscle markedly increases as the position of the muscle changes from one of full extension to one of full contraction; which observation indicates that more fibers are involved in the work when the muscle is in a position of full contraction – or, at least, they are if resistance that will require their assistance is imposed.

And since a muscular structure is thickest in its middle, this extra thickness indicating the presence of a greater number of strands of muscle fibers in that area, it logically follows that this thick midsection of the muscle is the last part called into play in a maximum-possible effort – and that it cannot be called into play unless the muscle as a whole is in a position of full contraction; thus it seems that muscular contraction starts at the ends of a muscle and gradually moves inward towards the middle of the muscle.

In spite of an almost complete lack of scientific studies of the effects of exercise, it is self-evidently true that exercise does produce increases in both muscular mass and strength; and if this is true in spite of the fact that only a small percentage of the actual total number of individual muscle fibers are performing any work at all in conventional exercises, then it logically follows that a form of exercise which involved working all of the fibers would produce an even greater degree of results. Or, at least, that has been the apparently logical assumption that most of our research work has been based upon.

And now we come to the physics of compound exercises...

Most human movements are compound movements, involving the use of several different muscular structures; and in conventional forms of exercises, this becomes another limiting factor.

If, for example, you are trying to exercise your torso muscles, it is necessary in conventional exercises to also involve the work of your arm muscles; and since the torso muscles are far larger and stronger than the arm muscles, the arms fail at a point in the movement where the torso muscles are not being called upon to work as hard as they are capable of doing.

Various forms of chinning exercises, for example, provide a much higher order of work for the bending muscles of the upper arms than they do for the muscles of the torso; you can prove this very easily to your own satisfaction with a simple test involving a few previously-untrained test-subjects. Have each of these subjects perform four sets of regular chins, with a four-minute rest between set, and with each set being carried to the point of failure.

Forty-eight hours later, if they have worked as hard as possible, most such subjects will be so sore that they cannot fully straighten their arms; but this soreness will be almost entirely restricted to the arms – and to the ends of the arm muscles at that. There will be little or no soreness in the torso muscles – and certainly nothing to compare to the soreness in the arms.

Pullovers? Well, in this instance, while it may appear that you are working the torso muscles without involving the arms, a moment of consideration will make it obvious that the arms are still the limiting factor; in bent-arm pullovers, you are limited to an amount of weight that your triceps muscles are strong enough to keep away from your head – and in straight-arm pullovers, the strength of the elbow tendons is the limiting factor.

And in both forms of pullovers, the previously mentioned limitation in regard to worthwhile range-of-movement is very much in evidence; not more than 90 degrees of worthwhile rotary movement is possible – and yet, the latissimus muscles have a total range-of-movement in excess of 240 degrees.

Upon close examination, it will be immediately apparent that all conventional exercises for the torso muscles are limited in somewhat similar ways; using conventional methods, it is simply impossible to provide full-range resistance, or actually-heavy resistance, for the torso muscles. Yet in spite of these obvious limiting factors, great degrees of improvement in the size and strength of these muscular structures can be produced by conventional forms of exercise – eventually.

Years ago, I asked myself, "...what would the results be if such restrictions could be removed, if all of the muscles of the body could be provided with full-range, rotary form, omni-directional, direct, balanced, automatically varying resistance?" And now we are well on the way to getting an answer to those questions.

But make no mistake about one point; barbells and conventional pulley devices are extremely productive if used properly – by comparison to any earlier method of training, the barbell is almost literally a miracle machine. But it is so productive in spite of the limitations listed above, not because of any inherent advantages; and this is simply another indication that some other method of training, without these limitations, and with the inherent advantages of having been designed to provide the known requirements for stimulating muscle growth, would be even more effective.

The use of a barbell is limited by simple, unchangeable laws of physics; barbells cannot provide the required rotary form of resistance – full-rangemovements are impossible with a barbell in all but a few exercises – barbells do not provide the necessity for automatically varying resistance, resistance that changes during the actual performance of each repetition –barbells provide almost no direct resistance in most exercises, and literally none in many other exercises – barbell resistance cannot be balanced to the strength of a muscle in various position.