The Future of Exercise
(1997 and Beyond)

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14

Insofar as I know, a man from Louisiana, Alvin Roy, was responsible for a rather widespread mistake in the field of exercise, the use of so-called "explosive" movements, things like "power cleans" and "jump squats," or any other exercise that involves sudden movement. Well, be advised, the next time you hear somebody suggest sudden movement during exercise, smile and walk away, because you are talking to a fool.

fig. 1

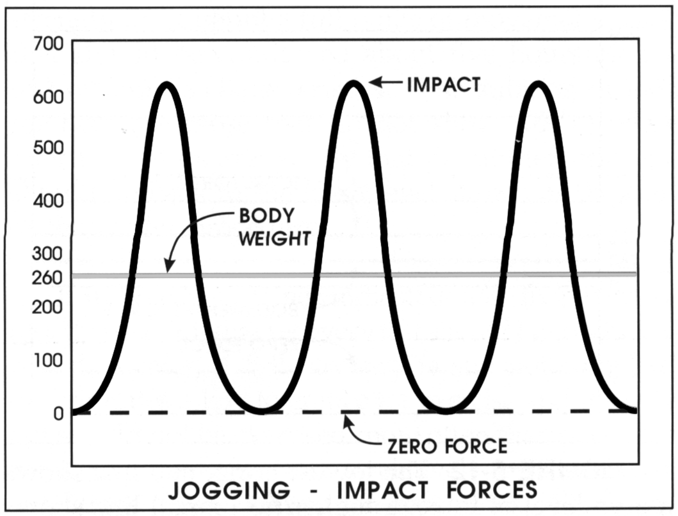
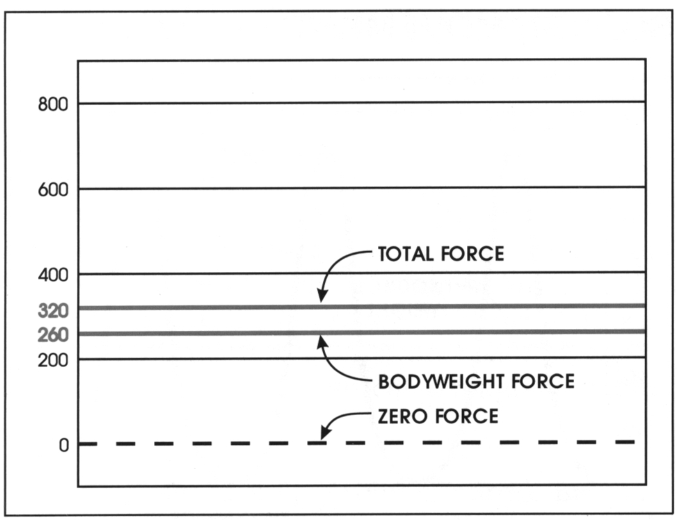


fig. 2



I first met Alvin Roy when he visited me in Lake Helen, Florida, shortly after I introduced the first Nautilus machines; he was, at the time, a strength coach for one of the NFL teams, and he visited me in Florida, he said, in order to tell me how to design exercise machines for football players. He was well known throughout the NFL and was a featured speaker during several annual football conventions, and he went to great lengths during his speeches to emphasize the importance of explosive movements during exercise; and, of course, almost all of the coaches who heard him, knowing little or nothing about exercise, believed him.

Initially, I thought he was just stupid, but the situation was actually worse than that: because Alvin did not believe the things that he was telling coaches; he was, instead, telling them what he thought they wanted to hear. The truth of the matter did not become obvious to me until I visited him during the Spring Training of the NFL team that he was then working for. While he was constantly preaching the merits of explosive exercises, he did not practice then himself; quite the contrary, he was so cautious that the exercises that he did use were simply worthless. Unfortunately, many other strength coaches believed what he said, and did use explosive exercises.

Sudden movements during exercise do not, as some people believe, develop "fast muscles," are far more likely to produce an injury. The following illustrations should make this point perfectly clear.

Figure 1: The fact that the level of resistance in an exercise remains constant does not mean that the level of force imposed upon the subject remains constant. This figure illustrates the levels of force involved during jogging in place. The lowest horizontal line shows zero level of weight (force), the higher horizontal line shows the body weight of the subject, 260 pounds, while the peaks and valleys shown by the curving line show the changes in force resulting from movement while jogging.

Standing still, the subject is exposed to a force equal to body weight, 260 pounds, 130 pounds of force on each leg. But while jogging, the level of force is increased to more than 600 pounds, and all of that is imposed upon only one leg; the force is increased by more than 300 percent. High levels of force caused by impact, even in a relatively low-speed activity.

fig. 3

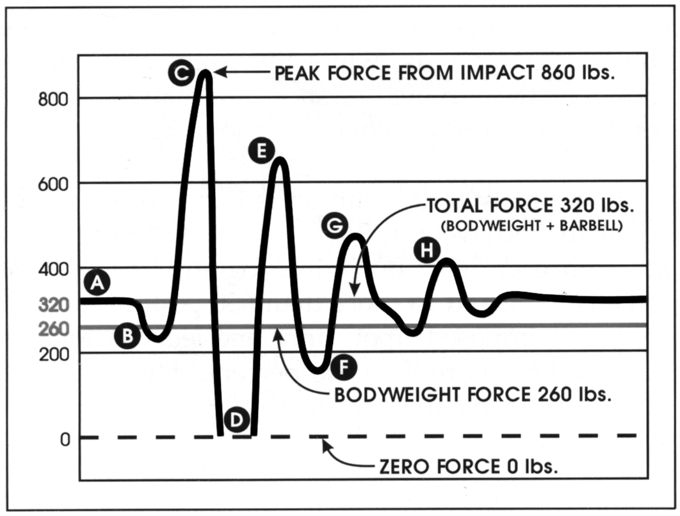


fig. 4

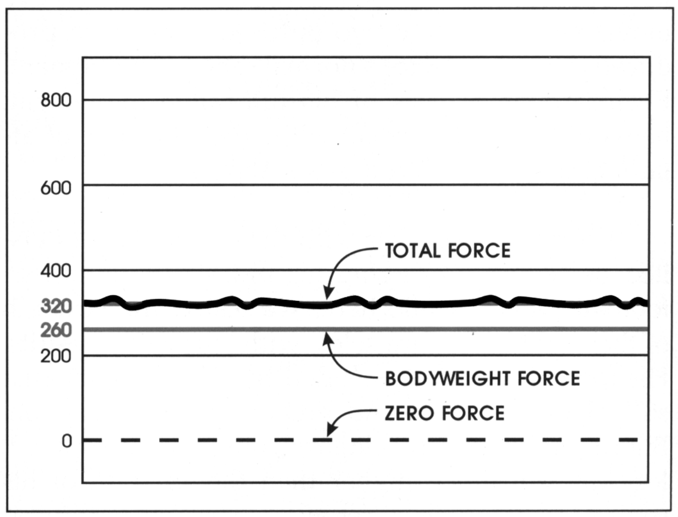


Figure 2: The lowest horizontal line shows a zero level of force, a higher horizontal line shows body weight, 260 pounds of vertical force, and the highest horizontal line shows the resulting force when the subject is holding a 60-pound barbell while standing motionless, 320 pounds of force.

Figure 3: But when the subject lifts the barbell with sudden movement, the resulting forces are changed to an alarming degree; changes in force shown by the red line of force on this chart.

Prior to the start of movement, in the place identified as A on this chart, force remains proportionate to weight, but just prior to the upwards movement of the barbell, the line of force drops below the actual level of force, marked as B on this chart; this initial reduction of force being produced by so-called PRE-STRETCH, when the barbell is permitted to drop a short distance immediately prior to the start of the upwards movement, This pre-stretch is an instinctive action prior to a maximum effort that produces a higher level of force in the following contraction.

But immediately following this initial drop of force, the level of force increases suddenly, and to a very high level, to a maximum level of 860 pounds, which means that the force produced by the barbell is ten times as high as its weight, adding 600 pounds to the force of body weight, a position marked as C on this force curve.

Then, having reached this high level of force, the downwards force on the subject is suddenly reduced to less than zero; less than zero because, at that point in the movement, marked as D, the barbell is lifting the subject into the air as a result of kinetic energy, and no force is being imposed downwards on the subject. But this upwards movement of both barbell and subject does not continue very long, and when they come back down the result is the wildly and suddenly varying levels of force shown by the curving line in the positions marked as E, F, G and H.

Such great variation in force is a result of impact forces produced by sudden movement; dangerous levels of force that are not required for any worthwhile purpose; force that can be avoided by slow, smooth movement.

Figure 4: This chart shows the variation in force produced when the same lift was performed with slow, smooth movement instead of sudden movement. While there is still some slight variation in force, indicated by the curving line moving slightly above and below the highest horizontal line of force, it is obvious that such force changes are of no real importance. Compare force changes shown here to those shown by Figure 3.

Is spite of the results of sudden movement against resistance, some people have been recommending sudden movement during exercise for the past twenty years; to no good purpose. When in doubt about proper speed of movement during exercise, move slower; it is impossible to move too slowly during exercise; but it is easy to move too fast, with results like those shown above.

All you are trying to do during exercise is to expose the muscles to known resistance for a relatively brief period, in order to produce the desired level of fatigue within a reasonable length of time. Any force above the minimum required to produce the desired level of fatigue adds nothing of value, but does reduce the safety of the exercise.

Injury during exercise comes from only one source, a force that exceeds the coexisting level of structural strength; so keep the force as low as possible consistent with the existing level of strength; work within the limits of functional strength, do not try to determine the limits of structural strength.

Motivation

Regardless of the potential value of the equipment, the subjects using it will not produce good results without motivation; compensation payments, litigation, and other factors can remove the required motivation.

The subjects involved in our first study group (mentioned in an earlier chapter) were all members of our research team; all of them were highly motivated, and they worked very hard . . . and their results were outstanding. No group of random subjects used in later studies did as well on the average. Some individual increases in strength have been even better than those shown by any member of our first group, but the average strength increases were not as high. Motivation, or a lack of motivation, being responsible for this difference.

This is an important subject that needs to be clearly understood. But given a little experience, it becomes easily possible to recognize patients that are not motivated.

Testing Recovery Ability

Another important factor during rehabilitation is recovery ability; some subjects recover from fatigue caused by exercise in a matter of minutes, while some do not even start to recover for a period of several days. Recovery tests involve only a test of static strength throughout a full range of movement; a test that should be conducted about five hours after a test of fatigue characteristics. The subjects to look for here are those that do not show full recovery after five hours of rest. By that point, their strength should be back to the fresh level shown at the start of the earlier procedure.

If full recovery is not indicated after five hours of rest, then a following recovery test should be conducted two days later; if full recovery is still not complete, this indicates a low tolerance for exercise and the subject should not be exercised more often than once each week, and then only with a relatively low number of repetitions, from eight to ten repetitions. Some few subjects will not make gains in strength if exercised more frequently than once every third week. And subjects that do best on a schedule of one exercise every second week are common; are usually subjects with a high percentage of fast-twitch fibers.

What to Expect from Exercise

The potential for muscular size, and the potential for both muscular strength and functional strength, and these are different factors, varies widely on an individual basis, on the basis of age, on a basis of sex and on a racial basis. The result being that some people have far more potential than others.

Potential for muscular size is determined by genetic factors; is largely determined by the relative length of the muscle-belly compared to the distance from insertion on one end to the insertion on the other end. Long muscle-bellies and short tendons provide the potential for unusual degrees of muscular size; while short muscle-bellies and long tendons mean a lower than average potential for muscular mass. Some people can build very great muscular mass, and some cannot; they lack the potential for great muscular size.

The functional strength of an individual is determined by several factors; the size of the muscles, the type of fibers the muscles have, the relative length of the limbs and thus the leverage advantages or disadvantages, short limbs being a great advantage for a weight lifter but a disadvantage for a basketball player.

But given an advantage of leverage, and with large muscles, some people are still not very strong; but not because there is something wrong with their muscles; this problem is usually a result of the fact that such an individual does not have the type of muscle fibers required for great strength, has fibers intended for endurance. So the fact that somebody else reached a certain level of strength or size does not mean that you can too, nor does it mean that the style or amount of training that they used will be right for you.

But there are things that you can expect; you can expect to increase your strength from its starting level if you have never performed exercise for this purpose; you can expect to increase your muscular size; you can expect to increase your flexibility to a marked degree in some movements and if you continue with exercise for several years you can expect to increase the size of your bones; and you can expect to produce all of these very worthwhile results without hurting yourself in any way, if you exercise in accordance with the instructions in this book.

Type of Results

Expect your muscular size and strength to increase steadily and rather quickly; six months of regular exercise may increase the strength of your muscles to twice the starting level of a previously-untrained individual. Muscles that you have never used to a meaningful degree will respond faster, while those that you have used will respond slower, but they will all become stronger, some by as much as several hundred percent.

Of particular interest for the primary subject of this book, the lumbar spine, most people have the potential to increase the strength of their lumbar-extension muscles to an enormous degree; primarily because most exercises do not work these muscles in a meaningful way, and because normal activities do not provide much work for these muscles. Many people can expect to increase the strength of these muscles by two-hundred percent within a few months, making them three times as strong as they were at the start, and some people can expect twice that degree of results. The neck of the average person usually has the potential for large and rapid strength increases; an area of great importance for preventing injuries, and also of importance for the rehabilitation of neck injuries.

Duration of Results

Some of the benefits of exercise last for years, while some are temporary and are lost if the exercise is stopped entirely; in general, the longer you maintain a high level of strength, the more you will retain after you quit the exercise that increased your strength in the first place.

If your starting level of strength is 100, and if you quickly increase it to 200, and then quit exercise entirely and return to your normal activities that were performed before starting the exercise, your strength will not remain at a level of 200, but it will not drop back to 100; part of your strength increase was permanent. Increasing the strength of your lumbar muscles to a high level will reduce the chance of a later back problem to at least some degree for the rest of your life, even if you stop the exercise after reaching a high level of strength.

But if you maintain that high level of strength for several years by continued exercise, then you will not lose as much when you quit the exercise; you may lose 80 percent of a strength increase that was maintained only briefly, while you would probably lose only 50 or 60 percent of a strength increase that was maintained for several years. Secondly . . . having increased the strength of a muscle to a significant degree, and having then quit exercising and having lost a large part of the increase, the next time you start exercising the previous level of peak strength will be produced more rapidly; the body seems to retain a memory of where it has been, and will reach a previously-existing level of strength much faster than it did the first time.

Bi-lateral Effects and Indirect Effects

In spite of the fact that most people are Type S, meaning that the results of their exercise are largely confined to the part of a muscle that is exercised, it is still true that hard exercise for a normal right leg will help to reduce the atrophy on an injured left leg that is immobilized in a cast; without such bi-lateral effect, you might lose 70 percent of the strength of the injured leg, while with such effect you may lose only 50 percent of the strength of the injured leg. A useful bit of knowledge for people working with injuries of the limbs.

Also . . . heavy exercises for the large muscles of the body produce at least some degree of size and strength increases in other, smaller muscles even when no exercise is performed for these smaller muscles. The value in rehabilitation should be obvious; work all of the muscles of an injured individual that you can; this will not only increase the strength of the exercised muscles but will help to prevent some of the atrophy that would otherwise result in the injured body part.

Evaluating Strength Increases

Gains in strength are usually evaluated by comparing the increase in strength to the initial level of strength, and then expressing the improvement as a percentage of the starting strength; if the initial level was 100, and the strength following rehabilitation was 150, that would be a gain of 50 percent. But using this system of evaluation can be misleading; sometimes giving the impression that gains in one area were far better than gains in another area, when the actual gains were consistent throughout a full range of movement.

Nine years ago, a study group of normal men increased their starting level of strength in the flexed position by an average of 87 percent, while increasing strength in full extension to a much greater extent; which gave the impression that their strength increases in full extension were much greater than in the flexed position. And, as a percentage of their starting level of strength, gains in full extension were much greater.

But when the actual increases in every position throughout a full range of movement were compared, the gains were very consistent; the average increase in the seven positions tested was 268 foot-pounds, with a low of 249 and a high of 297 . . . so the greatest increase was less than 11 percent above the average, while the lowest was 7 percent below average.

Using the percentage method, it would appear that strength increases in full extension were more than five times as high as in the flexed position, while the true difference was less than 20 percent. So it may be better to evaluate strength gains by comparing the actual increases in each position, without regard for the percentage of initial strength.

Problems with Normative Data

With knee pathology, the usual availability of a normal leg for comparison purposes provides an advantage during rehabilitation, gives you a standard for judging the progress of the injured leg. With torso rotation and cervical rotation, the right side can be compared to the left. But you have nothing to compare, no standard for judgment, when dealing with the most critical functions in spinal pathology, strength and range of movement in flexion/extension.

The most practical solution involves using each patient as a standard for judging their own improvement during rehabilitation. If they are improving, then you are moving in the right direction.

Normative data has been established in many areas of medicine, but trying to compare a subject with spinal pathology to averages is frequently misleading. Because an individual is different, compared to average, does not mean that they are abnormal, and even if abnormal, this is not always proof of pathology. The slow-twitch subject mentioned in an earlier chapter, following twenty-seven weeks of exercise, was still only slightly above average strength, which would indicate a relatively poor result if compared to average. But when compared to himself, his results were very good, an increase of 877 percent in strength in the extended position. His very low level of initial strength, and his relatively low level of later strength, were both results of his fiber type; comparing such a subject to average is misleading.

During research conducted to determine the best frequency for exercise of the lumbar-extension muscles, six large groups of subjects were compared . . . one group, the control group, performed no exercise, but was tested before and after the twelve-week period; showing no change in strength, the expected result . . . a second group exercised only once each two weeks . . . a third group exercised once each week . . . a fourth group exercised twice each week . . . a fifth group three times weekly; these groups using dynamic exercise . . . and a sixth group was exercised once each week with a static modality.

A comparison of the five groups that exercised indicated no apparent difference, all exercised groups gained; and, as groups, they gained to the same degree. It did not appear to matter whether they worked only six times within a period of twelve weeks or worked as much as thirty-six times during the same period.

But looked at individually, the amount of work did matter. One of the subjects in the three-times-weekly group lost strength from overwork. This subject, a very athletic woman, was placed in her group on a random basis, which was a mistake; exercised less frequently she would probably have produced large gains in strength instead of the loss actually produced. During her initial tests she displayed a fast-twitch response to exercise, a high level of fatigue from brief exercise; but at the end of the twelve-week period, she showed a slow-twitch response, very little fatigue from exercise. An apparent change in fiber type that resulted from overuse atrophy.

Like most athletic subjects, she was determined enough to continue with the program in spite of steady losses in strength; losses that were obvious from the fact that she was repeatedly forced to reduce the level of resistance in order to perform the desired number of repetitions. By the end of the program she had lost a large part of her starting level of strength, and appeared to have changed the fiber type in her lumbar-extension muscles. Trying to judge this subject by a comparison to average would be a mistake.

Several years ago, to determine true range of isolated lumbar-spinal movement, we X-rayed a large number of subjects in flexion, in lordosis, and in extension, Average range proved to be 72 degrees, with some variation on an individual basis; but one subject with a range of 70 degrees, which would appear to be normal if compared to average, proved to be grossly abnormal. Three of his lumbar joints had spontaneously fused and showed no relative movement, while the two unfused joints each produced more than twice a normal range of movement. Evaluated on a basis of his full-range movement, he would appear normal; while his true state of affairs clearly indicated a gross abnormality.

A former linebacker with the Chicago Bears visited us recently, bringing his oldest son, a college football player; while here, we tested the strength of their quadriceps muscles, with surprising results. His football career was ended by a knee injury that still gives him pain and greatly-reduced function. But the strength of this injured, obviously atrophied, leg was still much higher than the strength of his son's normal leg. A difference in srength produced by different fiber types in their quadriceps muscles. Even atrophied, he still showed a high percentage of fast-twitch fibers in these muscles, while his son has a high percentage of slow-twitch fibers.