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ATHLETICS IN SCHOOLS

By Max M. Novich, M.D.
299 Clinton Avenue, Newark 8, New Jersey

The following letter originally appeared in The Journal of the American Medical Association, Pp. 600, October 6, 1956. It is not the intention of The Journal of the NATA to in any way engender discussion between two fine physicians, but rather to show their unity of purpose and intense interest in the health and safety of the young athletes of our nation.--The Editor

To the Editor: – I appreciate the fact that Dr. S. E. Bilik, for whose work I have profound respect and admiration, has taken the time to comment at length in a recent issue of THE JOURNAL (of the American Medical Association) (161:1502, Aug. 11, 1956) on my article, "A Physician Looks at Athletics" (J.A.M.A.,161:573, June 16, 1956). I am in full accord with the basic principles that Dr. Bilik elucidated in his letter, but I am constrained to point out that he has misinterpreted my article to make it appear that my own opinions are to these principles. I do not imply that there is "some sort of tug of war between coaches. . .and physicians"; on the contrary, I am one of the many team physicians who enjoy an excellent and mutually profitable relationship with coaches. My position is that adequate health protection of athletic youngsters requires the "joint efforts of physicians, coaches, trainers" working as a team. I share Dr. Bilik's respect for Mr. Schneider, the coach of the high school for which I am responsible medically. Charlie and I must get along well-he hired me, after he had known me for years and after I had been a player on one of his own high school teams.

Second, nowhere in my article did I state or infer that coaches and trainers misuse their youngsters in order to advance the interests of the school. Of course no coach or trainer does that! I did, however, wish to direct attention to the fact that coaches and trainers–through ignorance, not ill will–often make decisions that adversely and sometimes permanently affect their players' health; that "well-meaning trainers, coaches, and officials cause more disability than they prevent." I plead against ignorance and its inevitable concomitant, indifference.. I agree with Dr. Bilik's description of trainers, insofar as the description applies to trainers in colleges and universities. The same broad generalizations cannot, unfortunately, be made about trainers in the secondary schools. I have always enjoyed excellent working relationships with trainers, a fact that is, perhaps, indicated by my recent election to advisory membership in the National Athletic Trainers Association. Continually in other papers and in talks to both physicians and non-medical personnel interested in the health of athletes, I have emphasized the importance of joint responsibility. I have many times pointed out that, in many areas of overlapping interest, trainers and coaches often exhibit a greater depth and precision of knowledge than do physicians about health and safety measures for the members of their teams.

I am astonished by Dr. Bilik's apparent attitude that team health and safety are not proper and immediate concerns of the physician. Surely Dr. Bilik does not mean to suggest that physicians abrogate their responsibility to supervise and control, if not actually execute, any measures that directly influence health and safety.

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NECK INJURIES IN SPORTS

By Edward D. O'Donnell

The purpose of this paper is not to catalogue the injuries of the neck but rather to point up the problem which faces the trainer on the field in his decision on continuation in play of the injured athlete.

Most injuries present one or more symptoms or signs which indicates the seriousness of the injury - unconsciousness in head injuries; severe pain in chest injuries; prostration in abdominal injuries; loss of function in extremity injuries - but neck injuries, except in true dislocations, may show nothing determinable on the field to help the trainer in his dilemma.

To be sure we are thinking primarily of football injuries since in no other sport is one so liable to injury and careful handling of injuries can do much to keep them in the minor category.

Neck injuries are brought about in various ways, and the observant trainer may, many times, know, even before he leaves the side lines, the nature of the mechanism which has given rise to the injury which will require a decision on his part.

Tackling about the neck: An arm curled about the neck and a vigorous tug with the weight of 180 pounds behind it could easily bring about a dislocation between the first and second segments of the spine in the neck and while irreparable damage could result immediately n which case no decision would be required of the trainer, the mechanical damage to the spine - without associated spinal cord damage - could create a situation where, in a quick turn of the neck, damage to the spinal cord itself could occur. Since no football victory is worth the life of a player or his complete paralysis, which is if possible a greater cost, removal of the player from the field for a decision by a competent medical man, based on the required studies, is the only feasible decision.

Striking on the head: A blow on the top of the head, with the head on the center of the neck, can result in a collapsing injury to one of the segments of the spine in the neck or upper back through the force transmitted through the head to the spine. This type of injury can be quite shocking to the person injured and probably, fortunately for everyone concerned, recovery is usually slow so that in the interest of not delaying the game the player is likely to be taken out. Even if shock is not prominent in the picture, a recognized injury of this type should cause the trainer to seek information from the player of any sharp pain in the neck or difficulty of moving the neck which again would be sufficient reason for side-lining the athlete until a medical opinion could be obtained.

Blows on the head which cause an acute flexion or forward bending of the head, is the mechanish which commonly causes a dislocation in the neck between the 3rd and 4th or 5th and 6th segments of the spine.

While this condition is commonly referred to as a "broken neck", the fracture - if one is present - is a minor part of the picture and the dislocation is the real problem. Again the damage to the spinal cord is the real danger and in the complete injury, again, the trainer would have no decision to make. However, since according to the medical authorities a dislocation can only

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ATHLETICS IN SCHOOLS (Cont.)

Trainers and coaches have their part to play, but—and this is the important consideration—the responsibility is joint, not exclusive. Certainly I do not suggest that team physicians buy athletic equipment, but I do suggest that team physicians be familiar with equipment, again so that they are able to execute their advisory responsibilities properly. My feeling is that a physician has every right to "meddle" in those areas concerning health and safety where his special knowledge implies special competence. No, a doctor need not treat every minor injury, but the decision as to whether an injury is minor is, usually, best left to the doctor. Of course first aid will be administered by coaches and trainers, but I urge these coaches and trainers to err on the side of caution and call a physician if there is any doubt at all about the nature or extent of the injury. The dangers of first aid given by laymen to seemingly slightly injured persons have already been well documented in the literature. Dr. Bilik has played a significant, indeed a pioneer, role in the treatment of athletic injuries and in sports medicine generally. However, after 30 years of involvement with nearly every phase of athletics, as player, coach, official, administrator, and team physician, I am not without adequate pegs of practical experience on which to hang my theoretical observations. There are so few physicians who have deep interest and broad knowledge about athletic injuries that I must close this communication with a plea for more, not less, communication between these few physicians.

NECK INJURIES (Cont.)

occur with ligament tears, it also happens that the injury to the ligament may occur without dislocation or the dislocation may reduce itself.

The important thing for the trainer to remember, is that even if only the ligaments are torn and the player, in the excitement of the game, feels able to continue, a new injury of even milder degrees may permit the bones to dislocate with serious damage to the player.

While no blame could be attached to a trainer who continued a player in the game after a neck sprain, I feel sure the trainer himself would never be able to disassociate himself from the consequences should serious damage occur.

Severe blows on the back with hyperextension, or backward snap of the head, which is an injury not unlike that resulting from a rear-end automobile collision, is another type of neck injury which while ordinarily not as serious as some of the types discussed above, could very well damage some of the spinous processes on the back of the neck. Here the patient's reaction may be sufficient on which to make a decision. If he feels unable to continue take him out. If he wishes to continue in the game let him but watch his playing and if he is not up to form, pull him out.

Twisting of the head in relation to the body: The neck in young people is ordinarily pretty flexible and can stand considerable twisting without serious damage. It might be advisable for the trainer in working with his players to test the range of motion in the neck. This could be valuable information to have in case of a neck injury to that player.

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NECK INJURIES (Cont.)

In brief, I can sum up my advice to you by saying that in neck injuries play cautious and hand the problem to the team doctor.

The neck is called the cervical spine and is the least well protected part of the spine through which the spinal cord and nerves go down through the body. The bones in the neck are also smaller and more delicate than those in the lower spine and more easily injured.

The higher the level of damage to the spinal cord the more serious the involvement of the body.

The flexibility of the neck also points up the importance of the ligaments which, of course, may be torn.

Exact diagnosis of neck injuries is difficult for doctors, even with all the laboratory aids at their disposal. If this is true, and I know it is true, you can appreciate the significance of the trainer's position with the excitement of the game, the roar of the crowd and the quarter-backing of just about everybody in the making of his decision on the field.

NATIONAL NEWS NOTES

Hi Fellow Trainers:

Here is a copy of an alumni Award of Merit presented to Clarence A. (Bob) Bauman, B.S. in P.T. by the President of St. Louis University.

Bob Bauman as you know is the trainer for St. Louis University, St. Louis Cardinals Baseball Team and an Associate Prof in Physical Education. This was quite an honor not only for Bob, but for all of us who are in the Training profession and it should serve as a stimulus to all trainers.

The following is copied from the Convocation Program, November 19, 1956 - Founders Day:

Clarence A. Bauman, B.S. in P.T.
School of Nursing, 1946

Born of a fine Catholic family of ten children, this devoted son of Saint Louis University has constantly lived within his native faith, devout and loyal. The father of three children, he has given one of them directly to God's work. A son, Richard, is now in his ninth year of study with the Society of Jesus.

For a number of years prior to his graduation in 1946 with the degree of Bachelor of Science in Physical Therapy, he was already a member of the University family. Beginning as the trainer of our athletic teams in 1928, he soon demonstrated not only professional competence but personal characteristics which endeared him to his collegues long before he won his academic license. After nearly thirty years of University association, he is universally loved and respected.

His primary contact has been with student athletes, and his genuine concern for their welfare, his deep understanding of their problems, have resulted in a solidarity in this segment of the student body rarely found in an urban university. His open-door policy of treating high school athletes from both private and public institutions without any thought of compensation, a policy which has advanced the University's educational and public relations beyond measure, is worthy of special acknowledgment. His reward for this altruistic service is expressed in the grateful letters from coaches, principals, parents, and athletes themselves.

Always smiling, always gentle, always sympathetic, never critical, never harsh, he represents to the many people with whom he comes in contact a personal composite of all the sterling qualities for which the University stands. Young in heart, and even younger in appearance than most others who have been with us for more than twenty-five years, he is an eminently worthy son of Saint Louis University. It is a happy privilege, Very Reverend President, to recommend for the Alumni Merit Award, Clarence A. "Bob" Bauman.

NATIONAL NEWS NOTES

THE FOOTBALL TRAINER IS A FORGOTTEN MAN BUT HE'S A SOLID FACTOR

By WALTER STEWART

Reprinted from the MEMPHIS COMMERCIAL APPEAL

The other day we were exercising our gums with Mr. Nash Buckingham, when that internationally-celebrated sportsman spake words which produced a high-protein diet for thought. Football was under the verbal gun at the moment and Nash asked us if we had ever thought

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THE FOOTBALL TRAINER (Cont.)

much about the vital role played by the trainer of teams with plastic hair-dos.

Actually we had—in a habitually vague sort of way. But the further we went, the more vital these roles became, so it's hats off to Mickey O'Brien of Tennessee, Doc Knight of Ole Miss, Joe Worden of Vanderbilt, Dutch Luchsinger of Mississippi State, Bill Ferrell of Arkansas, and all their overworked brethren.

The trainer, for the most part, works in strict anonymity. Unless he is dredged for information concerning the status of a knee belonging to Marty McMuscle, the peerless fullback, his name never reaches the printed page except as the last item in the football brochure.

THE BIG DIFFERENCE

But a college team would be a rudderless barge without him. Just compare a football trainer with one who conditions pugs. The latter has only one creature in tow – weeks into which to sharpen him for 10 or 15 three-minute rounds.

From Sept. 1 to the beginning of December the collegiate bone-bender must somehow coddle 40 or 50 savage young personalities through day after day of personal combat which would wring a shudder from the Emperor Nero, even on days which he faced without a hangover.

A varsity training cubicle is a rather magic scene trimmed by steam and throbbing with emotion. One young paladin sits on the edge of a table—a huge, iron shoe affixed to the left foot. At a slow cadence he straightens the leg throwing weight on the healing knee.

Another is immersed in the whirlpool bath—another crouches in a complication of ropes, weights and pulleys and manfully tugs out an infirmity. Others relax under ultra violet or wait to get a charleyhorse rubbed out.

THE MANY PROBLEMS

The trainer must be almost everywhere at once—an order here, a pat on the back and vast judgment concerning the condition of an injured man. Most coaches allow their trainers full sway in the matter of football service. If the trainer decides that a tackle should be held out for a week because of a twisted shoulder, the coach will agree if he trusts his trainer—and he shouldn't have him if this confidence doesn't exist.

The trainer's greatest problem is the decision of return. We'll say that a highly prized halfback has wrenched his knee early in the season and that the hinge has come slowly back into line. The club needs him badly if it is to win a significant October game. But what if the knee collapses and the lethal young scholar is out for the season? You have exchanged the dubious possibility of winning a single game for a campaign which must blend with disaster.

ONLY ONE REAL FACTOR

And most massive of all factors is the future of the boy himself. We have known few football trainers who weren't kindly human beings, and these have to realize that a gamble could build a crippled future. Yes, it is a tangled problem based upon professional judgment and professional skills secret to practitioners of these healing arts.

And most trainers are the father confessors of the squad. They are usually commander-in-chief of the football dormitories and closer to the players than any member of the coaching staff.

They know what the lads like to eat and read and watch on television. They know how hard they're hitting the books and whose girl friend has taken a powder. So the young men with muscles come to the trainer with problems they wouldn't dare spread before the coach, who is often an austere man of short patience.

And good morale on a squad is a whacking part of the trainer's responsibility. He is in a position to know, better than any other bit of brass, that there is an ingrowing bitterness between the quarterback and the left end, so he must do a slab of patching—a pouring of oil upon troubled waters.

Hail to the trainer, friend of mankind.

ACROSS MY DESK

A few days ago, while the Executive Director of the Student Health Service and I were attacking a 10 a.m. cup of coffee (the Health Service brews the best cup on campus she handed me a list of ailments copied in original contest and spelling as written by students entering the clinic for consultation. I picked out a few pearls of wisdom to repeat herewith:

Enimia, chiropractor trouble, can't lorn good, stripped throte, bioul (he was constipated), shor hipe, sick on Monday morning; now weak & has no taste, violent ray treatment, acme, a sprong foot. It swole up soon as I sprong it. Sour thorate, diarea, broncul asma, abesc tooth, want wrist tapped, sour throt, valva titus invective, nourose, phistula on rectam, while in serves troubel parsely corrected, whoritis, bruishes and pull nerves, minstrel period, epiglitis is swolin, fit trust for hernia, spraned ancle and don't fill good.

Also, male trouble, parinital sist, coated tung and blisers of feet, desire pills, paratismal tichardia, head all stuffed up and feel worse to come, sick of my stomack, wrench sholder, apendized, strept throat, runs, see dr. about enimos, spranned ankel, hip dislocation or similar disorder in same place, headacke and direareha, notte on leg, looks like infection is ready to set in; need exrays, throat feels contracted, sore kernels, mononucleosis I think, back out of place from fall on tramp, mold behing ear, gum earitation, and painful genial glands.

The first look is worth some pretty good guffaws, but hold on a moment--these gems are by students from freshman year through graduate college. The original list is so extensive that is is improbable that any department

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ACROSS MY DESK (Cont.)

of any college on campus was without representation. Now, not all the students who authored these complaints were running temperatures of 212 degrees at the time, so the boo-boos cannot be blamed on delerium. Instead it appears that some of these same student's educators were a little feverish at the time they decided how best prepare these youngsters for a world that needs them. I'm sure this institution is no different in its calibre of faculty or quality of student than any other state institution in the country.

The time has come for all of us in education to pause long enough to look back on what our efforts have have actually produced.

* * *

Of interest to all members is the November 17,1956 issue of The Journal of the American Medical Association. The predominance of articles concern sports and include fine contributions by such authors as A. J. Ryan, M.D.; Augustus Thorndyke, M.D.; and T. B. Van Itallie, M.D. and associates. Some research that may be already familiar to you by several noted physical educators is also included. These articles will help to augment interest in what we know is a field of enormous importance--that of sports medicine.

THE DEVELOPMENT OF STRENGTH BY MEANS OF STATIC AND CONCENTRIC MUSCLE CONTRACTIONS

By Donald P. Rodgers
State University of Iowa, Iowa City

This research was carried out in the Physical Education Laboratory at the University of Iowa. The author wishes to express his appreciation for the assistance given by Professor Frank D. Sills.

Several studies (1,2,3,5,6,7) relative to the effectiveness of various methods of weight-training for the development of strength have been reported. These studies have been concerned, primarily, with the concentric functioning of muscles.

STATEMENT OF PROBLEM

The purpose of this study was to compare the amount of strength developed by weight-training exercises performed in the usual manner with exercises in which the weight was held in prescribed positions for six seconds.

PROCEDURE

Nineteen male students from the basic-skills classes in physical education at the State University of Iowa served as subjects. Nine subjects, referred to hereafter as the "static group", were supervised in their weight-training program by the writer. Ten subjects, referred to hereafter as the "concentric group", were supervised by an instructor to whom the study had been explained in detail.

The subjects in the concentric group performed weight-training exercises in the usual manner thirty minutes three times a week for six weeks. The subjects in the static group, in thirty-minute periods three times a week for six weeks, exercised by holding weights in

prescribed positions for six seconds. Both groups performed the following exercises: situp, pullover, supine press, and forearm curl.

The subjects in the concentric group used weights which required maximum effort for performance of six to ten lifts in one bout. (Lift is used to designate the movement of a weight from the starting position to the prescribed position and back to the starting position.) Three bouts were performed for each exercise.

The subjects in the static group performed one partial lift for each bout, and three bouts for each exercise. They performed the exercises with as much weight as they could hold in the prescribed positions for six seconds.

Before the weight-training program began, and at the ends of the second, fourth, and sixth weeks of the program, the subjects were tested in situps, pushups, curls, and pullovers (Figure 1). A cable tensiometer was used in the testing.

ANALYSIS

Analysis of the data obtained from the concentric and static groups may be found in Tables I and II and in Figures 2 to 5.

Table I presents the coefficients of reliability for the criteria, namely, situps, pushups, pullovers, and curls. The r's which range from .90 to .99 are based on two trials for each of the four events administered before the exercise program started

Table I
Coefficients of Reliability for Criteria

Test	r
Situps	.96
Pushups	.99
Pullovers	.98
Curls	.90

The difference between the initial and the final scores for each of the four events were determined for the concentric group and for the static group. The significance of the difference between the differences (changes) for the two groups was tested by the t test (Table II). In view of the P's (.50 to .90) that were obtained, the null hypothesis, namely, that the differences could readily have arisen on a chance basis was accepted.

Graphs for the means of the situps (recorded in tensiometer units) performed by the concentric and the static group at the beginning of the experiment, at the end of six weeks appear in Figure 2. Similar graphs for pushups, pullovers, and curls appear in Figures 3 to 5.

Throughout the experiment the static group's performance was superior to that of the concentric group in the situps, the pushups, and the pullovers; and at the beginning of the experiment and at the ends of the fourth and sixth weeks the static group's performance was superior to that of the concentric group in the curls. Only at the end of the second week, when the concentric group slightly exceeded the static group in the

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THE DEVELOPMENT OF STRENGTH (Cont.)

curls, did the concentric group exceed the static group in any of the performances.

Table II

Significance of Differences between Mean Gains of Concentric Group (N = 10) and Static Group (N = 9) in Situps, Pushups, Pullovers, and Curls Recorded in Tensiometer Units

Group	Initial Mean	Final Mean	Mean Gain	Difference between Mean Gains	t*	P
			Situps			
Concentric	31.90	42.90	11.00	.77	.2200	.90
Static	45.33	55.56	10.23			
			Pushups			
Concentric	39.40	58.50	19.10	2.21	.8308	.50
Static	51.44	68.33	16.89			
			Pullovers			
Concentric	25.00	31.40	6.40	1.05	.5738	.60
Static	29.11	36.56	7.45			
			Curls			
Concentric	44.50	50.00	5.50	.39	.3333	.80
Static	47.00	52.89	5.89			

* A t of 2.11 is required for a P of .05.

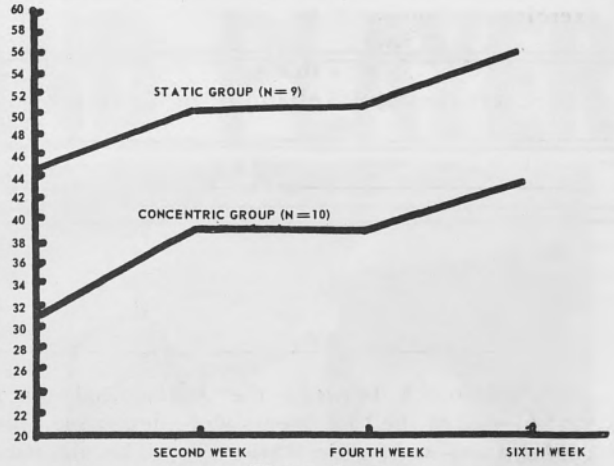

Figure 2
Means of Situps for Static and Concentric Groups

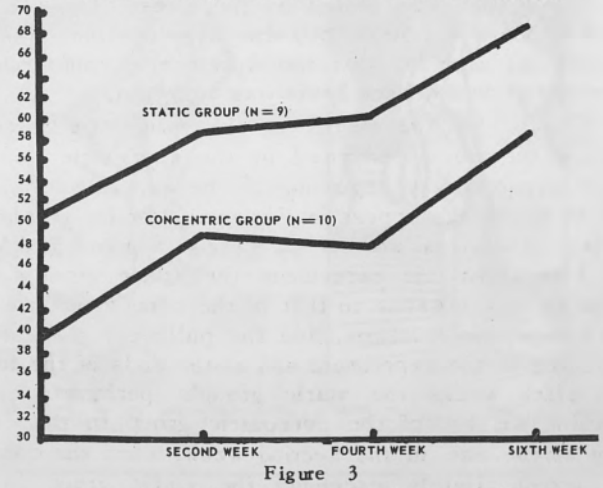

Figure 3
Means of Pushups for Static and Concentric Groups

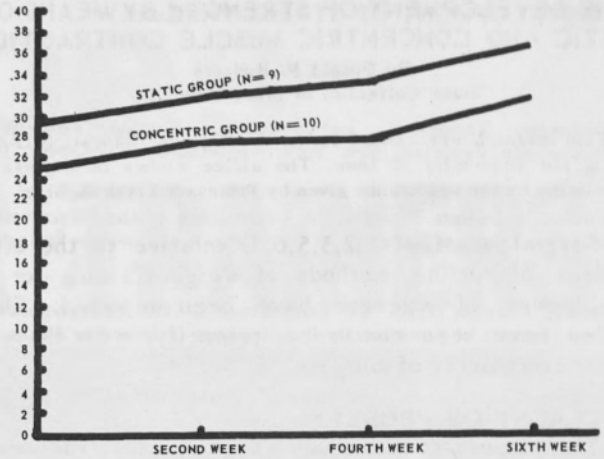

Figure 4
Means of Pullover for Static and Concentric Groups

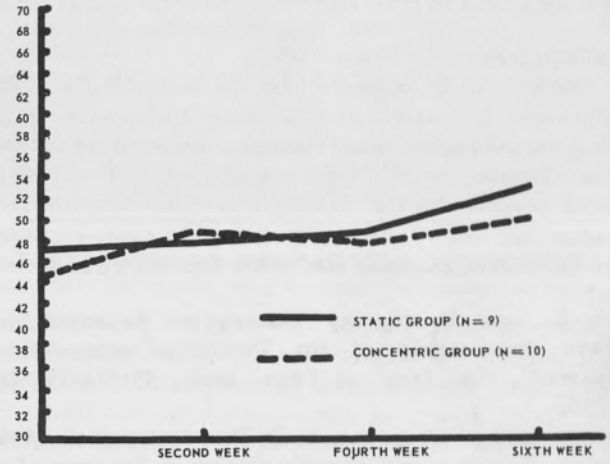

Figure 5
Means of Curls for Static and Concentric Groups

SUMMARY

The purpose of this study was to compare the amounts of strength developed by two methods of weight-training: one based on concentric contractions, and the other on static contractions.

Nineteen men students enrolled in the weight-training course offered in the required physical-education program at the State University of Iowa were used as subjects. Strength tests (situps, pushups, pullovers, and curls) were administered at the beginning of the experiment and at the ends of the second, fourth, and sixth weeks. During the experiment one group engaged in weight-training in the usual manner, and the other group exercised by holding weights in prescribed positions for six months.

In the six-week period both groups gained in strength as measured by the four tests. With the exception of one administration of one test, the static group exceeded the concentric group in all the administrations of all the tests. The differences between the gains for the two groups, however, are not statistically significant. Hence the hypothesis that the two methods do not differ relative to effectiveness in the development of strength is accepted.

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THE DEVELOPMENT OF STRENGTH (Cont.)

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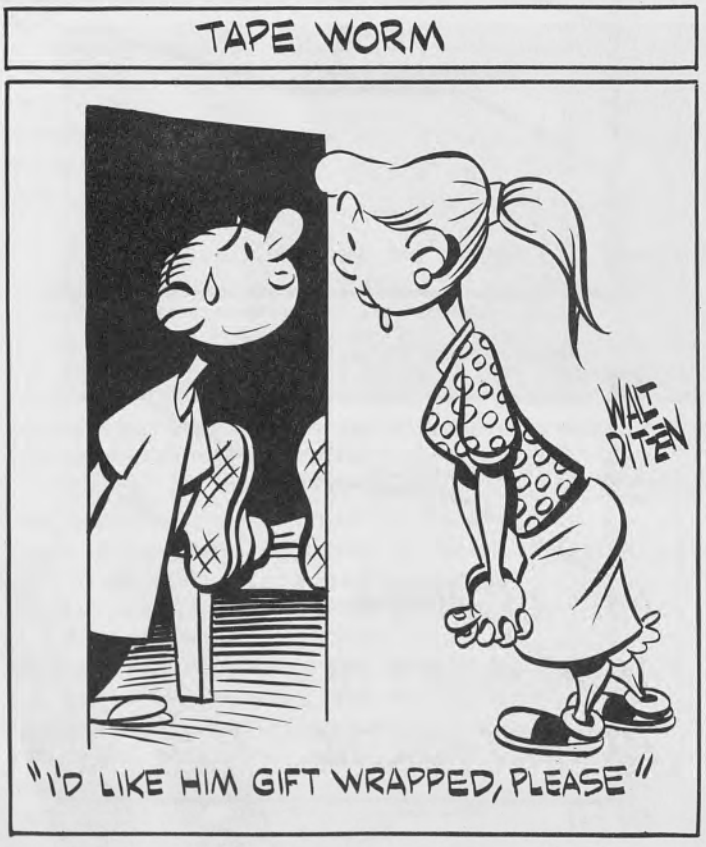

BIKE tapes
DESIGNED FOR TRAINERS

Ordinary tape won't "grab" and hold securely—because it's not designed for athletic use. Sometimes a trainer has to do the job over; often he has to re-tape between halves. And that wastes tape and time.

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PROGRESSIVE RESISTIVE EXERCISE AND ITS UTILIZATION IN THE RECOVERY PERIOD FOLLOWING KNEE INJURY.

KARL K. KLEIN*

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The use of Progressive Resistive Exercise as a post injury technique has been adequately established as a scientific method of approach in the problem of establishing maximum muscular function.[1] Experimental evidence indicates that the problem of rebuilding to the normal level, that is, the strength before injury, does not particularly need specific technique of application but once this normal level is reached, systematic Progressive Resistive Exercise is needed to build toward maximum muscular strength.[2] Muscular strength is the best natural protection for the knee joint. It is further accepted by the author that due to the known characteristics of muscle atrophy of the quadriceps[3] as well as hamstring muscle groups that the application of Progressive Resistive Exercise from the early restoration phase to completion of the program will produce systematic and insured results of strength recovery reaching well into the maximum areas[4]. Such results may be anticipated within a period of four to eight weeks of exercise on a basis of three exercise periods per week (this time element does not include the immediate post-operative period of approximately two weeks during which light progressive weight work has proved beneficial). In making the preceeding statement the author is not purposely disregarding the recently published work by Muller and Hettinger[5], which indicates the use of a six second static muscular contraction for the building of specific muscular strength, but wishes to recognize the future potential of this significant work as a contribution to the entire area of physical restoration and conditioning.

At present there are two recognized systems of Progressive Resistive Exercise, the DeLorme and Oxford techniques[6,7] which with modifications, have been used in the post-operative and/or post-injury phase of recovery following knee injury. The most recent research relating to specific methodology of progressive techniques was recently published[8] and offers some new concepts, derived from the application of old accepted weight lifting methods, that may be utilized to advantage in this type of exercise program. Such methods are capable of producing exceptionally fine results when scientifically applied and systematically progressed throughout the planned exercise program. The author wishes to stress the need for the utilization of such scientific techniques if the maximum results are to be obtained for the injured athlete. We still have to face the fact that knee injury has been the number one problem of athletic injury for years and along with it is the problem of muscular restoration in collaboration with medical treatment.

Although the major emphasis in muscular restoration has emphasized the quadriceps program the author feels that *the hamstrings should be considered with equal emphasis.* Again reference is made to the broad scope of data gathered by the author, through tensiometer testing of injury cases, which has shown relative hamstring weakness accompanying quadriceps deterioration following injury.

With such information available it is important to stress the need for a parellel emphasis on hamstring development throughout the exercise program. The method of exercise application is determined by the same method as used for the quadriceps exercise and through such consideration maximum functional support is developed. It is of related interest to note the findings of Mathews, Shay and Clarke[9] in their extensive army pack carrying experiments recently published, that there is a high relationship between physical condition and the ability of the musculature to

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[1]DeLorme, T. L. and Watkins, A. L., *Prrogressive Resistive Exercise,* New York: Appleton, Century-Crofts, 1950.
[2]Muller, E. A. and Hettinger, T. H., Uker Unterschiede der Trainingsgeschwindigkeit Atrophierter und Normaler Muskeln, *Arbeitsphysiologie;* 15, 223-230, Dec. 1953 (About the Differences of Training Speed in Atrophied and Normal Muscles—*Max Planck Institute for Labour Physiology,* Dortmund, Germany.
[3]Smillie, I. S. *Injuries of the Knee Joint,* Edinburgh; E. & S. Livingstone, Ltd. p. 1-13, 1951.
[4]Klein, K. K., A Study of Cross Transfer of Muscular Strength and Endurance Resulting from Progressive Resistive Exercise Following Injury, *Journal of the Association for Physical and Mental Rehabilitation,* 9:5: 159-161, Sept., 1955.
[5]Hettinger, T. H. and Muller, E. A., Muskelleistung and Muskeltraining, *Arbeitsphysiologie,* 15: 111-116, Oct., 1953. (Muscular Efficiency and Muscular Training—*Max Planck Institute for Labour Physiology,* Dortmund, Germany).
[6]DeLorme, T. L., *op. cit.*
[7]Zinovieff, A. N., Heavy Resistive Exercise—The Oxford Technique, *The British Journal of Physical Medicine,* 14: 129-132, June, 1951.
[8]MacQueen, I. J., Recent Advances in the Technique of Progressive Resistance Exercise, *British Medical Journal,* 1193-1198, Nov. 20, 1954.
[9]Mathews, D. K., Shay, C. T. and Clarke, H. H., Relationship Between Strength Loss in Pack Carrying and Certain Motor Physical Fitness Criteria, *Research Quarterly,* 26:4: 426-439.

maintain its strength. Their studies indicate a high relationship between the ability of the hamstrings to maintain strength in physical activity and physical fitness; and that this muscle grouping and its ability to maintain strength during strenuous physical activity is the best predictor of physical fitness. Such findings tend to indicate to the author the possibility of a positive relationship between hamstring strength loss, or lack of it, and the incidence of knee injury. Such a statement may be hypothetical, but it is based on an engineering analysis of the supporting effectiveness of the muscles supporting the knee in relationship to applied force in contact activity.

The question of determining the exact starting place and method of program progression undoubtedly is of fundamental concern to all interested in handling the problem from the standpoint of its scientific application. The simplicity of utilizing the Single Maximum lift technique as the fundamental factor for the basis of programming has already been established[10]. This technique has been used to advantage without the use of other testing apparatus and has proved to be an effective method for use in establishing the individual exercise program.

The following information has been published and extracted as reference here. Such information will be used as the basis for the program that is to be presented later on in this paper. The use of the tensiometer[11] is a valuable asset in the total procedure in that it assists in reducing administration time as well as aiding the gathering of accurate data. Specific reference is made to the recent research by Clarke[12] in which the study recommended 50% of the tensiometer reading for the 10RM of quadriceps exercise when the measure of strength is made at 135°.

In further discussing the Single Maximum Lift technique the following points have to be considered:[13]

1. Accuracy of measurement is necessary for determining the single maximum lift capacity of the subject. *It is what the patient can do once to complete extension and not repeat a second time.*
2. If the subject is able to complete a second lift, be sure to allow a rest period before again attempting another effort to determine the single maximum lift.
3. The estimation of the single maximum lift capacity is the most difficult part of the total program to establish. Accuracy here will greatly enhance the development of the rest of the program.
4. To determine the 10RM of capacity from the single lift capacity, subtract five pounds from the total weight load and the remaining weight may be used for the first exercise period.
5. If the subject is not able to complete the 10RM on the first day of exercise he will probably do so by the end of that week. If the same situation occurs during the second week a greater reduction is probably necessary from the single lift capacity.
6. If continued deviations from the normal test pattern persist over a two week period, further study of the individual problem is recommended in order that maximum benefits may be insured.
7. The problem of individual differences should be considered in making deviations from the established procedures.

In the total experiments eight subjects participated and a total of thirty-eight tests were administered for determining the 10RM, from the single lift capacity, *by reducing the weight load five pounds.*

Another question likely to arise is the method for progressively incrementing the amount of weight to be added weekly in order to advance the strength development of the subject. Again reference is made to the experimental study by Zinovieff[14] which indicated *that an increase of ten pounds in maximum single lift capacity per week can be expected through the application of the Oxford technique.* This method of weight addition was also used by Klein and Johnson and was found to work satisfactorily in the number of tests previously discussed. During the past four years of identical method of weekly weight addition to the 10RM has been used by the author with exceptionally fine results. During this period approximately one hundred exercise programs have been successfully administered under this technique.

The primary purpose of Progressive Resistive Exercise deals with the problem of strength building. Where muscle atrophy and/or muscular weakness exists and the restoration of strength is the chief objective,[15] i.e. strength for support, then it is imperative that the areas of maximum muscular capacity be utilized in the exercise processes and that weekly increases of weight application be necessary for continuous building of muscular strength. Efforts to increase muscular strength by the use of light weights

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[10]Klein, K. K. and Johnson, E., Research: A Method of Determining the Maximum Load for Ten Repetitions, in Progressive Resistive Exercise for Quadriceps Development, *Journal of the Association for Physical and Mental Rehabilitation,* 7: 4, July, 1953.

[11]Clarke, H. H., *Cable Tension Strength Tests,* Chicopee, Mass.: Brown-Murphy Co., 1953.

[12]Clarke, D. H. and Herman, E. L., Objective Determination of Resistive Load for Ten Repetitions Maximum for Quadriceps Development, *Research Quarterly,* 26: 4, Dec., 1955.

[13]Klein, K. K. and Johnson, E., *op. cit.*

and increased repetition ofs exercise are endurance-producing and will not significantly raise strength levels to expectations. Smillie[15] states that, "endurance is a quality of normal muscle which *should not* be sought until the muscle returns to normal strength levels."

The foregoing material has been presented as evidence that thought and effort has gone into the development of specific exercise techniques to be utilizd in the problem of restoration following knee injury. It has been pointed out previously that atrophy of the supporting musculature of the knee is quite rapid and failure to apply the use of specific exercise techniques in the rehabilitation program only increases the potential of future injury as well as physical inefficiency on the part of the athlete due to the lack of functional support and stability.

The following are to be considered as practical suggestions for the development of the individual exercise program for strengthening the supporting musculature of the knee. It is important to remember that the planning and development of the program is based on individual testing and evaluation:

1. Work in close cooperation with the team physician or orthopedist related to the specific problem. Have him determine just when Progressive Exercise program should begin.
2. Be sure that adequate instructions are given to the subject so that the exercise will be carried out exactly as prescribed and make use of an exercise chart that is progressed weekly.
3. Demonstrate and explain correct exercise procedures and insist that they be carried out exactly as prescribed.
4. Start each exercise program with a few repetitions of light weight work. i.e. if the maximum 10RM is 40 pounds, warm up with four or five repetitions of 20 pounds.
5. Emphasize the importance of the rest period between each set of the prescribed exericse.
6. Before testing for maximum single lift have subject warm up with light weights.
7. Stress the *importance of complete leg extension in all quadriceps exercise.*
8. In hamstring exercise stress the importance of not flexing beyond 90 degrees. Beyond this point the hamstrings have a tendency to relax and lateral sway can be dangerous. (refer to diagram).
9. Impress the necessity of regularity in exercise application.

Certain fundamental equipment is necessary for the administration of this type of progressive exercise program:

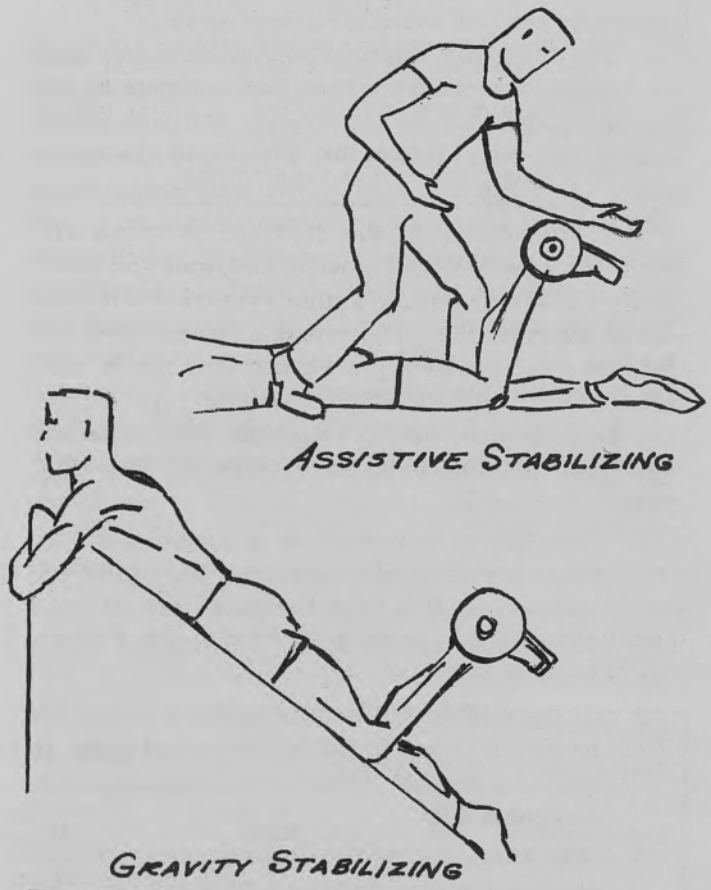
a) —one iron or aluminum boot and cross bar and snap on clips.

b) —a variety of graded weight from two and one-half to twenty pounds, (about one hundred pounds in all.)[16]

c) —one exercise table or bench and one stall bar or low bench for subject to sit on while changing weights.

d)—one strap to be used as a guide for the raising and lowering of the boot during exercise. This assistance, although not actually an active action, prevents lateral sway of the boot. This assistance is especially important in the hamstring exercise.

The following is an example of a progressive resistive exercise sequence that may be used as a guide for programming other specific problems. The awareness of cross transfer of training[17] to the contralateral side must be considered as the program progresses because the single maximum strength of the unexercised side is the strength goal objective for the exercised leg and is the guide to the development and restoration of bilateral muscular balance.



[14]Zinovieff, A. H., *op. cit.*
[15]Smillie, I. S., *op. cit.* p. 1-18.
[16]DeLorme, T. L. and Watkins, A. L., *op. cit.*
[17]Klein, K. K. and Williams, H. E., Research: A Study of Cross Transfer of Muscular Strength Gains During Reconditioning of Knee Injuries, *Journal of the Association for Physical and Mental Rehabilitation,* 8: 2, March, 1954.
[18]MacQueen, I. J., op. cit.

Progressive Resistive Exercise Program — Quadriceps and Hamstrings*

	1st Week			**2nd Week**	
	10 RM**	25 lbs.		10 RM	35 lbs.
	5-8 RM	35 lbs.		5-8 RM	45 lbs.
Quads	1-4 RM	40-45 lbs.	**Quads**	1-4 RM	50-55 lbs.
	15 RM	15 lbs.		15 RM	25 lbs.
	10 RM	20 lbs.		10 RM	30 lbs.
	5-8 RM	30 lbs.	**Hamstrings**	5-8 RM	40 lbs.
Hamstrings	1-4 RM	35-40 lbs.		1-4 RM	45-50 lbs.
	15 RM	10 lbs.		15 RM	20 lbs.
	Single lift capacity should be about 50 lbs. Test unexercised side.			**4th Week**	
	3rd Week			10 RM	55 lbs.
	10 RM	45 lbs.		5-8 RM	65 lbs.
Quads	5-8 RM	55 lbs.		1-4 RM	70-75 lbs.
	1-4 RM	60-65 lbs.	**Quads**	15 RM	45 lbs.
	15 RM	35 lbs.		10 RM	45 lbs.
	10 RM	40 lbs.		5-8 RM	55 lbs.
Hamstrings	5-8 RM	50 lbs.		1-4 RM	60-65 lbs.
	1-4 RM	55-60 lbs.	**Hamstrings*** **	15 RM	35 lbs.
	15 RM	30 lbs.		Re-check single lift of both legs at end of 6th week. Approximate balance should be obtained.	
	Single lift capacity should be about 70 lbs. Test unexercised side.				
	5th Week			**6th Week**	
	10 RM	65 lbs.		10 RM	75 lbs.
	5-8 RM	75 lbs.		5-8 RM	85 lbs.
Quads	1-4 RM	80-85 lbs.	**Quads**	1-4 RM	90-95 lbs.
	15 RM	55 lbs.		15 RM	65 lbs.
	10 RM	50 lbs.		10 RM	55 lbs.
	5-8 RM	60 lbs.		5-8 RM	65 lbs.
Hamstrings	1-4 RM	65-70 lbs.	**Hamstrings**	1-4 RM	70-75 lbs.
	15 RM	40 lbs.		15 RM	45 lbs.

* The first three exercises in each category are strength-building; the fourth is for development of endurance.
** RM—Repetition maximum for the particular bout of the exercise; lower leg to full extension and return to flexion in quadriceps exercise and flexion to 90 degrees and return to extension in hamstring exercise. Exercises are performed with an even sustained contraction of about 2 seconds to full extension and 2 seconds to flexion.
*** Experience indicates that at some place during the exercise program, the hamstrings lose their ability to advance at the same rate as the quadriceps.

The foundation of the described programs are drawn from the work of Zinovieff, DeLorme and MacQueen combined with the author's experience in this area of rehabilitation. The program is developed for three exercise periods per week with one day of rest between each period. The maximum application should be no more than four periods per week. Excessive exercise is detrimental to progress[18]. The program is outlined in Table I.

There is evidence, as a result of extension research data, which indicates that the average hamstring muscle strength is only about 62% of the average quadriceps strength of a large number of athletes that have been measured. This strength relationship may readily account for the necessity of reducing hamstring weight load in the latter part of the program because this muscle group reaches its maximum potential more rapidly in the specific type of exercise used and its capacity to continue the heavier weight load is decreased.

Further emphasis may be given to the rebuilding of the qualities of muscular endurance by additional activities that are of endurance status: i.e. running on a smooth surface, use of a tread mill, etc. Care should be taken in giving specific instructions not to participate in running activities that require fast changng of direction during the early phase of the recovery program.

Double Boot* Program

	7th Week			**8th Week**	
Quads	10 RM	120 lbs.	**Quads**	10 RM	140 lbs.
	5-8 RM	140 lbs.		5-8 RM	160 lbs.
	1-4 RM	150-160 lbs.		1-4 RM	170-180 lbs.
	15 RM	100 lbs.		15 RM	120 lbs.
Hamstrings	10 RM	80 lbs.	**Hamstrings**	10 RM	100 lbs.
	5-8 RM	100 lbs.		5-8 RM	120 lbs.
	1-4 RM	110-120 lbs.		1-4 RM	130-140 lbs.
	15 RM	60 lbs.		15 RM	80 lbs.

* Double Boot—long bar with both boots on the bar. The weights are placed on side of the boots and locked on. Both legs are exercised simultaneously.

If bilateral balance is obtained it is always possible to continue the program for a few more weeks to raise the total strength level. This can be accomplished by utilizing a "double boot" program i.e. using twice the weight load of the single boot exercise program and starting it from the previously listed program. The weight loads could be doubled but have been reduced with evidence of satisfactory results. If there is evidence of bilateral muscular weakness, with balance existing, then a double boot program may be used from the beginning. The determination of the single lift capacity would be the starting place for development of the program. Outline for a suggested "double boot" program is offered in Table 2.

It is suggested that following each exercise program the hamstrings be stretched by a series of toe touches from a standing position; ten to fifteen stretches should be done. This suggestion is made because of the tendency of the hamstrings to shorten during activity and the muscle elasticity should be maintained for maximum functional development.

The planning of the exercise program is an individual proposition and should be considered as such when making the initial evaluations for determining the exercising sequence. Accuracy is important because it is only through accuracy of measurement that the maximum progress can be expected in a reasonable amount of time. i.e.—four to eight weeks depending on the starting condition.

Contact with the team physician is important so that he will know of the progress of the subject during all phases of the program advancement.

If the subject is not able to complete all of the prescribed exercise, in each period, and this situation exists for a week or two then it is essential that a re-evaluation for the Single Maximum lift capacity be accomplished. In this manner maximum progress can be maintained.

Although no guarantee can be made regarding the results of such an exercise program in terms of future athletic competence, one may be assured that the best effort has been given to the process of recovery of maximum function and that a tried and proved system of progressive resistive exercise is the best method of approach to the problem.

IN THE NEXT ISSUE

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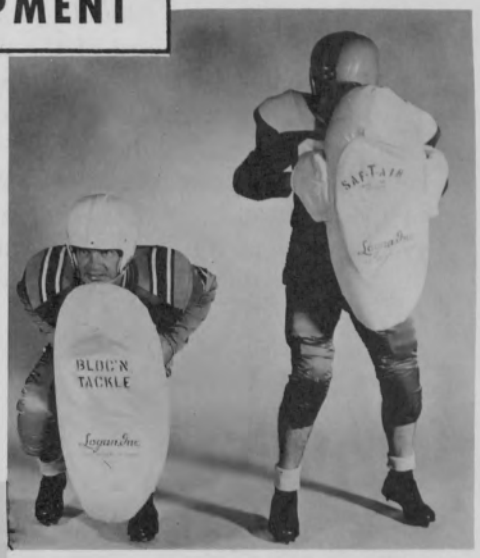

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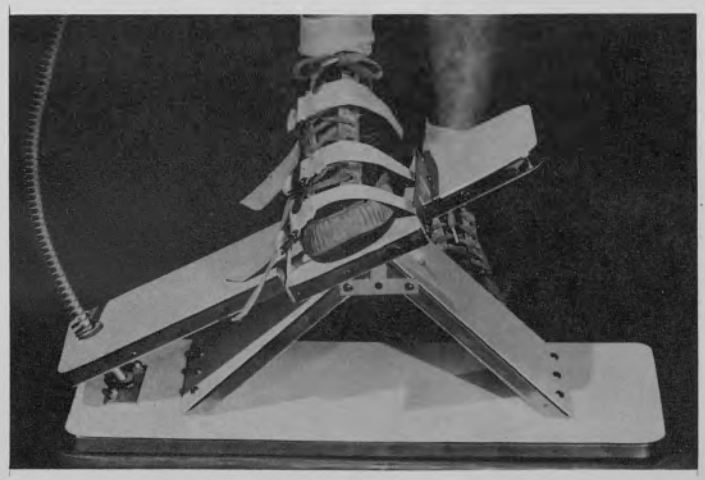

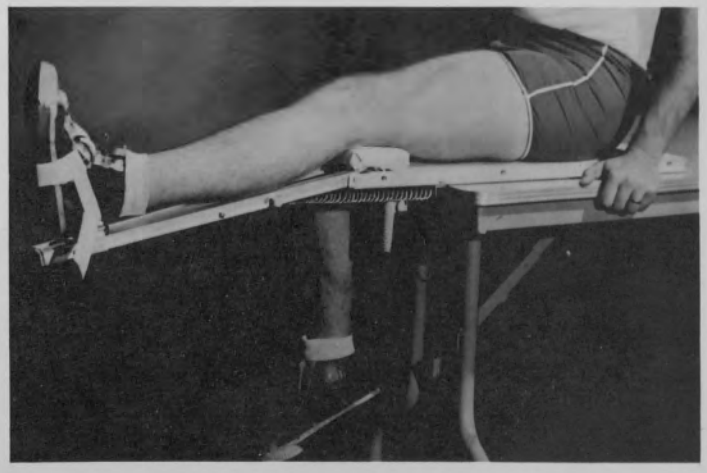

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