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Dr. R. Tait McKenzie: pioneer and legacy to physiatry.

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Title: R. Tait McKenzie: Pioneer and Legacy to Physiatry

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"In history, a great volume is unrolled for our instruction, drawing the materials of future wisdom from the past errors and infirmities of mankind."

Edmund Burke

INTRODUCTION

Our purpose in this paper is to illustrate scientist and physician R.Tait McKenzie's contributions to the scientific development of physical training and therapeutic exercise in restoring function and reducing disability. McKenzie's legacy to PM&R is his fundamental concept, much later articulated by the American College of Sports Medicine, as to the importance of frequency, intensity, time, type, volume, and progression of therapeutic exercise [1,2]. His classic book [3] instructs physicians for the first time as to the scientific value of exercise in health and disease. He categorizes the specific pathological conditions that can be effectively treated with exercise, and he emphasizes the precision necessary in dosage and timing to achieve the benefit. In the preface to his first book, *Exercise in Education and Medicine* [3], he exposes the medical profession's one-dimensional approach to therapeutics, i.e. an emphasis only on pharmacology, an approach that has prevailed until very recent times [4].

"Perhaps a certain laziness which is inherent in both patient and physician tempts to the administration of a pill or draught to purge the system of what should be used in normal muscular activity, but there is a wide dearth of knowledge among the [medical] profession of the scope and application of exercise in pathologic conditions, and the necessity of care in the choice and accuracy of the dosage will be emphasized throughout the second part of this book" [3].

As a scientist and clinician, McKenzie also recognized the lack of interest by the medical profession in the physiology of exercise and the importance of physical training for promoting good health and function.

McKenzie's use of physical therapy in the rehabilitation of the war wounded in Great Britain, Canada, and the United States during World War I (WW I) entitles him to recognition as one of the earliest pioneers of physical medicine and rehabilitation (PM&R). His second textbook, *Reclaiming the Maimed: A Handbook of Physical Therapy* [5], was used by the military in all three countries to develop and establish physical therapy services in the Reconstruction Hospitals during WW I. His work influenced physiatrists Frank Granger, George Deaver [6] and John Stanley Coulter, three major leaders in the field in the decades following the war.

EARLY INFLUENCES: MCGILL, HARVARD, AND SPRINGFIELD

McKenzie experienced a "fascination [with] acrobatics and gymnastics" during his early undergraduate years at McGill University [7]. He competed in track and field and set the intercollegiate high jump record in 1886 before entering medical school. During his medical school days, he developed his first interests in physical education and was inspired by Dudley A. Sargent, MD, who conducted a six-week course at the Harvard Summer School [8]. McKenzie attended courses for two summers in 1889-1890 on the theory of systems in physical education, anthropometry, applied anatomy and other sciences, which were applied in class drills involving exercises with weights, vaulting with bars and horses, tumbling and dancing. Sargent's systematic measurement of body proportions and research involving thousands of male and female students that included physiological studies of respiratory capacity and grip strength,

established that training approaches must be scientifically based. This same scientific rigor is evident in McKenzie's future cardiac studies [9]. Many of the machines used in gymnasiums throughout the United States such as rowing, pulley systems for specific muscle groups, and lifting were developed by Sargent. However, Sargent faced opposition to his scientific approaches to the study of physical conditioning by the conservative elements of academe. But, McKenzie predicted that Sargent's place in the history of physical education would be as "pioneer, thinker and scientist" [10].

It was during medical school at McGill University that McKenzie began to instruct students in gymnastics under the direction of James Naismith, Director of Athletics [11]. McKenzie's interest in exercise physiology developed during his years at the University, as is reflected in his appointment as Medical Director of Physical Training following graduation from medical school. Naismith would subsequently join another of Sargent's students, Luther H. Gullick, MD, who was a pioneer in physical education and founded the first school at Springfield College. (Naismith and Gullick are credited with the invention of the game of basketball [12]). Following graduation from medical school, McKenzie became a close friend of and collaborator with Gullick and the two trained new directors of the YMCA in physical education. Gullick offered McKenzie a position at the YMCA in Springfield [13], but McKenzie chose not to join the YMCA for professional and personal reasons. McKenzie also taught anatomy at McGill and his appreciation of anatomy, kinesiology and sports was soon reflected in his art as a sculptor (Figure 1), which would earn him international recognition [14].

Although McKenzie had no specialized training in general surgery or orthopedic surgery following his internship in Montreal he restricted his practice to orthopedics and musculoskeletal diseases after he joined the faculty of the medical school at McGill. Graduates of Canadian and

US medical Schools in the 1890s were licensed to practice medicine and surgery following an internship of 1 year. If they restricted their practice to one field, such as orthopedic surgery, on a full time or almost full time basis (personal communication Dr. David B. Levine), this validated them as a specialist. McKenzie's earliest publications [15] deal with posture/exercises in the prevention/treatment of scoliosis, and he is characterized later as an orthopedic surgeon with a special interest in "orthopedic gymnastics" [16].

UNIVERSITY OF PENNSYLVANIA

Physiatrist Frank Krusen, considered the father of physical medicine [17] claims in his accounts that McKenzie was the first professor of physical therapy in the nation [18], and certainly he was one of the earliest to hold that appointment in a major US medical school - the University of Pennsylvania, the oldest medical school in the nation. McKenzie's appointment as Professor of Physical Therapy in 1907 [19] followed his appointment as Professor of Physical Education in 1904. His early teaching included instruction in exercises that are applicable to "curvature of the spine [and] locomotor ataxia", included in course work in physical education for medical students [20] at the University. However, the Physical Laboratory was not established in the hospital for the training in hydrotherapy and other therapies as part of medical education until 1911-1912 [21]. Archival documents record that "Dr. Joseph Nylin, a trained masseur...graduated from the University of Pennsylvania" joined the faculty as an associate to McKenzie in 1912 [22]. Sophomore medical students were given a series of lectures twice a week on exercises and massage for specific diseases; additional lectures were given to senior students during medicine and surgery rotations. Demonstrations of hydrotherapy and other physical modalities were added as the curriculum evolved [21].

Because of his dual role teaching physical education and physical therapy, McKenzie was effective in introducing training programs in physical examination and exercise to improve the health and correct educational deficiencies in the student population. In addition to these innovative contributions to medical education, he made scientific observations and published his findings in the medical literature during these early years at the University [23]. It is during this period McKenzie began to write his classic textbook on exercise in health and disease. He states his reasons for doing so in the following notation [19] shortly after his arrival at Penn in 1904:

“Living in Philadelphia, the home of the leading Medical publishers, and with a seat on a Medical faculty, each member of which had written a standard textbook on his subject, it was natural that the subject of writing would come up early.” [19]

McKenzie is in fact approached by a leading publisher and finds that “at the time there are no textbooks on the subject” [19]. Only one book had been published on exercise at that time, Ferrand LaGrange’s *Physiology of Bodily Exercise* [24]. But McKenzie held the view that “in the realm of medicine...no attempt had been made to give a comprehensive view of the whole subject” [18]. McKenzie’s textbook, *Exercise in Education and Medicine*, was first published in 1909 [3] and is regarded by the founders of sports medicine and historians of physical education as a classic [4,25]. It is praised as the “most comprehensive volume” that “brought physical medicine, rehabilitation and athletic knowledge together” [26,27]. Berryman [4] places it with Sargent’s book in linking exercise with health and medicine. Part I is devoted to the classification of exercise, massage, physiology of exercise, the German and Swedish schools of exercise, and physical education in schools and for recreation. The second part of the book focuses on the use of exercises in pathological conditions effecting posture, cardiovascular disorders, neurological diseases such as locomotor ataxia, and treatments for obesity and

musculoskeletal conditions. He is very precise in describing the accompanying symptoms and physical findings such as loss of balance with ataxia. He cites Silas Weir Mitchel, considered the father of neurology in USA, who explained a treatment protocol based on the exercises of Frankel, a German neurologist.

“The exercise treatment of ataxia...was used 40 years ago in America by Dr. Weir Mitchell...invented by Frankel, of Heiden [Germany]. ...rising from a chair the tabetic patient usually forgets to draw his feet backward. ...He has ... to learn this simple coordination over again [3].”

With drawings, McKenzie maps out the progression of training exercises to restore balance during walking, indicating a favorable prognosis, and then he applies additional exercises for dressing and other activities of daily living. He cautions that the training of individuals should avoid excessive fatigue and advises monitoring pulse rate and respiratory parameters. This textbook includes the first comprehensive discussion of the “dosage” essential in the use of therapeutic exercise, and this discussion becomes the foundation for the prescription of exercise in PM&R [2].

McKenzie’s 1913 publication on the influence of exercise on the heart [9] reflects his interest in cardiovascular physiology and cardiac rehabilitation, an interest that continues throughout his career. Dr. Joseph Wolffe, a cardiologist and one of the founders of the American College of Sports Medicine, praises McKenzie’s early attention to cardiovascular exercise [25].

“Dr. McKenzie demonstrated, time and again, that response to exercise with few exceptions, proved to be a sound clinical test of the heart’s ability to perform work and that functional heart murmurs, certain cardiac irregularities were untrustworthy guides in the evaluation of the integrity of the heart.”

THE GREAT WAR

Orthopedic surgeons at the beginning of the 20th century, such as Robert Lovett [28], Robert Jones, Joel Goldthwait, Fred Albee, and Henry Kessler, had a comprehensive approach to the restoration of function that extended beyond their surgical skill. Several worked with physical therapy aides in civilian hospitals before the war, and the aides complemented the surgeon's efforts. These orthopedic surgeons also understood the importance of occupational therapy and vocational training. Kessler emphasized this appreciation in his book "The Knife is Not Enough" [29]. McKenzie was part of this tradition, but he brought a dimension of therapeutic exercise, which he extended into muscle re-education, functional training, gymnastics, sports and dancing. Opportunities to employ these unique aspects of therapeutic exercise were soon to unfold with events in Europe and the United States.

The advent of WW I provided an opportunity for physicians with interests in physical training and physical therapy to apply their skills to both enhance the fitness of inductees and restore function to the wounded and those with medical and post-surgical conditions. McKenzie's patriotic fervor led him to take a leave of absence from the University for 18 months to join British forces in 1915 at the beginning of the War (Figure 2). He came under the command of Sir Robert Jones, "who founded the chain of orthopedic centers, to which reconstructive centers were attached" [5]. McKenzie indicates in a 1917 paper [30] on the treatment of neurological injuries that this approach attracted the attention of the Surgeon General of the United States.

"In the great orthopedic centers established throughout England by Lieutenant-Colonel Sir Robert Jones...[which] form[ed] the backbone of the treatment... the Surgeon General of the United States has already sent over a

contingent of orthopedic surgeons to make themselves familiar with the subject
and to establish centers to accommodate thirty-five thousand cases in France.”

McKenzie’s first task was to assess the health status of soldiers determine unfit for service in the
army.

“Arriving in England in 1915 he was distressed by the sight of many men who were
unfit... Dr. McKenzie substituted health education, remedial physical training and
recreation...in the place of rest, inactivity and a life akin to hibernation. His experiments
proved to be the most effective in hastening recovery of the sick... Gradually, it gained
acceptance that properly supervised physical education revitalizes while prolonged rest
devitalizes and cripples” [25].

McKenzie’s treatment approaches for wounded soldiers combined traditional physical
therapy modalities with his innovative concepts of precise therapeutic exercise programs,
occupational therapy, and vocational retraining. His approach to the restoration of function of
nerve injuries represents one of the first descriptions of the use of graded exercises with
hydrotherapy and antigravity exercises. He reported [30] on a series of more than 500 cases
(1917) in which he employed a system for grading of muscle strength and then applied muscle
reeducation programs appropriate to the muscle strength. The muscle reeducation he describes as
“progressive active movements...to bring back and strengthen voluntary power and later,
gymnastic and vocational training”. This approach is similar to Lovett’s approach with polio
cases [31] refined by Robert Bennett at Georgia Warm Springs in the 1940s [32].

McKenzie’s appreciation of the benefits of occupational therapy and especially the use of
adaptive equipment is unique for a military physician in 1916. His understanding of the

distinction between occupational therapy and vocational training is clearly defined in his textbook [5]:

“A distinction is frequently drawn between occupational therapy and vocational training. In the former, the movements are given as treatment, and the work done is a secondary consideration. The patient saws wood because the arm muscles can thus be contracted and relaxed a definite number of times. It is really a gymnastic exercise done with a saw. In vocational training the object is to make a good box by sawing the board in definite lengths, and the arm exercise is secondary, though essential.”

In a letter [33] to the editor of the Journal of the American Medical Association (JAMA) in 1918, he identifies “devices for men who have lost one or two arms” and this appears to be early examples of adaptive feeding and recreational equipment for the upper extremity amputees (Figure 3).

It is these scientific studies, case reports, and his success returning more than 70 % of the war wounded under his care at Heaton Park to active service [34,35], which established his reputation in military circles as an expert in functional restoration of wounded soldiers. McKenzie recognized the need for a physical therapy textbook to guide army physicians since no text in English existed for the military at the time. He approached the development of his handbook of physical therapy in the same fashion as his book on exercise in 1909, drawing from exercises in the Swedish and German literature and improvising concepts of mechanotherapy [34] that were influenced by Sargent and others. Granger [36] and Lovett [28] cite McKenzie’s publications and expertise in mechanotherapy, which involved “machines” or apparatus for

active and passive exercises to increase finger, wrist, shoulder and lower extremity range of motion and strength.

McKenzie's work on the rehabilitation of the "crippled soldier" was well known by leaders in US medicine and surgery and is cited in W.W. Keen's classic surgical textbook [37]. Harry Mock, a pioneer industrial surgeon in the Surgeon General's Office, advised Frank Billings, Head of Reconstruction and Rehabilitation in WW I, that McKenzie was "the only man for the job" [38] to advise the US Army regarding physical therapy, and as a result Billings invited McKenzie "*to take charge of the department of physiotherapy to standardize the work and to secure the proper personnel in physiotherapy that will enable us to do that work well*" [39].

The subsequent success of rehabilitation hospitals in the US has been attributed to the pioneering efforts of US military physicians, such as Frank B. Granger, who set up the program of physical therapy in the US Army reconstruction hospitals [40]. The program that Granger implemented, however, was based on his visit to the British Army with Joel Goldthwait, head of Orthopedic Surgery for the American Expeditionary Forces and their observations of the program in reconstruction hospitals of Great Britain that had been established under the leadership of McKenzie [27]. Granger's approach in the convalescent hospitals in France and the US, like McKenzie, stressed the team approach to rehabilitation. McKenzie's scientific publications before and during the war [30,34,35] and his *Handbook on Physical Therapy: Reclaiming the Maimed* [5], the official text and standard for British, Canadian and US armed forces, must have influenced all [28,36] who shared it including professionals at the convalescent facility in France that physiatrist John Stanley Coulter headed [41].

INFLUENCE ON GRANGER, MOCK, COULTER AND DEEVER: 1919-1930

Developments in the United States immediately following the war reflected the translation of these war experiences into civilian practice. The physical treatments developed by physicians in convalescent hospitals, pioneered by McKenzie and others, “formed the basis for modern Physical Medicine”[27]. For example, physiatric leaders Coulter, Granger, and Mock transitioned their efforts to raise the standards of research, education and practice in physical therapy, since many of the empirical claims were unsubstantiated, considered suspect and at times fraudulent by medical professionals. McKenzie’s emphasis on the requirements of scientific rigor is reflected in their work. Organizations were formed of physicians with special expertise in physical medicine and of physical therapy aides; both groups recognizing the need to improve the standards of training (Table 1A).

Coulter became very active in one of several new organizations of physical therapy physicians (Table 1A), the Congress of Physical Therapy (CPT) founded in 1923. His connections to Granger and Mock during the war [42] are well documented, and within several years he was elected the third president of the CPT. Granger founded and served as first president of the Academy of Physical Therapy (APM), established in 1923 the same year as the Congress of Physical Therapy. The APM was an organization which included former electrotherapists, but many physical medicine physicians belonged to both organizations [43,44]. Both Granger and Coulter were strong advocates of improving the educational standards of physical therapy aides following the war, and both were commended in historical accounts [45,46] of the American Physical Therapy Association (APTA). McKenzie’s influence can be

seen in the efforts of Granger and Coulter to strengthen the team approach to rehabilitation in these organizations. These physician pioneers, like McKenzie [34], recognized that the physical therapist aide's knowledge and skill was integral to raising the standards of physical therapy in medical practice.

The creation of the AMA Council of Physical Therapy (AMACPT) in 1926 [47] was the first official recognition of physical therapy physicians. The AMACPT was chaired by Mock, who was well-versed in McKenzie and Granger's contributions. Most of the early reports of the AMACPT dealt with safety and standardization of therapeutic modalities of heat, electricity, and radium, with far less attention to therapeutic exercise, although exercise was listed as one of six categories in the definition of modalities [47]. The following definition most likely reflects McKenzie's influence on Mock:

Therapeutic Exercises.—Muscle training exercises, passive and active, mechanotherapy, occupational therapy, games.

While Mock was knowledgeable of physical therapy in his practice in Industrial Medicine, he was not a full time practitioner.

Frank Granger, however, who was appointed to the AMACPT in 1927 was the first full time physical therapy physician [48]. Granger, while on the AMACPT, recognized McKenzie's contribution to the invention of mechanical exercise equipment and the benefits of exercise in competitive sports in addition to the need for better research to validate physiotherapy [36]. Following Granger's death in 1928, he was succeeded by Coulter to the AMACPT in 1931 ensuring continuity by full time practitioners of physical medicine. Although McKenzie was not directly involved in these deliberations he continued to publish and present papers on sports and to physical therapy societies [49,50] (Figure 4).

Deaver, considered the grandfather of rehabilitation medicine [6], was likely exposed to the physical therapy course taught by McKenzie and Nylin when he was a sophomore and senior at the University of Pennsylvania before he entered the military. Deaver, a recent medical school graduate in 1917, familiar with the YMCA approach to physical training, also employed drills accompanied by music in his fitness training for soldiers [51]. Like McKenzie, Deaver applied exercise therapy and other physical therapies to rehabilitate the war wounded of WW I. McKenzie [52] and Deaver published back-to-back articles in the journal for directors of YMCA's on treatment of the war wounded [51,52]. Both trained masseurs and other staff to provide physical training, and both recognized that restoration of function was a team effort [53]. McKenzie and Deaver continued a relationship after the War during Springfield College reunions in Philadelphia in 1921 [54].

It is interesting to speculate on how these early experiences and Deaver's association with McKenzie may have influenced his choice of joining Coulter at Northwestern in 1930 [6], and his subsequent move to NYC, where his career in PM&R unfolds, first with Coulter, then at the Institute for the Crippled and Disabled (ICD), and later with Rusk at New York University (NYU).

This approach of restoring the war wounded to optimal functioning with a team effort, first reported by McKenzie and Deaver in WW I, was expressed again in Deaver's relationship with Howard Rusk. Early in WWII, Rusk approached Deaver, when he met him at the ICD and asked his advice regarding the establishment of rehabilitation centers for the Air Force. "Do you think you could set up such a program?" Deaver replied that they had already offered such a program to the Army and VA, but was told it was not needed. Rusk replied "We need it in the Air Force" and Deaver replied "We'll be glad to do it for you" [55, p 3-29].

The year 1930 is significant for the field of PM&R, because a number of important events occurred in the lives of these early pioneers. Following Granger's death, Coulter succeeded him on the AMACPT, McKenzie retired, and Deaver joined Coulter at Northwestern University. Krusen began publishing on physical therapy, which led to his recruitment to the Mayo Clinic and his departure from Temple University in 1935 [17] (Table 1B).

INFLUENCE ON PHYSICAL MEDICINE 1931-1938 AND BEYOND

In 1934, McKenzie became active in the Academy of Physical Medicine (APM), originally founded in 1923 by Granger as the Academy of Physical Therapy [44]. McKenzie chaired a symposium at the annual APM meeting in 1936, which featured the first Director of the London Hospital Department of Physical Medicine, Sir Robert Stanton Woods, two national experts from Columbia University and the Sargent School in physical education, and a presentation on exercise physiology from the Harvard Fatigue Laboratory (HFL). This was an example of efforts to update physical medicine in regard to exercise physiology and physical education. Inviting participation by a member of the HFL illustrates his visionary leadership concerning the importance of the physiology of exercise as a necessary component of future research in PM&R. His judgment in 1936 is validated, since The Harvard Fatigue Laboratory, when viewed 6 decades later, is recognized as having attracted some of the most important leaders in this field [56]. Robert Darling [57] former chair of PM&R at Columbia and Edward Gordon of Chicago and Jefferson Medical College are products of this research environment in the 1940s.

Although, McKenzie like Deaver [58] did not play a major role in organized PM&R, he was elected president of the APM in 1938. This is a critical year in the development of Physiatry

as a specialty. McKenzie is aware of the achievements of the AMA Council on Physical Therapy and recognized this in his presidential letter to the members of the ACP in 1938 [43].

“Every profession must have an organization such as ours, composed of its leaders...capable of...cultivation of their own special field. It is especially necessary in work such as ours which has so recently attained official recognition...keeping fellows informed...with new discoveries in Physical Medicine”

In 1937, Krusen was informed by his colleagues at Mayo that the time for consideration of a specialty board had arrived [42]. Krusen and the leadership of the CPT had already approached the APM, while McKenzie was an officer, to consolidate with the Congress of physical therapy. This was a strategy in preparation for the formation of the Society of Physical Therapy Physicians (SPTP), whose primary purpose was to work for specialty status [58]. It is unclear what McKenzie’s position was on this movement since he died prior to the meeting, but events unfold and leadership for these efforts are identified in the next two years, and the outcome was momentous for PM&R. In 1938 Krusen is elected president of CPT and Coulter becomes the first president of the newly formed Society of Physical Therapy Physicians. This organization became the American Academy of Physical Medicine (AAPM&R) in 1954. Although Krusen was named chair of the Research Committee of the APM by McKenzie, together with Mock and Albee in 1938, he continued his efforts toward consolidation and through his leadership in the Congress for the future recognition of the Board of PMR. The members of the APM became absorbed into the SPTP and the Congress over the next few years; in Coulter’s history of physical medicine in 1946 [48] he names only two organization representing physical medicine, the Congress and the Society of Physical Medicine.

Many of these pioneers who were former members of the APM and of the CPT (later the ACRM (Table 1B) and played key roles on behalf of the specialty during and/or following the war, will be recognized by the ACRM's Gold Key Award [59]. These leaders included Goldthwaite (1935), Mock (1937), Coulter (1943), Krusen (1944), Deaver and Kessler 1953.

McKenzie's legacy at the University of Pennsylvania is well documented [60]. Dr. Joseph Nylin, who succeeded him in 1931 presented a paper at APM in 1938 together with Krusen and Walter Zeiter [61]. Nylin is listed as one of the charter members of the SPTP the following year [58], and this links McKenzie's legacy at Penn with the future AAPM&R. Following Nylin's death in 1945, George Morris Piersol, an orthopedic surgeon who was well known to McKenzie, succeeds him. Piersol gained national recognition in PM&R and received the Gold Key Award of the Congress in 1954 joining many of the earlier pioneers. Piersol groomed William Erdman as his successor that same year and Erdman became a major physiatric leader during the next 3 decades.

CONCLUSION

McKenzie's vision of physical medicine and rehabilitation (PM&R) through the prism of physical education reveals the major taproot that fed the early growth of Physiatry. As a scientist with an appreciation of exercise physiology, and as a physician with an understanding of the pathophysiology of trauma and disease, he was able to apply accurate anatomic, physiologic, and kinesiology measurements, develop specific training programs and design recreational and vocational activities to restore maximum function without injury or other negative outcomes for patients with many different conditions. He was perhaps the first physician scientist to articulate the concepts we embrace today for retraining individuals with sports injuries and neurotrauma.

His national stature as a pioneer in sports medicine, an artist, a physical educator and PM&R physician [25,27,62] is well-deserved. His legacy to the practioners of PMR such as Granger, Coulter, and Deaver extends to partners in physical and occupational therapy, kinesiology and biomechanics, because he understood these basic concepts and appreciated the requirement of a team effort to achieve the best results.

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Tables

Table 1 A. Timelines for organizations and abbreviations for Physical Therapy (Physical Medicine and Rehabilitation) organizations.

Name	abbreviation	Membership
American Society of Physical Therapy Physicians 1938 American Society of Physical Medicine 1944 American Society of Physical Medicine and Rehabilitation 1951 American Academy of Physical Medicine and Rehabilitation 1955	ASPTP or SPTP ASPM ASPM&R AAPM&R	Physiatrists requiring Board certification
American College of Radiology and Physiotherapy 1923 American Congress of Physical Therapy 1925 American Congress of Physical Medicine 1944 American Congress of Physical Medicine and Rehabilitation 1952 American Congress of Rehabilitation Medicine	ACRP ACPT ACPM ACPM&R ACRM	Physiatrists and related medical professionals
American Academy of Physical Therapy 1923 American Academy of Physical Medicine 1933-1944	AAPT or APT AAPM	Physicians with interest/skill in Physical Medicine

Table 1 B. Timelines Pioneers in Physical Medicine and Rehabilitation

Leaders	Years	Title	Organization	Events
McKenzie	1904-7 to 1930	Professor	University of Pennsylvania School of Medicine	1 st Professor of Physical Education & Physical Therapy in US. “Interest in orthopedic gymnastics” (Packard)
McKenzie	1915-19	Major	British Armed Forces & consultant to Canadian & US Armed forces	WW I 1 st Handbook Physical Therapy in US.
Granger	1906-1917	Instructor	Tuft & Harvard Medical Schools	Major interest electrotherapeutics
Granger	1917-19	Colonel	US Army	WW I Head Physical Therapy US Army
Granger	1919-1929	Assistant Professor	Tufts Medical School	APT 1923 Founder AMA Council Physical Therapy 1 st Physical Therapist MD 1926
Coulter	1911-1920	Lieutenant Colonel	US Army (1911-20)	WW I Head 1 st US Convalescent Rehabilitation Hospital in France 1918
Coulter	1926-1949	Professor & Chair	Northwestern University.	President Congress 1926 AMA Council PT 2 nd MD 1931
Krusen	1926-1935	Associate Dean	Temple Medical School	Physical Medicine 1 st Physical Medicine Department US
Krusen	1935-1965	Professor & Chair	Mayo Clinic; University of Minnesota Medical School.	President APM 1936 1938 SPTP with Coulter 1947 Chair ABPMR
Deaver	1931-1932	Instruct	Northwestern University School of Medicine	Joins Coulter
Deaver	1932-1937-	Medical Advisor	NYU School PT	Directed training in therapeutic exercises, surgery and orthopedic surgery
Deaver	1938-1946	Director	Institute Crippled & Disabled	Publishes 1 st Text Activities of Daily Living (ADL)
Deaver	1947-1969	Professor	Institute PM&R	
Rusk	1940s	Major	US Army	WW II Rehabilitation Hospitals
Rusk	1945-1980	Professor & Chair	New York University	Founded Institute PM&R

Figure Legends

Figure 1 - Flying Sphere. McKenzie was a world renowned sculpture of athletes [14,25,27] and the Flying Sphere was modeled from a study in motion by Muybridge. Courtesy of the University of Pennsylvania Archives.

Figure 2 - Major McKenzie at Heaton Park Depot, England 1915. Courtesy of University of Pennsylvania Archives.

Figure 3 - Illustration of mechanotherapy for finger injury [34]. Machine for exercising the fingers. First position. Finger extended. Movement. Flexion at the meta-carpophalangeal joints. Movement represented by dotted lines. (Weights In ounces).

Figure 4 - R. Tait McKenzie. Professor of Physical Education and Professor of Physical Therapy at University of Pennsylvania. Courtesy of the University of Pennsylvania Archives

Figure 1
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Figure 2
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Figure 3
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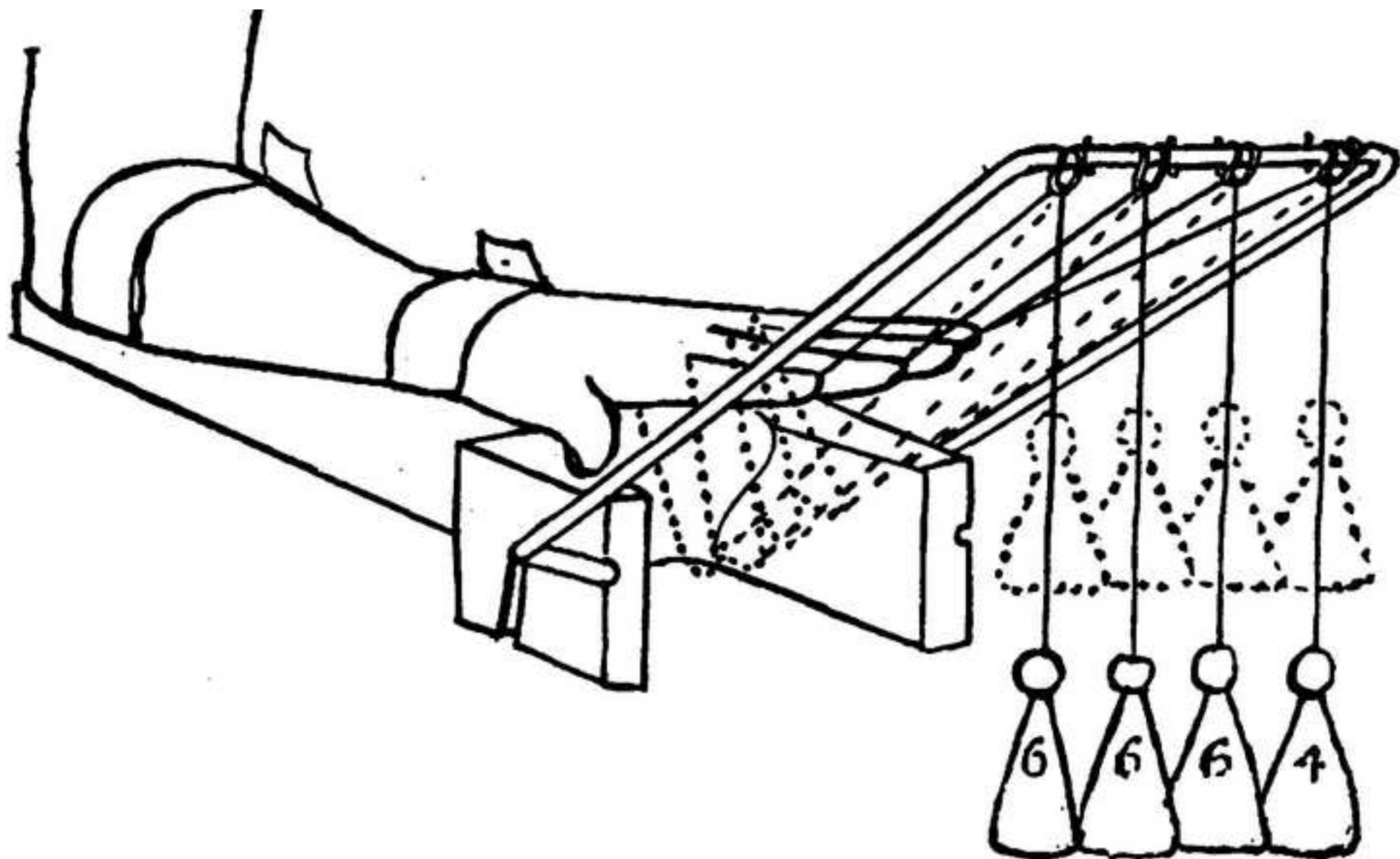


Figure 4
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