Fourth Printing

ORTHOPEDIC OPERATIONS

INDICATIONS · TECHNIQUE AND END RESULTS

By

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TO CHARLES J. ROWAN

The Surgeon and Friend, in Appreciation of His Unselfish Interest in Orthopedic Surgery.

PREFACE

This book is submitted to the profession as a final account of the writer's experience in the several phases of operative orthopedic treatment. Because it is so largely based on personal observations, it must of necessity have its limitations, both qualitatively and quantitatively. Some of those into whose hands the book may find its way will not be slow to point their finger at this particular shortcoming. May they remember, however, that personal conviction backed both by reflection and by experience is the mainspring of unbiased teaching. While it has been the writer's earnest endeavour to present, to the best of his knowledge, what he considers the truth, yet he is ready to admit that the whole truth cannot come from a solitary voice.

The plan of the volume is to combine into a trias *the indications, the technique and the end results*. In a presentation of this kind, these three seem inseparable. There is the plan and principle of procedure; there is the technique of execution; and there is the final judgment rendered by the definite end results. The writer has tried to present all three as equivalent and for this reason indications and statistics are given equal prominence with the operative technique.

It is fully anticipated that not a few readers will criticize the fact that many operative procedures have been omitted. If so, it did not happen because their existence was not known but rather because their validity did not impress itself sufficiently, or they represented merely irrelevant variations of a general principle.

In the evaluation of operative procedures, there were four guiding principles:

1. Is the operation rational from the physiological, and mechanical point of view?

2. Does experimental evidence corroborate the expectations of regeneration and repair placed upon the operation?

3. Is the operative technique in keeping with our experimental or empirical observations?

4. Are reliable statistics available to justify the procedure in the light of definite end results?

In formulating the answers to these questions, certain theoretical digressions of physiological, mechanical and biological nature could not be avoided. Care was taken, however, not to make them too lengthy so as not to detract from the pre-eminently practical character which the writer hopes this book will present.

The book is divided in three parts. The *first* deals with general surgical facts and with the general approaches to operations. It makes the reader acquainted with the patient as a whole. The *second part* gives the operative procedures on the several structures of the locomotor system; and the *third* presents the precise clinical situations in which these operations are to be applied.

If this work is used as a reference book, the reader will first have to recognize the specific case which confronts him in the clinical situations described in the third part; next he will have to inform himself in the second part on the technique of the particular operative procedure advised in the third part. Likewise, the statistics given in the second part pertain only to the operation as such; whereas those given in the third part pertain to the value of the particular operative procedure in the specific situation.

The writer is greatly indebted to the Department of Anatomy, in particular to Dr. E. M. MacEwen and Dr. E. W. Scheldrup for the use of anatomic material and for their instruction.

In the compilation of data, photographs and illustrations the writer has had most valuable help from present or former members of his staff. He wishes to acknowledge gratefully the help given to him by Dr. T. L. Waring and Dr. C. W. Ruhlin for their valuable assistance with the manuscript and illustrations; to Drs. J. E. Milgram, J. Kulowski, and J. V. Luck for their assistance and helpful suggestions; to Drs. R. M. Wray, H. Unger, A. R. Smith, other members of the staff, and post-graduate students for their work on literature, collection of cases, statistics, and photos; to Daisy Stillwell and Esther Hicock, the artists, for the illustrations; to Dr. Wm. Cooper for his help with the anatomical drawings; to Mrs. T. P. Wiegand and Mrs. Wm. Machovec for a great deal of scientific clerical work; to Mr. F. Kent for the photographic work; to Miss N. A. Frohwein, the medical librarian, and last but not least to Mr. Charles C Thomas, the publisher, for his devoted and most painstaking labors in the publication of this book.

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Iowa City, Iowa

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INDICATIONS, TECHNIQUE,
AND END RESULTS

PART I

GENERAL BIOLOGICAL, ANATOMICAL, PATHOLOGICAL, AND CLINICAL TOPICS PERTAINING TO ORTHOPEDIC OPERATIONS

CHAPTER I

THE BIOLOGY OF FUNCTIONAL RESTORATION

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Introduction

A knowledge of the possibilities and limitation of tissue regeneration, and tissue adaptation is an essential equipment for every orthopedic surgeon; his judgment depends on it; whether he deals with tissues by conservative or by operative means, they are always being tested for these regenerative and adaptive qualities. To be able to recognize their biological limitation is part of the surgeon's business. More than that, variations in functional adaptation of tissues which occur under pathological conditions must be recognized and evaluated; and since such variations are caused not only by local changes but also by constitution, age, general state of health or some specific constitutional pathological background, it involves a thorough general examination of the patient as well as the intricate knowledge of his local condition. There are many instances in orthopedic surgical practice where the general condition of the patient gives us little concern; but there are many more, however, in which it is highly important. After all, recuperation means the ability as a whole to accommodate oneself to the changed conditions imposed upon by the operative procedure. Frequent mistakes are made in misjudging the patient's general ability to such accommodation, and yet it is the latter which, to a great extent, determines whether the tissues upon which operation is performed will be able to adapt themselves to physiological use. It is one thing to fuse the knee for arthritis and another to do it for tuberculosis. It is the same operation but on two entirely different patients and, because of the different constitutional background, the tissue reaction to the same type of procedure must be expected to be different.

a. Form and Alignment

1. *Functional Adaptation of Bone*

The so-called functional adaptation of bone is very largely under the influence of external physical forces, that is, the strains and stresses to which bone is subjected in the performance of its function. This is generally expressed in what is called Wolff's law; its original concept was that the form as well as the architecture of bone corresponds mathematically to the physical demands of the external stresses. We know now that bone in its form and development is subject not only to physical, but also to biological laws, hence *Wolff's law of functional adaptation* may be stated as follows: In its formation and development, both under normal and under pathological conditions, bone is extremely responsive to physical strains and stresses, more so than any other tissue; yet, because of the influence of biological factors such as growth control from glandular or nervous elements, its ultimate formation is a compromise between the purely physical and the biological influences which determine its growth. But so strongly is bone growth under mechanical influence that it reflects both in external and in the inner architecture, the effects of weight and other mechanical stresses to a degree approaching perfection. The predominence of physical stresses, however, is not all comprehensive. Even under normal conditions, biological growth tendencies modify form and structure of bone so that it no longer becomes a true mathematical expression of external forces.

This is much more the case under pathological conditions, for instance, when metabolic alterations or growth disturbances of all kinds greatly interfere with the directional influence of extrinsic stresses of bone; yet, even under pathological conditions of disease, trauma or operative interference, the adaptive tendency is strong enough to lead to constant changes in form and structure.

In the growing, the ability of structural adaptation is much stronger than in the adult bone. We see rachitic bowlegs straighten automatically under physical stresses; there is absorption at the convexity, apposition of bone at the concavity until again normal, straight contours are obtained.

There are of course certain limits to the functional adaptability of bone; they are wider in the young, narrower in the old; and it is the surgeon's business to acquire an approximate idea to what extent the functional adaptation and resumption of normal contours and normal structure might reasonably be expected in a given case.

2. *The Functional Adaptation of Soft Tissue*

Under pathological conditions the soft tissues undergo similar changes of form and structure as does bone. For instance, the positional changes in the joint lead to a rapid structural shortening in the surrounding ligaments and muscles; the question is, to what extent can such contracted tissue again re-adapt itself to approach normal condition; to what degree can contracture be overcome, when mechanical forces are applied to restore the original length of muscles or ligament?

In some contractures, for instance in spastic contractures, the muscles have not yet undergone structural changes and have retained their elasticity. Such muscles are responsive to stretching, and under constant and adequate pull they will again assume their normal length, and the contracture will be overcome. But where there is a structural change, for instance in interstitial myositis, the elasticity of the muscle rapidly decreases, so that the limit of elastic yield is reached very soon.

The practical implication is that conservative treatment in purely paralytic and spastic contractures can go very much farther and must be pushed to much greater limits than it can in such structural contractures, as occur in interstitial myositis or under inflammatory and traumatic conditions which change muscles into scar tissue.

Only experience can teach how far each individual case will respond to conservative mechanical correction. At the same time an understanding of the physical nature of the contracted elements enables us to anticipate the limits to which conservative treatment can go. For instance, in myositic contractures it can be reasoned that the resistance of the indurated muscle may easily assume a degree greater than the resistance of the articular reinforcements and that further attempts to stretch the contracted tissues will only lead to disalignment in the articulation and subluxation. In fact, this occurs frequently in the knee joint; when a subluxation results from excessive efforts to straighten the knee, it is evidence that the surgeon is incapable of estimating the relation between the resistance of the contracted muscle and that of the reinforcing capsular apparatus. Such instances of contractures, where the resistance of the muscles is so great that the yield occurs in the articulations rather than in the muscle, are frequent; then the muscle must be lengthened, or its bony attachment stripped free; and in extreme cases where the muscle can no longer be dealt with even operatively, for instance, in contracture of the finger flexors, it may come to the point that operations on the skeleton become necessary so as to adapt the skeleton to the muscle rather than the soft tissues to the skeleton.

b. Function

1. *Relation Between Stability and Mobility*

The function of the muscle apparatus is static and dynamic. The static function lies in the maintenance of posture, equilibrium, and position, while the dynamic function calls for the mobility and functional freedom of muscles and joint. In some articulations, for instance in the lower extremity, or in the trunk, static functions prevail; the muscles principally maintain position.

In others, for instance, in the joints of the upper extremity the dynamic functions prevail; here, the change of position is more important. However, change and maintenance of position is always mechanically so closely interwoven that it seems impossible to separate them. It is only possible to say that some joints will be more useful if the static function is preserved, even though the dynamic function is lost; others, vice versa, will be more useful if some of their stability is sacrificed for the benefit of mobility. The mechanical arrangement of the muscle is always such that it never acts purely as a rotating force but it always has at the same time a stabilizing effect upon its joint. When we obliterate a joint in normal position its static function of maintaining position is saved; at the same time, the function of its muscles is entirely eliminated, and they become useless so far as this particular joint is concerned. On the other hand, when muscle function is restored or reconstructed, not only is visible motion recovered but a certain amount of stabilization is likewise restored, because of the stabilizing component included in all muscular contraction. The question is only whether the newly created mechanical situation approaches what is normally required of stabilization, or not. That is to say, is a muscle-tendon operation adequate to provide stabilization? On the whole the requirement of stabilization is much more exacting than that of mobilization. An operation may provide a fairly satisfactory movement in a joint, but it may not provide sufficient stability for it to stand up under weight stress. If for this joint stability is the first essential, such an operation naturally is a failure. There can be no compromise in stabilization. The superincumbent weight will always have to be sustained and, therefore, inadequate stabilization is no stability at all. Herein lies a principle which is most essential in reconstructive surgery. Here is, in fact the answer to a most fundamental problem: *Wherever stability must meet high requirements, such as in the lower extremity and the trunk, any sacrifice of it to the benefit of mobility necessarily leads to failure.* This is the reason why in the lower extremity and in the trunk the stabilizing operations have a wider field than is the case in the upper extremity. Mobilizing operations such as arthroplasties can only be carried out, if the muscular apparatus is sufficiently good to assure us not only that the joint can be moved but that the joint can hold its balance and remain stable.

2. *Active Stability*

Actively, stability is provided by the muscle balance. The muscle tension is so regulated about the joint as to neutralize all rotatory components; no rotation occurs, only the stabilizing effect of the axial component remains; the muscles act as guy ropes.

In the general scheme of locomotion *this function of the muscle to develop tone without actively moving the joint is of far greater importance than the active mobilization.* We call the function of the muscle in which tension alone is displaced without physical motion, *the isometric contraction.* This is a stabilizing function of the muscle. Contrary to what is usually believed, the stabilizing function of the muscle is far greater than the mobilizing.

3. *Passive Stability*

(a) Bone. In the passive stability of the bone, *the principal factor is its unit resistance to gravital and other external stresses.* It is very essential for the surgeon to have an appropriate idea of these resistances for all kinds of stresses; principally, however, *to pressure, bending and shearing stresses.* Wolff's law in its original form does not differentiate the stresses, they bring principally all pressure stresses. We know, however, that bone reacts to bending and shear differently than to pressure. We also know that stresses up to a certain degree lead to hypertrophy and new formation of bone; and beyond this degree, to atrophy and absorption. Under normal physiological condition of standing or walking, the pressure stresses are within the limits of bone stimulation.

Bending and shearing stresses, however, more easily exceed the stimulative phase and then become destructive forces. For instance, bending stresses in bone grafts readily lead to absorption, as seen in infractions and in the so-called Looser's transformation zones appearing in grafts. The surgeon must recognize this, because more often than not absorption of the graft and pseudarthrosis are the result of excessive bending or shearing stresses.

(b) THE SOFT STRUCTURES. The soft structures are considerably taxed for distension stresses. The elasticity of the muscle has a great deal to do with its resistance to excessive stretching.

The stress resistance of the ligaments is also known. Murray Gratz has established accurate data for the ligamentous structures or fascial structures, showing that they have a unit resistance of about 7000 pounds per square inch.

But the unit stress resistance varies widely with age, constitutional disease, as in generalized arthritis, where the ligamentous resistance becomes very low. Therefore, what the surgeon must know first of all, is *the patient's constitution and make-up,* so that he may draw his conclusions as to the individual resistance of the soft tissues to strain and stress.

(c) THE JOINTS. Normal alignment is an essential for the stability of the joint. In fracture deformities, disalignment of the joint and deviations in the normal relations to the body planes are of far greater consequence than the disalignment of the shaft of the bone. Horizontality of the joint axis is an essential for all weight bearing articulations; lack of horizontality or slant of a joint leads to strains in the musculature and ligaments, and it cannot be sustained for any length of time without grave damage to these structures. In many instances, for example, in some cases of traumatic varus or valgus deformity of the ankle joint, a simple osteotomy above the joint which restores the normal position of the joint axis is all that is required.

If the faulty joint position persists even to a slight degree, as in the genu valgum or in ankle valgus, it leads sooner or later to a deterioration and disintegration of the joint. Such a remote effect can be seen in the hip joint where it may remain entirely latent during juvenile and adolescent life, but very frequently produces active joint symptoms in middle age due to the excessive strain upon the defective articulation.

4. *Principles of Operative Reconstruction of Muscle Balance*

This question will be discussed more in detail in the chapter on tendon transplantation (*Part II. III.*). We shall merely indicate here the most essential points.

It is difficult to carry out a rearrangement of the natural balance of the muscles distributed about the joint. Such a rearrangement is advisable only in cases in which adequate substitution of missing muscles is feasible. The situation involves three major issues.

1) Is the supplanting muscle approximately of the same absolute muscle power as the supplanted one?

2) Does it have the same direction of mechanical leverage?

3) Can it be independently innervated for the purpose of replacing the action of the supplanted muscle?

The first point presupposes a knowledge of the relative weight and strength of the muscle.

The second point presupposes a thorough knowledge of the reconstruction, anchorage and gliding mechanism.

The third point involves the problem of muscle re-education. The limits of muscle re-education are not definitely known; we know, however, that if the supplanting muscle acts as a synergist to the supplanted one in certain normal situations, this aids greatly in re-educating the muscle to its new function. We do not know to what extent the muscle will accept a new pattern of innervation. We can only say that the farther removed the original function of the muscle is from that of the muscle which it supplants, the lesser is the likelihood of it taking on the innervation of the supplanted muscle.