

THE ORTHOTIC PRESCRIPTION DERIVED FROM A CONCEPT OF BASIC ORTHOTIC FUNCTIONS^{a b}

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ABSTRACT

The effects of an orthotic device are always a direct result of the forces and moments which it applies to the human body. These forces are utilized to perform one or more of the following three basic orthotic functions: to support body weight, to control joint motion (direction, range, strength), and to change the shape of body tissues. No orthotic device can be expected to perform any other function.

These basic orthotic functions make possible more precise communication than hitherto of the medical objectives involved in an orthotic prescription, without requiring the physician to obtain a detailed knowledge of orthotic technology. The medical objectives are restated by the physician, in terms of the basic orthotic functions; the result is a list of orthotic objectives which serves as the foundation for a prescription. When these orthotic objectives are arranged in order of their importance and numerical values are assigned to such specifications as desired ranges of motion or amounts of weight bearing, the physician has provided the essential information that the orthotist needs in order to fabricate and fit the most practical and effective device possible.

^a This work was supported by Children's Bureau Grant C-21 and Veterans Administration Research Contract V1005M-2075.

^b Also published as: Henderson, W. H., and Lamoreux, L. W.: *The Orthotic Prescription Derived from a Concept of Basic Orthotic Functions*. Biomechanics Laboratory, San Francisco and Berkeley. Technical Memorandum. San Francisco, The Laboratory, Oct. 1966. 12 pp.

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I. INTRODUCTION

For many years, physicians have been finding it increasingly difficult to make effective use of recently developed techniques in the orthotic management of medical problems. The amount of new information to be considered has been growing steadily at the same time that patient loads have been increasing. A similar situation has faced orthotists and therapists, although, perhaps, to a lesser degree. The difficulties of keeping abreast of current information have been compounded by inadequate communication between physicians in various medical specialties and by the increasing numbers of paramedical personnel who are called upon to assist them.

In this paper an approach and a method are outlined which we believe can help to solve these growing problems by providing a basis for more precise communication, between medical and paramedical personnel, of orthotic requirements and goals. Such an improvement in communication will permit the paramedical personnel to be of more assistance to the physician and to contribute more to the management of the patient's problem.

II. DEFINITION OF AN ORTHOTIC DEVICE

An orthotic device is an external appliance designed to apply forces to the body in a controlled manner. The nature of these forces and the way in which they are applied will vary according to the body segment involved and the individual functional or therapeutic objectives, but in *all* cases the effect of the orthotic device results from the application of forces to the body.

This definition grew out of an attempt to reduce orthotic considerations to fundamental terms in order to establish a basis for meaningful and precise communication between the physician, the orthotist, and the therapist, by describing clearly the essential medical and biomechanical aspects of disability as they are related to the prescription of a device. As a result of a general tendency to develop devices for specific clinical needs, there has appeared a wide variety of devices with an equally wide variety of opinions as to their respective merits. In many instances, the specifications and indications have been nonexistent, vague, or lost in the maze of published descriptions and claims. Regional variations in practice and terminology have led to rejection in one location and acceptance in another. In addition, rather severe limitations in treatment can occur when a physician prescribes only those devices with which he is familiar and which he knows are readily available.

The classification of orthotic devices in the literature is unsatisfactory. In many instances, devices are classified according to the medical

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objectives they are supposed to attain, with no consideration of their fundamental functions, that is, what they can actually accomplish. We often read of supportive, corrective, assistive, stabilizing, or immobilizing devices, but such classifications are not sufficiently specific to be genuinely instructive or meaningful to the physician, the orthotist, or the therapist. Any orthotic device can be described as assistive, whereas a specific brace may quite properly also be described as being simultaneously supportive, corrective, and stabilizing. Problems arise because of variations in individual interpretation and because a single term seldom suffices to describe a device accurately.

By describing an orthotic device in terms of what it is expected to do instead of why it is needed, a much more meaningful and useful description of the desired function is possible. A careful analysis of the many uses to which orthoses are put has led us to conclude that there are definite limits to what such devices can be expected to do. On the basis of the concept that an orthotic device is an appliance designed to apply forces to the body, it is our belief that in all orthotic devices these forces are utilized to perform one or more of the following *three basic orthotic functions*:

1. to support body weight
2. to control joint motion (direction, range, strength) by
 - a. limiting motion (partially or wholly)
 - b. restoring motion (partially or wholly)
3. to change the shape of body tissues by
 - a. bending or twisting skeletal structures
 - b. stretching soft tissues

An orthotic device *cannot be expected to perform any other function.*

In orthotic treatment, devices are designed to perform the above basic functions, either singly or in combination, in order to aid in the achievement of such representative medical objectives as prevention of joint collapse, maintenance of joint or segmental position, protection of damaged or weakened soft tissue, alleviation of pain through external support of body weight or through control of motion, prevention or control of unwanted motion, replacement of lost or reduced motion, and correction or prevention of deformity, including contractures.

III. DEVELOPMENT OF THE ORTHOTIC PRESCRIPTION

A necessary step in the achievement of a suitable and effective orthotic device is the restatement of the medical objectives (which are frequently rather general) as specific orthotic objectives. The physician can state his objectives clearly without considering the details of brace

construction by defining the objectives in terms of the three basic orthotic functions. If a medical objective cannot be restated readily in these terms, the problem may be insoluble through the use of an orthotic device and may require other forms of management. The restatement can be conducted systematically, joint by joint or segment by segment. It is important to list not only what is desired at each joint or segment but also what is *not* desired.

Once the specific orthotic objectives have been defined in this manner, the physician is able to assign priorities to them. The resulting *functional description*, or list of desired functions rated in order of importance, will, in the simplest cases, constitute a prescription. In many other instances, the physician will be able to complete the prescription simply by assigning numerical values to such specifications as desired ranges of motion, amounts of weight bearing, and joint positions. In complex problems, the physician may find it necessary to consult with the orthotist or other members of the medical and paramedical team to arrive at an effective and practical orthotic treatment program. In this instance, the functional description provides a basis for precise communication between the physician and the paramedical personnel since it clearly states the physician's orthotic objectives. In a few instances, he will be able to accomplish all his aims with readily available devices. In some other cases, where standard devices are inadequate, the statement of orthotic objectives will enable the orthotist to devise a suitable non-standard device. There will be many instances, however, in which technological limitations will require compromises in the stated objectives. In such cases the functional description enables the physician and his consultants to examine the desired objectives one by one and determine which objectives must be abandoned or modified. Specific technological limitations are thereby brought to the attention of all concerned, so that everyone involved becomes more acutely aware of the areas in which the development of improved or new techniques is required.

Suggested procedures for developing an orthotic prescription can be outlined as follows:

1. *A diagnosis and prognosis* are established by the physician on the basis of medical information.
2. *The medical objectives* are established by the physician, with use of technical, technological, and psychosocial information supplied by consultants or assistants if desired.
3. *A functional description* is developed by the physician. This is a statement of orthotic objectives obtained by restating the medical objectives in terms of the basic orthotic functions.

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4. A *treatment program* is developed by the physician, with assistance of the orthotist, the therapist, or other personnel as needed. The program may include an orthotic prescription, therapy, surgical procedures, or a combination of these approaches.

As an example, let us take the case of a 12-year-old boy with a unilateral flail leg, with minimal hip involvement. The medical objectives may be to enable the patient to walk without crutches or canes, to permit the leg to bear weight during ambulation, to avoid deformation of the bones, particularly at the joints, to prevent the development of contractures, and to compensate for a shortening of the limb of $1\frac{3}{4}$ in. From these objectives, the physician can write the following functional description:

- Hip: Do not restrict existing motion.
- Knee: Limit motion during weight bearing, to achieve stability and prevent hyperextension.
Do not restrict existing motion when the leg is not bearing weight, so that the undesirable effects of immobilization can be avoided.
- Ankle Complex: Restore foot dorsiflexion and eversion to avoid stumbling during ambulation and to prevent contractures.
- Shoe: Build up heel and sole to equalize leg lengths in order to aid in weight bearing and reduce the possibility of scoliosis. (The buildup of the heel and sole should be equal to reduce the likelihood of contracture of the calf muscles.)

After writing the functional description, the physician knows in considerable detail what his orthotic objectives are and is prepared to communicate these objectives, either directly to the orthotist as a prescription, or to a paramedical team which will aid him in writing a practical orthotic prescription that incorporates as many of his objectives as possible. In extremely complex cases of disability, where the treatment may include therapy and/or surgical procedures in addition to orthotics, the paramedical consultants can be called upon to assist in the formulation of an integrated treatment program.

After completion of the prescription, the orthotist chooses an appropriate combination of devices or components to achieve the prescribed objectives. He takes the necessary measurements and fabricates and fits the device. When available, a therapist should be given the responsibility for checkout of the device (inspecting it for fit, comfort, and workmanship), and for training of the patient in its use. He may collaborate with the physician in the evaluation of its effectiveness. The physician is

responsible for long-term followup; by referring to the prescription and the original functional description, he (often aided by other members of the team) has a good basis for evaluating the completed device systematically by checking its performance, point by point.

IV. INFORMATION RELEVANT TO THE PRESCRIPTION

Several different types of information may have direct bearing on the development of the orthotic prescription. Although some readers may find much of this information obvious, an incomplete understanding of all the relevant points or lack of awareness of the best sources for it can materially delay the progress of orthotics. The types of information to which we refer can be classified as medical, technical, technological, and psychosocial.

The *medical information* assembled and interpreted by the physician will not be discussed in this paper since only its interpretation as it pertains to orthotics concerns us here.

By *technical information* we mean anatomic, physiological, mechanical, and biomechanical factors. The physician and other members of the team may be assumed to be familiar with the pertinent anatomy and physiology. The principles of mechanics and biomechanics, however, are not widely understood or applied by everyone concerned with the development of the prescription. From our definition of orthotics, it follows that all these persons must be able to determine what forces are involved, understand their effects on the body, and be prepared to deal with them effectively. An important step in developing such a proficiency is to become fully conversant with such elementary concepts of mechanics as *force*, *pressure*, *moment* (torque), and *equilibrium*.

Biomechanical information will always be involved in the development of an orthotic prescription. In general, some knowledge of the geometry, internal and external forces, and functional characteristics of normal joint systems will be required in order to determine the effects of disease, injury, and congenital abnormality. Examples of biomechanical considerations which may be useful in the development of the orthotic prescription are:

1. Locations of the axes of rotation and the planes of motion of joints in order to permit accurate analysis of moments and correct positioning of brace joints.
2. Magnitudes of muscle forces and the moments (torques) which result from their action about specific joints: Insufficient moments may be an indication for external assistance, as in a hemiplegic who requires a toe-lift brace; excessive or unbalanced forces or moments may lead to de-

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formities, such as hyperextension of the knee in a patient with paralysis of the hamstring group and resulting unopposed action of the quadriceps.

3. Directions and ranges of normal joint motions so that such abnormalities as contractures or joint deformities can be identified.

4. Patterns of motion required for performance of functional self-care activities and locomotion under various conditions.

5. Phase relationships of normal muscle action in order to make possible the evaluation of abnormalities of gait.

6. Forces and moments required for or resulting from acceleration or deceleration of the body or of body segments, such as forces operating in the control of knee and hip motion during the swing phase of walking.

7. Gravitational effects and the mechanisms of balance as they relate to stability and energy expenditure.

8. Forces and force distributions (pressures), as they exist or are required, as in the case of a patient wearing a cervical brace: The magnitudes of necessary forces on the chin and occiput must be anticipated so that adequate surface contact area can be provided to keep pressures acceptably low.

Frequently this information, or part of it, is intuitively considered by the physician in the process of establishing the medical objectives. Occasionally, however, he may feel the need for additional consultation with other members of the team, in which case the information might come from the therapist, the anatomist, the physiologist, the engineer, or some other qualified person.

It might at first glance appear that *technological information* relating to materials and techniques would be of great importance in the development of an orthotic prescription. Certainly, technological factors are of prime importance in the construction of a device, and technological limitations may have to be considered in the development of a practical prescription. However, in the development of the functional description technological information has no relevance whatever.

Psychosocial information includes such factors as home, family, and community relationships, economic and psychological considerations, and possible special requirements related to school or occupation. This information is generally collected by the physician, but when paramedical personnel are available the social worker, the psychologist, the therapist, the vocational counselor, the nurse, or the orthotist may make significant contributions.

V. ADVANTAGES OF THIS APPROACH TO ORTHOTICS

The use of the basic orthotic functions to describe the orthotic objectives of a given medical problem has several advantages:

1. The distinction between the medical and the orthotic objectives is clearly drawn.
2. The physician is provided with a basis for expressing his medical objectives in orthotic terms.
3. Priorities can be assigned to the resulting orthotic objectives.
4. The physician can write a meaningful prescription without having to acquire a comprehensive knowledge of the technical aspects of orthotics.
5. The functional description and the resulting orthotic prescription provide the basis for a systematic evaluation of a completed device.
6. Limitations of current orthotic technology are made apparent.