History of Muscle Strength Grading

The Medical Research Council of Great Britain (MRC) system is the best known and most commonly used muscle strength grading system for manual muscle testing (MMT) worldwide. Dyck et al1 trace the development of the MRC system to the treatment of war injuries and poliomyelitis. S.W. Mitchell, a Civil War surgeon, recognized nerve damage as a cause of muscle weakness in 1872. Mitchell and M.J. Lewis were later responsible for the first known effort to grade neuromuscular signs when they classified ataxic gait in 1886. In 1917, R.W. Lovett, a Boston orthopedist, published the muscle scoring system later adapted by the MRC based on his experience treating poliomyelitis; he credited W. Wright, a physical therapist, with developing the muscle testing methods.2 As a result of their experiences treating World War II injuries, 12 surgeons formed the Nerve Injuries Committee of the British Army (G. Riddoch [Chair], W.R. Bristow, H.W.B. Cairns, E.A. Carmichael, M. Critchley, J.G. Greenfield, J.R. Learmonth, H. Platt, H.J. Seddon, C.P. Symonds, J.Z. Young, F.J.C. Herrald) and developed the classic handbook Aids to the Investigation of Peripheral Nerve Injuries.3 This manual illustrates the major actions of limb muscles and how they should be tested; defines the concepts of prime movers, synergists, and antagonists; and includes the muscle grading scale familiar to all orthopedic surgeons (Table 1). A modified version of this manual, Aids to the Examination of the Peripheral Nervous System, fourth edition, was published in 2000.4 Because the MRC system was intended to be used to grade recovery from paralysis (grade 0) attributable to nerve repair, the greatest emphasis is placed on severe degrees of weakness (grades 1, 2, 3); although this system is ordinal, the difference in strength between different grades was not assumed to be constant. In general, the intertester and intratester reliability of MMT graded with the MRC system has proven acceptable.2

Problems With the MRC

Not surprisingly, the MRC system has been widely used to describe muscle strength in the upper extremities of people with conditions other than war injuries and poliomyelitis. It has been modified almost as often as it has been used, primarily because of the wide, difficult-to-quantify gaps between grades 3 and 4 and grades 4 and 5 and because large joint motors such as the deltoid may recover enough strength to provide resistance to MMT (grade 4) without having enough strength or strong enough synergists to provide full motion against gravity (grade 3). Another problem with this system is inherent intersubject variability in muscle strength, rendering it useful primarily for intrasubject changes in strength rather than intersubject comparisons. In addition, this system tempts the examiner to consider a muscle with a certain grade of strength as having the same degree of recovery as another muscle with the same grade, when in fact the amount of recovery necessary to enable the deltoid to be graded 3 may be considerably different than the amount of recovery necessary to enable a wrist extensor to be graded 3. The challenges of applying MMT graded by the MRC to all types of nerve injuries as a measurement of the results of modern repair techniques, combined with the fact that no other muscle grading scales are widely accepted, have led to attempts to modify this system. “Critical Reappraisal of MRC Muscle Testing for Elbow Flexion” by MacAvoy and Green quantifies some of the problems encountered when the MRC is used other than as originally intended—for instance, to quantify improvement between grades, especially grades 3, 4, and 5.
Modifications of the MRC

In the past 6 years at least 8 publications in *The Journal of Hand Surgery* have referred to this grading system to quantify the results of surgical reconstruction in tetraplegia, nerve repair, brachial plexus birth palsy, brachial plexus injury, and opposition transfer for carpal tunnel syndrome. All cited the MRC (although Leechavengvongs et al did not cite an original MRC publication), but all modified its intended use by presenting only preoperative data; reporting only “average increase of British Medical Research Council units”; subdividing grade 4 into 4 –, 4, and 4/H; adding together the scores of muscles sharing the innervation of a peripheral nerve to create a composite score; describing deltoid function as grade 4 without full shoulder abduction against gravity; or eliminating grades 4 and 5 but expanding grades 2 and 3. Of all these recent *Journal of Hand Surgery* publications, only Chen et al and Curtis et al note that they have used a modified version of the MRC, and only Curtis et al formally validated their modification, the Active Movement Scale, by studying interrater reliability.

Discussion

Perhaps World War II surgeons using early techniques of nerve repair were gratified to achieve grade 3 strength in a previously paralyzed muscle, and the differences between grades 3, 4, and 5 did not concern them, because this level of recovery was usually not attained. Modern techniques may achieve better results and engender higher expectations of a measurement system.

A new system of grading for MMT should retain the advantages of the MRC (wide acceptability, ease of use, usefulness for most muscles, applicability to motor recovery from all types of nerve injury). Useful potential modifications of the MRC include a grade for a muscle that achieves strength against resistance but not against gravity and a standardized subdivision of grade 4.

At the cost of the convenience of MMT, actual measurement of torque provides much more detailed and accurate measurement of muscle strength, especially for the shoulder and elbow. The gold standard is isokinetic dynamometry using machinery (eg, Cybex [Medway, MA], KinCom [IsoKinetic International, Harrison, TN]). The clinical usefulness of such a machine, however, is limited by the cost and size of the apparatus and the time required for positioning and testing. In addition, the minimum measurable strength on some isokinetic dynamometers may be more than that recoverable by nerve repair. Specialized devices have been developed for measuring isometric elbow and shoulder strength and hand and wrist twisting strength, but these are not widely available. A handheld dynamometer (HHD) provides more accurate measurements of isometric muscle strength than MMT and is easy to use as long as the examiner has sufficient strength to stabilize the device. Methods of increasing reproducibility and reliability using a HHD have been developed, and normative data are available for different populations. (An example of such a device available in the United States is the microFET 2 Dynamometer; Hoggan Health Industries [West Jordan, UT].)

Unless HHD is widely adopted or until a better grading system is developed and well validated, the MRC will continue to be used. When it is altered, these alterations should be specifically described and enumerated, and the resulting system should be referred to as a modification. Otherwise, tinkering with the MRC erodes the elegant and prescient intent of the Nerve Injuries Committee. With their publication of the MRC, this group of surgeons accomplished a remarkable achievement: a simple grading system used worldwide for over 60 years, applied with extraordinary success despite its shortcomings. Its wide acceptance precludes the need for further validation of the MRC, but any substantial alterations should be validated before presentation to show that they reliably and reproducibly achieve the goals of the investigators.

Table 1. Medical Research Council Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Muscle State</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>No contraction</td>
</tr>
<tr>
<td>1</td>
<td>Flicker or trace of contraction</td>
</tr>
<tr>
<td>2</td>
<td>Active movement with gravity eliminated</td>
</tr>
<tr>
<td>3</td>
<td>Active movement against gravity</td>
</tr>
<tr>
<td>4</td>
<td>Active movement against gravity and resistance</td>
</tr>
<tr>
<td>5</td>
<td>Normal power</td>
</tr>
</tbody>
</table>

Data from the Medical Research Council.

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Corresponding author: Michelle A. James, MD, Shriners Hospital for Children, 2425 Stockton Blvd, Sacramento CA 95817; e-mail: mjenes@shrinenet.org.

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References


