Volume nine

Symposium on reconstructive hand surgery

Editors
J. William Littler
Lester M. Cramer
James W. Smith

Educational Foundation of the American Society of Plastic and Reconstructive Surgeons

Volume nine

Symposium on reconstructive hand surgery

Editors

J. WILLIAM LITTLER, M.D.

Chief of Plastic and Reconstructive Hand Surgery,
Roosevelt Hospital, New York, New York

LESTER M. CRAMER, M.D.

Professor and Chairman, Section of Plastic Surgery,
Temple University, Philadelphia, Pennsylvania

JAMES W. SMITH, M.D.

Associate Professor of Plastic Surgery,
The New York Hospital–Cornell Medical Center,
New York, New York

Proceedings of the Symposium of the Educational Foundation
of the American Society of Plastic and Reconstructive Surgeons, Inc.,
in collaboration with The Committee on Continuing Education,
the American Society for Surgery of the Hand, held at Rockefeller University,
The New York Hospital–Cornell Medical Center,
New York, New York, November 2-4, 1972

With 458 illustrations, including 2 full-color plates

The C. V. Mosby Company

Saint Louis 1974

Volume nine

Printed in the United States of America

Distributed in Great Britain by Henry Kimpton, London

Library of Congress Cataloging in Publication Data

Symposium on Reconstructive Hand Surgery, New York, 1972.
Symposium on Reconstructive Hand Surgery.

(Proceedings of the Symposium of the Educational Foundation of the American Society of Plastic and Reconstructive Surgeons, v. 9)

"[Symposium held] in collaboration with the Committee on Continuing Education [of] the American Society for Surgery of the Hand."

1. Hand—Surgery—Congresses. 2. Surgery, Plastic —Congresses. I. Littler, J. William, ed. II. Cramer, Lester M., 1926- ed. III. Smith, James Walter, 1926- ed. IV. American Society for Surgery of the Hand. Committee on Continuing Education. V. Series: American Society of Plastic and Reconstructive Surgeons. Educational Foundation. Proceedings of the symposium, v. 9. [DNLM: 1. Hand—Surgery—Congresses. 2. Surgery, Plastic—Congresses. WE830 S987 1972]
RD559.S84 1972 617'.575 74-12410
ISBN 0-8016-3022-3

TS/NK/B 9 8 7 6 5 4 3 2 1

Symposium on reconstructive hand surgery

Contributors

Jerome E. Adamson, M.D., F.A.C.S.

Chief, Department of Plastic and Reconstructive Surgery, Norfolk Area Medical Center Hospitals, Norfolk, Virginia

F. William Bora, Jr., M.D.

Assistant Professor, Department of Orthopaedic Surgery, School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

John A. Boswick, Jr., M.D.

Professor of Surgery, Department of Surgery, University of Colorado Medical Center, Denver, Colorado

T. Ray Broadbent, M.D.

Associate Clinical Professor of Plastic Surgery, University of Utah College of Medicine, Salt Lake City, Utah

Harry J. Buncke, Jr., M.D.

Associate Clinical Professor of Plastic Surgery, University of California Medical School, San Francisco, California

Richard I. Burton, M.D.

Associate Professor of Orthopaedic Surgery, University of Rochester School of Medicine and Dentistry, Rochester, New York

Gary Busenkell, M.D.

Arizona Orthopedists, P.C., Phoenix, Arizona

James H. Carraway, M.D.

Attending Plastic Surgeon, Norfolk General and Kings' Daughters Hospitals, Norfolk, Virginia

Sylvester J. Carter, M.D., F.A.C.S.

Clinical Professor of Surgery, New York Medical College; Attending Surgeon and Chief of Hand Surgery Section, Flower Fifth Avenue Hospitals, Metropolitan Hospital and Medical Center, Grasslands Hospital, and Sydenham Hospital, New York, New York

Robert K. Dean, M.D.

Clinical Associate, Department of Surgery, Medical College of Ohio, Toledo, Ohio

Richard G. Eaton, M.D.

Chief, Hand Clinic, Roosevelt Hospital; Associate Clinical Professor of Surgery, Columbia College of Physicians and Surgeons, New York, New York

Milton T. Edgerton, M.D., F.A.C.S.

Professor and Chairman, Department of Plastic Surgery, University of Virginia School of Medicine, Charlottesville, Virginia

Ray A. Elliott, Jr., M.D.

Assistant Professor of Plastic Surgery, Albany Medical College, Albany, New York

Adrian E. Flatt, M.D., M.Chir., F.R.C.S.

Professor of Orthopaedic Surgery; Director, Division of Hand Surgery, University of Iowa Hospital, Iowa City, Iowa

Gerald T. Golden, M.D.

Resident, Department of Plastic Surgery, University of Virginia School of Medicine, Charlottesville, Virginia

Gerald J. Herbison, M.D.

Associate Professor, Department of Rehabilitation Medicine, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania

Charles E. Horton, M.D., F.A.C.S.

Senior Attending Plastic Surgeon, Norfolk Area Medical Center Hospitals, Norfolk, Virginia

John C. Kelleher, M.D.

Assistant Clinical Professor, Department of Surgery, Medical College of Ohio, Toledo, Ohio

Harold E. Kleinert, M.D.

Clinical Professor of Surgery, University of Louisville School of Medicine, Louisville, Kentucky

Patrick G. Laing, M.D.

Clinical Professor of Orthopaedic Surgery, University of Pittsburgh Medical School, Pittsburgh, Pennsylvania

Paul G. Lendvay, F.R.C.S., F.R.A.C.S.

Honorary Plastic Surgeon, Prince of Wales Hospital, Prince Henry Hospital, Sidney, Australia

Graham Lister, F.R.C.S.

Fellow in Plastic and Hand Surgery, University of Louisville School of Medicine, Louisville, Kentucky; formerly Senior Registrar, Plastic Surgery, Canniesburn Hospital, Glasgow, Scotland

J. William Littler, M.D.

Chief of Plastic and Reconstructive Hand Surgery, Roosevelt Hospital, New York, New York

Walter L. Mersheimer, M.D.

Professor and Chairman, Department of Surgery, New York Medical College, Flower and Fifth Avenue Hospitals, and Metropolitan Hospital and Medical Center, New York, New York

Professor Hanno Millesi, I. Chir.

Universität Klinik, Vienna, Austria

Richard A. Mladick, M.D., F.A.C.S.

Senior Attending Plastic Surgeon, Norfolk Area Medical Center Hospitals, Norfolk, Virginia

John de L. S. Morris, M.D.

Chief, Diagnostic Radiology, Roosevelt Hospital, New York, New York

James F. Murray, M.D.

Assistant Professor of Surgery, University of Toronto, Toronto, Ontario, Canada

Joseph E. Murray, M.D.

Professor of Surgery, Harvard Medical School; Chief Plastic Surgeon, Children's Hospital Medical Center, Peter Bent Brigham Hospital, Boston, Massachusetts

William E. Staas, Jr., M.D.

Associate Professor, Department of Rehabilitation Medicine, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania

Daniel B. Tuerk, M.D.

Instructor, Department of Plastic Surgery, University of Virginia School of Medicine, Charlottesville, Virginia

Paul M. Weeks, M.D.

Head, Plastic Surgery Division, Department of Surgery, Washington University School of Medicine, St. Louis, Missouri

E. F. Shaw Wilgis, M.D., F.A.C.S.

Attending Hand Surgeon, Union Memorial Hospital, Baltimore, Maryland

Charles M. Woolf, Ph.D.

Dean, College of Liberal Arts, Arizona State University, Tempe, Arizona

Robert M. Woolf, M.D.

Associate Clinical Professor of Plastic Surgery, University of Utah College of Medicine, Salt Lake City, Utah

Preface

In November of 1972, following months of careful preparation by Dr. James Smith and Dr. Lester Cramer, on behalf of the Educational Foundation of the American Society of Plastic and Reconstructive Surgeons, over five hundred physicians and allied personnel gathered at Rockefeller University in New York City for a three-day symposium on care of the disabled hand. The attendance attested to a growing awareness for those patients of all ages and from all walks of life who suffer from disabilities of the hand. This volume contains the essence of that meeting. Many subjects were of necessity excluded from the symposium in order to concentrate on more fundamental and technical aspects of special problems.

Our contributors present a provocative array of subject matter extending from basic principles of hand surgery to sophisticated procedures made possible by microsurgical techniques. This more recent refinement has great value and is essential in selected cases complicated by vascular and nerve involvement, for it allows a more meticulous coaptation of these critical structures, as demonstrated by Millesi's excellent work. Nonetheless, such technique is but an adjunct to the hand surgeon's ingenuity, for it is only through a carefully planned and skillfully executed primary or secondary surgical and rehabilitative program that the motivated hand patient will be restored to the greatest useful functional potential within the shortest period of time. It is to this end that the following material is devoted.

J. William Littler

Contents

Part I

Basic architecture and functional anatomy

Chapter 1

Hand structure and function

J. William Littler, M.D.

Man's hand gives to his spirit the power for universal domination and ". . . it presents the last and best proof in the order of that principle of adaptation which evinces design."

Charles Bell, 1833

This chapter concerns the basic architectural and functional aspects of the human hand, a primitive yet perfected prehensile pentadactyl structure modified little since the Primate's origin eons ago. Despite its primordial condition, inherent structural and mathematical principles allow for great adaptability and, through the brain, ingenuity.

A semicircular row of four carpal bones forms the base of the hand. The ancient Arch of Tiberius (Fig. 1-1) might easily have had for its original design this transverse skeletal arrangement. The simple architectural principle of the segmented cuneiform arch is demonstrated in Fig. 1-2 with the capitate (os magnum) as the keystone, flanked radialward by the lesser and greater multangular (trapezoid and trapezium) bones and ulnarward by the hamate. Sturdy ligaments unite these wedge-shaped bones, and the arch is further strengthened by the broad volar retinacular ligament that forms the "floor" of the vaulted carpal tunnel, preventing prolapse of the digital flexor tendons during wrist flexion. Two central metacarpals (II and III) are bound firmly to the lesser multangular and capitate bones and constitute with the carpal arch the *fixed skeletal hand unit*.

Viewed laterally, this fixed unit exhibits a special longitudinal carpometacarpal arch or curve roughly simulating a common cycloid, one often favored in bridge construction (Fig. 1-3). The unit is stabilized at the radiocarpal joint by powerful extensor-flexor muscle tendon systems responsible for wrist stability in the basic acts of digital flexion and extension,

Fig. 1-1. It is possible that man's skeletal remnants revealed to him the basic principles of architecture. The crude Arch of Tiberius in the Roman Forum could have had for its original design the semicircular carpal arch of the hand, so perfectly demonstrated in the simple but elegant segmented cuneiform (Roman) arch.

Fig. 1-2. A, Second and third metacarpals and semicircular carpal arch constitute the fixed unit of the hand. **B,** Lateral metacarpals (I, IV, and V) have a variable range of movement determined by their basal carpal articulations and their tether to the central metacarpals (II and III): the first (I) through the powerful flexor-adductor intrinsic musculature; the fourth and fifth (IV and V) through the intervolar plate ligaments.* These lateral mobile metacarpals, empowered by extrinsic and intrinsic muscles, are rotated externally and internally and provide the versatile transverse arch (equiangular curve) so essential for grasp adaptability. *C,* Capitate (os magnum)—"keystone" of arch. For definition of R, a_1, and a_3 see Fig. 1-3.

*Absence of intervolar plate ligament affords freedom to thumb metacarpal (I).

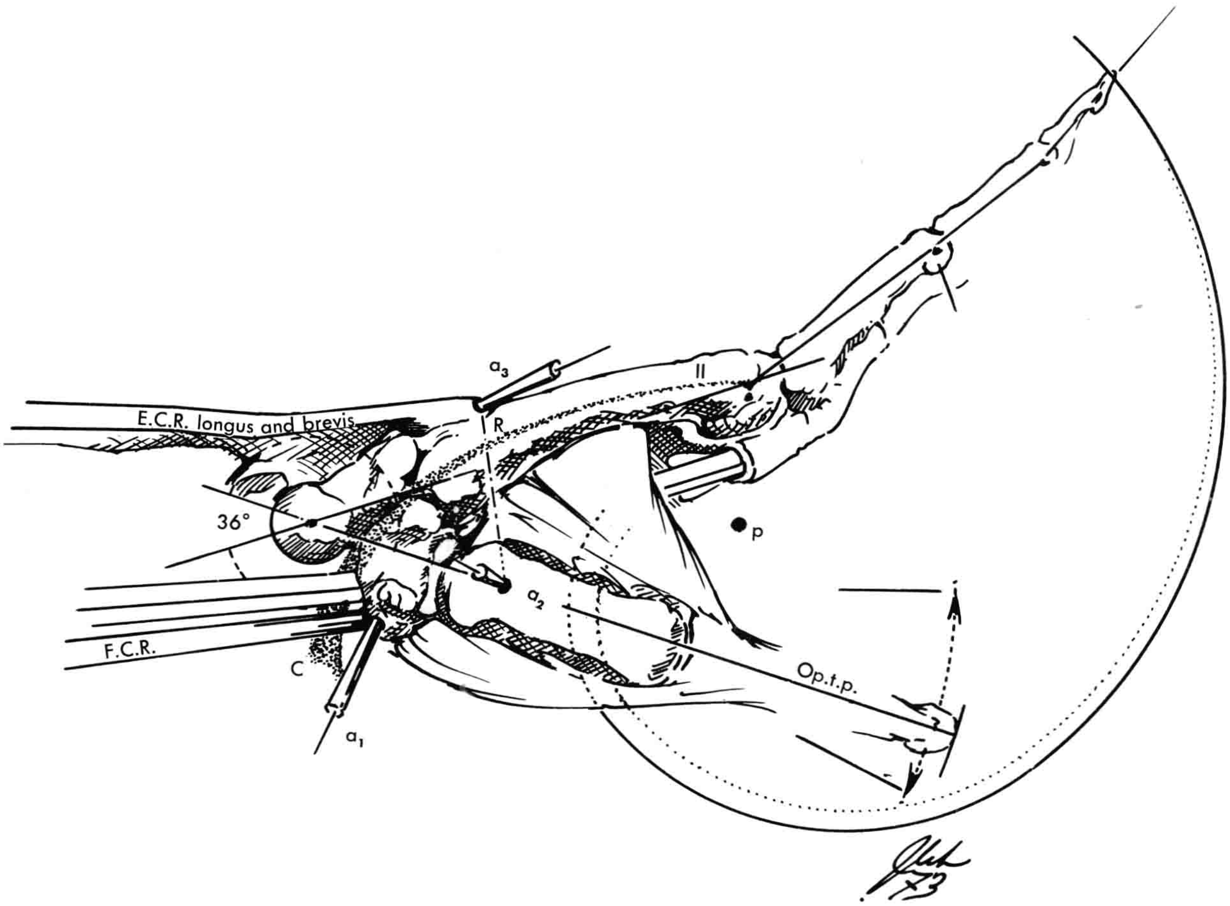

Fig. 1-3. Fixed carpometacarpal longitudinal arch exhibits a special curve not unlike the common cycloid, *C* (stippled); a sturdy base (controlled at radiocarpal axis* by powerful wrist extensor and flexor muscles) is thus afforded the mobile metacarpal and phalangeal components.† In optimum functional position, *Op.t.p.*, thumb metacarpal projects from carpal base (trapezium) at intermetacarpal angle of 36 degrees (and in 20 degrees of radiopalmar abduction). The axes of thumb metacarpal movement are a_1, flexion-adduction, extension-abduction, and circumduction; a_2, palmar plane adduction-abduction; and a_3, locus and variable radius (R) of circumduction.

*The center of wrist movement is through head of os magnum (capitate).

†In the sagittal plane the normal fingertip from full extension to full flexion traces an equiangular curve with its polar axis at *p*.

with which they are reciprocally synergistic. Of the three wrist extensors, the extensor carpi radialis brevis, inserted into the base of the central metacarpal, has the greatest mechanical advantage on the radiocarpal axis and is therefore most important in stabilizing the wrist for power grasp.

Despite their primary role, these important wrist extensor muscles are often rendered involuntarily ineffective even by relatively minor hand injury and/or immobilization.* It is imperative, therefore, that they promptly be returned to strong active independent use through concerted volitional effort. At times the wrist must be immobilized in extension by a plaster gauntlet and effort directed toward regaining active digital interphalangeal flexion power; the synergism existing between the extrinsic digital flexor and the wrist extensor systems will then restore action for the latter automatically.†

A particular angular relationship exists between the articular surface of the greater multangular and the fixed second metacarpal that allows the mobile first metacarpal to have an optimum functional intermetacarpal projection angle of approximately 36 degrees with 20 degrees of radiopalmar abduction. It is in this projection (fist position) that a fusion of the basal thumb joint is mandatory for optimum function in the event of traumatic joint disruption, painful osteoarthrosis, or an uncompensated intrinsic muscle paralysis (Fig. 1-4).

Mobile lateral metacarpals (I, IV, and V) and all phalanges provide for the complex adaptable transverse and longitudinal arches that constitute the compound curves of the hand. The lateral metacarpals are tethered to the central metacarpal (III); the first, controlled by powerful adductor musculature, has far greater mobility than the fourth and fifth, which are restrained by the intervolar plate ligaments, allowing a limited extension-flexion rotation arc through the action of the extensor carpi ulnaris and hypothenar muscles. These lateral metacarpals create the *adaptable transverse metacarpal* arch (Fig. 1-2, *B*).

The adaptable transverse and longitudinal arches of the hand are developed by the mobile lateral metacarpals and the phalanges as they flex and extend around the *fixed skeletal unit.* From full extension-abduction to full flexion-adduction the phalanges of the fingers empowered by the extrinsic and intrinsic muscle systems encircle a "polar axis" in their sweep through an equiangular pathway* to encompass progressively smaller diameters (Fig. 1-5).

This particular function is based on an inherent numerical series that gives a clue to the order of things in nature and the arts. The interarticular (axial) lengths found in the hand follow closely the well-known mathematical sequence attributed to

*The patient will often use digital extensors for wrist extension in lieu of the normal wrist extensors.

†Movements, not muscles, are represented in the cerebral cortex.[6]

*A plane curve that cuts all its radii vectores at the same angle.

Fig. 1-4. With basal thumb joint fused in optimum position, a flexion-adduction and extension-abduction cardinal plane of movement provided by metacarpophalangeal and interphalangeal joints maintains a strong, functional relationship with fingers.

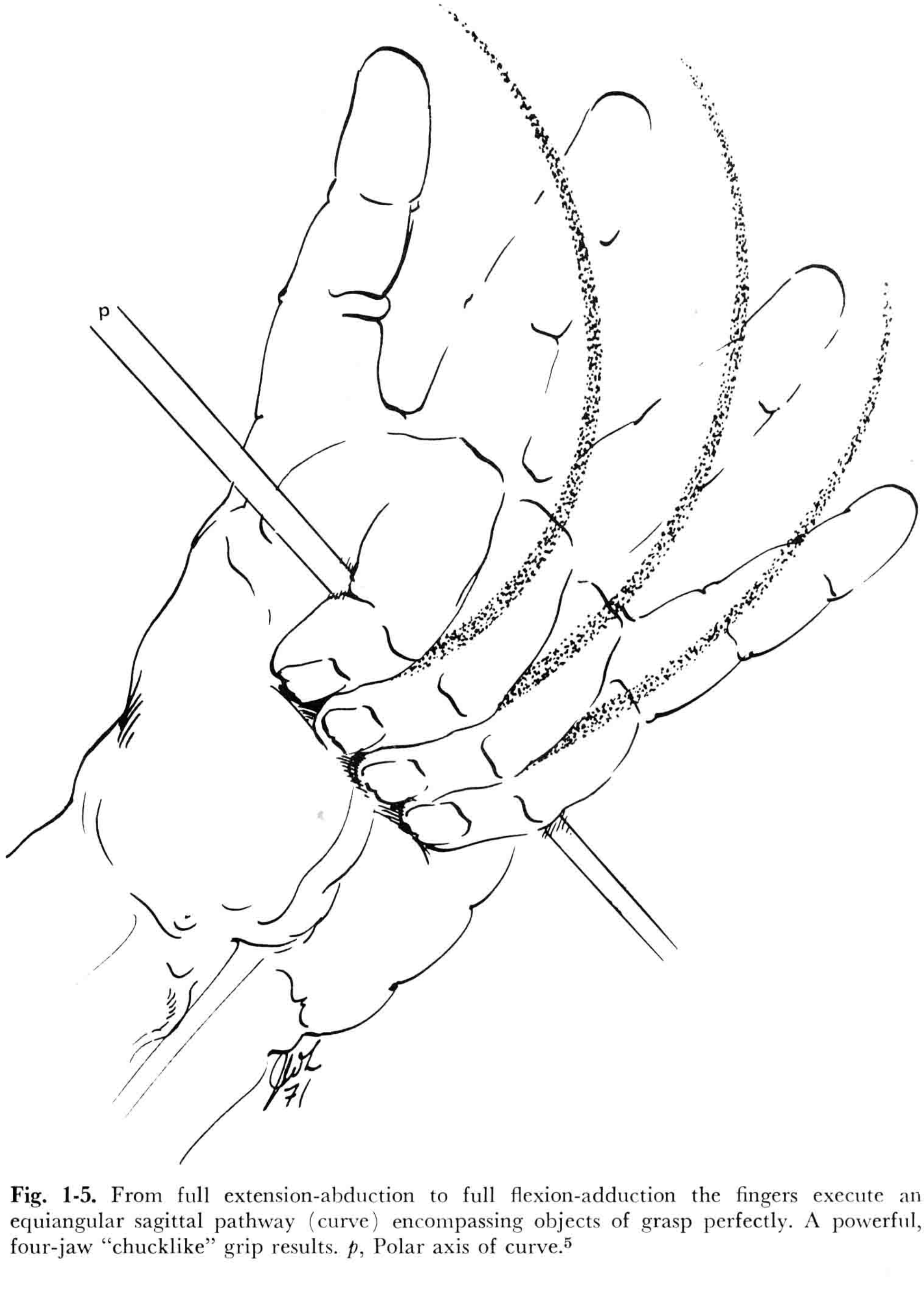

Fig. 1-5. From full extension-abduction to full flexion-adduction the fingers execute an equiangular sagittal pathway (curve) encompassing objects of grasp perfectly. A powerful, four-jaw "chucklike" grip results. *p*, Polar axis of curve.[5]

Leonardo da Pisa (known as Fibonacci, circa 1202).* A break in the curve is inevitable with the joint imbalance created by an intrinsic muscle paralysis (claw deformity) or a loss of superficial flexor tendon function.

The terminal phalanx of man's thumb is a developmental exception in length and pulp volume over that expected by the series. It is for the most part the only major deviation from the primitive pattern, having, unlike the anthropoids, a powerful long flexor tendon (Fig. 1-6). When diametric to the fingers, the normal independent thumb equals them in power and provides for firm grasp and pinch.

*The one to the other of the numerical series 0, 0.1, 1.2, 3, 5, 8, 13 . . . has a ratio of 1:1.618.

Text continued on p. 10.