Emergency Surgery of the Hand

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Foreword

It is a privilege and honor to provide a foreword to *Emergency Surgery of the Hand*. I completed my training in both orthopaedic and plastic surgery in 1991, one year before the first edition of this all-encompassing compendium was first introduced. A quarter of a century later, I was asked by two of my hand surgery heroes (one a senior world ambassador and statesman [Michel Merle] and the other an extraordinary protégé [Aymeric Y.T. Lim]) to introduce the latest edition of their scholarship.

France and Asia have served as beacons of light, illuminating the care and repair of the human hand. Legends such as Baron Guillame Dupuytren and Raoul Tubiana, French masters of the art and science of hand surgery, established the foundation of hand surgery in France and disseminated their knowledge throughout the world. Robert Pho inspired a generation of Singaporean hand surgeons who embraced microsurgery and expanded the horizons of the operating microscope, which is, in the opinion of many, the most essential tool in care of the severely injured hand. By translating their knowledge of emergency hand care from French into English, they have provided a lasting gift to the world of hand surgery. The foundation of modern upper extremity surgery as we know it was built on experience with hand injuries. It is essential to know emergency hand care if one is to practice hand surgery.

The advances in care of the injured hand outlined in this book include new concepts in free tissue transfer and the expanded role of pedicle flaps. The mastery of anatomy is emphasized in this book, linking such knowledge with principles of structure repair and, if required, tissue replacement. The final and essential component of treatment, the approaches to rehabilitation, complete treatment, which should be always individualized, never standardized! Emergency care of the injured extremity must weave each of these domains into one fighting force, combating cicatrix, stiffness, edema, dystrophy and adhesion. It is with such an approach, which has clearly been outlined by the authors, that function can be restored and social integration made possible for the patient. Today it is possible to transplant a new hand if the mutilated injury is nonsalvageable. A foreign concept 25 years ago is now a reality!

Ben Franklin was America's first ambassador to France. He also founded America's first hospital, Pennsylvania Hospital. It has functioned well for over 250 years. I perform surgery at Pennsylvania Hospital and respond to calls from the emergency room for patients who require care for hand injuries. Franklin learned much from the French and brought back knowledge to America that helped craft our democracy and American heritage. I have learned much of my hand craft by studying the French School of Hand Surgery, dissecting flaps in the Ecole de Paris anatomy labs, and adapting the Asian philosophy of reconstructive microsurgery by visiting China, Japan, Taiwan and Singapore. My quest for knowledge has required me to travel far.

By embracing the knowledge in this book and learning the principles and practice of emergency hand surgery, you need only travel from page to page and chapter to chapter. The world of emergency hand surgery is now here in one place, at your fingertips. Explore the experience and knowledge of global leaders and innovators in emergency hand care and treatment philosophy by exploring this book. You need search no further for the pathways that guide you in restoring (according to Sir Charles Bell) the most beautiful instrument of the mind, the human hand.

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Foreword

La "Main Traumatique", *Emergency Hand Surgery*, was first published (in French) in 1992 and has been the basic hand surgical text for a generation of surgeons in France, Italy, Spain, Germany and South America. It bears the imprint of its senior authors, Michel Merle and Gilles Dautel. Their depth of clinical and technical expertise, acquired through 40 years of experience, is apparent in the chapters that follow. The illustrations are of very high quality and this book is a self-sufficient atlas. In addition, it is their deep understanding of the pathology of trauma and reconstructive techniques, combined with astute clinical judgment, that make this book an invaluable resource for surgeons at all levels. After translating the third volume, *Elective Hand Surgery*, into English, I am honored to be able to make this book available to a larger English-reading audience.

Aymeric Y.T. LIM

Preface

Since the first edition of this book on emergency hand surgery was published in French in 1992, this discipline has undergone an extraordinary development internationally. All countries with a modern economy have organized hand surgery units in the public hospital as well as the private sector. The accident and emergency departments have become vigilant in recognizing devascularization of a finger or a hand, which requires rapid microsurgical treatment.

The surgeon has received multicultural training in the sense that he is an orthopedic surgeon, plastic surgeon and microsurgeon all at once. His culture requires him to understand the anatomy and biomechanics of the hand, the principles of tendon healing and nerve regeneration. The refinement of rehabilitation protocols and orthotics also requires perfect collaboration between surgeons, rehabilitation doctors, orthotists, physiotherapists and occupational therapists.

The fourth edition, from which this translated edition is taken, is enriched in most of its chapters with new surgical techniques, favoring those that allow early rehabilitation, most often using the protection of orthotics. In the indications, we have also taken into account the socioeconomic context that requires the prioritization of techniques that favor a rapid return to professional activities.

Thomas Jager, also a graduate of Nancy, contributed through his culture and experience in enriching this work with several clinical cases illustrated with high-quality documents.

The hand surgeon should be ambitious in his approach to treating a patient with a hand injury, which requires him to gather a team around him who are willing to work in an emergency. Professor Lim and his team at the National University Hospital in Singapore outlines emergency microsurgery at the beginning of this book. We would like to thank him for sharing his remarkable experience, which concerns the entire care branch of a hand surgery department.

We would also like to thank all our friends who through their passion, skill and bilingualism agreed to carry out editions in their own countries, in particular Professor Stefan Rehard of Frankfurt, who took care of the German editions, Professor Guillermo Loda of Buenos Aires and Dr. Marcelo Racca of Cordoda for the Spanish versions, Professor Luca Vaienti of Milan for the Italian version, and Professor Aymeric Lim for the English version. Only great bilingual surgeons could have achieved this enormous task.

The Elsevier-Masson editions once again demonstrated their skill and endowed this work with a new and especially attractive presentation, for which we would like to thank them.

Michel Merle

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In remembrance of Professor Jacques Michon, Professor J.W. Littler and Professor H.J. Buncke, who so generously shared their knowledge with me.

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Thanks to Michel and Yseult Bouriez and their children, Christian, Hélène and Ghislain, whose patronage contributes to the highest level of training for the new generations of hand surgeons.

Thank you to Dr. Raymond Lies, surgeon and honorary general manager of the Centre Hospitalier Kirchberg in Luxembourg, who allowed us to develop the Department of Hand Surgery and to create the first "SOS Main" service in the Grand Duchy of Luxembourg, as well as the Medical Training Center.

Thanks to Beat Leu, who by his support has enabled the international distribution of this book in several languages.

And finally, thank you to Dr. Sylvie Merle-Michon who undertook the proofreading of this treatise.

Contents

Abbreviations

AA	Axillary artery
ADM	Abductor digiti minimi
AdP	Adductor pollicis
APB	Abductor pollicis brevis
APL	Abductor pollicis longus
APTT	Activated partial thromboplastin time
AV	Axillary vein
CESUM	Confédération Européenne des Services d'Urgence de la Main [European Confederation of Hand Emergency Services]
CMC	Carpometacarpal
CRPS	Chronic regional pain syndrome
DIML	Dorsal intermetacarpal ligament
DIP	Distal interphalangeal
DISI	Dorsal intersegmental instability
DRL	Dorsoradial ligament
DRUJ	Distal radioulnar joint
ECRB	Extensor carpi radialis brevis
ECRL	Extensor carpi radialis longus
ECU	Extensor carpi ulnaris
EDC	Extensor digitorum communis
EDM	Extensor digiti minimi
EPB	Extensor pollicis brevis
EPI	Extensor proprius indicis
EPL	Extensor pollicis longus
FCR	Flexor carporadialis
FCS	Flexor communis superficialis
FCU	Flexor carpoulnaris
FDMB	Flexor digiti minimi brevis
FDP	Flexor digitorum profundus
FDS	Flexor digitorum superficialis
FESUM	Fédération Européenne des Services d'Urgence de la Main [European Federation of Hand Emergency Services]
FGF	Fibroblast growth factor
FPB	Flexor pollicis brevis
FPL	Flexor pollicis longus
GHOISS	Ganga Hospital Open Injury Severity Score
HMC	Hamatometacarpal
IFSSH	International Federation of Societies for Surgery of the Hand
IGF	Insulinlike growth factor
IML	Intermetacarpal ligament
IP	Interphalangeal
IVRA	Intravenous regional anesthesia
LMWH	Low-molecular-weight heparin
MCP	Metacarpophalangeal
MESS	Mangled Extremity Severity Score
NGF	Nerve growth factor
NSAIDs	Nonsteroidal antiinflammatory drugs
ODM	Opponens digiti minimi
OP	Opponens pollicis
PDGF	Platelet-derived growth factor
PIP	Proximal interphalangeal
PL	Palmaris longus
POL	Posterior oblique ligament
RCL	Radial collateral ligament
ROM	Range of motion
SAOL	Superficial anterior oblique ligament
SCM	Sternocleidomastoid muscle
SLAC	Scapholunate advanced collapse
SNAC	Scaphoid nonunion advanced collapse
STEM	Single treatment with early mobilization
TAM	Total active motion
TFCC	Triangular fibrocartilage complex
TGF	Transforming growth factor
TMC	Trapeziometacarpal
TPD, 2PD	Two-point discrimination
UCL	Ulnar collateral ligament
VEGF	Vascular endothelial growth factor
VISI	Volar intersegmental instability

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Ultrasound-Guided Regional Anesthesia of the Upper Limb

I. BAECKELMANS, E. COLLING, J.-P. GALEAZZI, J. WELTER

INTRODUCTION

Upper extremity surgery, whether elective or emergency, can be done under regional anesthesia in the vast majority of cases. Used alone or as a supplement to general anesthesia, regional anesthesia allows for lower opiate consumption, less postoperative nausea and vomiting and better pain control. This chapter explains how regional anesthesia is used in the upper limb. We will emphasize the important anatomic landmarks to administer regional blocks safely in the upper extremity. We will describe different types of regional anesthesia for the upper limb, their indications and pitfalls. The availability of a wide range of local anesthetics, new drug delivery systems, and use of adjuncts for administration, such as ultrasound (US) or nerve stimulators, make regional anesthesia a very safe and precise procedure. When administered correctly, regional anesthesia has a nearly 100% success rate and fewer side effects. It can be used in an almost unlimited range of conditions, including previously contraindicated situations (eg, anticoagulated patients).

What Is Regional Anesthesia?

Regional anesthesia developed as an offshoot of local anesthesia. In September 1884 Dr. Karl Koller, an ophthalmologist, performed the first operation under local anesthesia (topical cocaine solution) in a patient with glaucoma. That same year Dr. Richard Hall published a report on the first successful nerve block of the inferior dental nerve by Dr. William Halsted using cocaine hydrochloride. Together they went on to develop different regional nerve block techniques. The aim of regional or conduction anesthesia is to make the body part supplied by a nerve insensitive to pain so that surgery can be performed on it. It also causes altered temperature sensation and paralysis of the muscles supplied by the nerve. Regional anesthesia works through the interaction between the drug and the target nerve fibers. Local anesthetics inhibit depolarization of the nerve membrane by blocking voltage-gated sodium channels. These channels are very important for the propagation of action potential that leads to conduction of an electric charge. This conduction of electric charge is how the peripheral and central nervous systems communicate with each other. Clinically approved, commercially available local anesthetic drugs have a reversible effect. All local anesthetics have a similar chemical structure made up of an aromatic portion, an intermediate chain, and an amine group. Onset of action is related to the drug's lipid solubility and diffusibility. How long the anesthetic effect lasts is related to the drug's protein-binding ability.

The four most commonly used brachial plexus blocks for upper limb regional anesthesia are the axillary, infraclavicular, supraclavicular and interscalene blocks. With these four distinct approaches, one can cover almost all kinds of upper limb surgery. When administering local anesthetic for nerve blocks, it is crucial to have a clear understanding of the topography of neurovascular structures in the neck, shoulder and upper extremity. The introduction of US guidance in administering regional anesthesia has further improved the safety of this procedure. US-guided regional anesthesia has effectively reduced the incidence of local anesthetic systemic toxicity. US allows us to see instantly what is happening underneath the skin when the needle is introduced. It shows us

the nerves we need to block and structures we need to avoid, such as vessels and lungs.

INITIAL ASSESSMENT OF TRAUMA

Stabilization and Primary Management of a Patient With an Injured Limb

Appropriate resuscitation should be started at the accident site following the "life-before-limb" approach. The injured limb is dressed and immobilized as it lies. Avoid the urge to clean the limb on site with antiseptics. Bleeding is controlled by elevation and compression bandaging. If there is projectile massive bleeding from the limb, a tourniquet may be used to prevent exsanguination. It is preferable to use a commercial tourniquet or blood pressure cuff. These cuffs have adequate surface area to distribute the pressure and avoid skin injuries. More important, the amount of pressure applied can be regulated. This is usually set to 100 mm Hg above systolic blood pressure. It is most important to note the time of application, and this information should be handed over to the receiving medical team in the emergency room. This time can be marked or written on the patient's arm, thigh or forehead. This is to prevent caregivers from forgetting the presence of an inflated tourniquet. Leaving the tourniquet on for a long time causes distal tissue necrosis. This leads to loss of the limb and also has serious systemic effects when released. Intravenous (IV) fluids should be started, and the patient should be transferred immediately to a trauma center. Remember to keep the patient warm during transport and provide IV or intramuscular analgesia. In cases where the accident caused an amputation, the amputated part should be preserved as detailed in Chapter 15 and delivered to the trauma center as soon as possible.

REGIONAL ANESTHESIA IN THE AMBULATORY SETTING

Preoperative Evaluation

In any situation where patients present for surgery days or weeks after the last clinical encounter, it is important for the surgeon to reassess the patient to confirm that surgery is still indicated. Informed consent should have been taken at the time when the patient was listed for surgery, and this consent is reaffirmed with the patient. Generally patients would already have an idea what anesthesia they will receive. For major operations under regional anesthesia, patients are advised to fast 6 hours prior to the procedure just in case there is a need to convert to general anesthesia. It is important to check if the patient had any previous allergic reactions to local anesthetics, even if this is extremely rare. The patient should be weighed to calculate the maximum dose he or she can tolerate. The surgeon or anesthesiologist should also note if the patient is on any antiplatelet or anticoagulation therapy. Depending on the type of surgery and the patient's medical condition, patients would have been advised whether it is safe to continue these medications during the perioperative period. With the use of US guidance, performing upper limb peripheral nerve blocks in patients taking blood thinners is no longer an absolute contraindication.

In emergency situations where surgery is lifesaving, this detailed approach may not be possible. Members of the surgical team should explain to the patient (if possible) or members of the patient's family without delaying the surgery.

Preparation for Anesthesia

Once in the operating theater, the patient is prepared in the induction room. IV access is obtained in the nonsurgical limb, and monitoring devices are placed. Patients are asked to confirm their identity, the operative site and any known allergies. Baseline vital parameters are recorded, and patients receive supplemental oxygen before any medication is administered. The entire anesthetic procedure is explained to the patient to help relieve anxiety. It is most important to inform patients about what they may feel in case of an allergic reaction or drug overdose and advise them to report to the doctor immediately should any of these occur. This communication with patients is the best way to detect intolerance to local anesthetic or adverse effects of intravascular injection. A light sedation with midazolam can be given to very anxious patients.

Administration of Anesthesia

Regional anesthesia for upper limb surgery is administered as peripheral nerve blocks. The entire procedure should be done under rigorous aseptic conditions, much like the actual surgery itself. This includes surgical hand scrub for the anesthesiologist, donning of sterile gowns and gloves, and use of sterile covers and transmission gel for the US. Using long-acting anesthetic drugs, the peripheral nerve block can be performed in the induction room, much earlier than the surgical procedure, to decrease operating room turnover time. The use of US guidance has changed the administration of peripheral nerve blocks dramatically. It allows the anesthesiologist to visualize the tip of the needle, the anatomic structures the needle is passing through, and most important, the target nerves to be blocked. This reduces the discomfort for the patient in terms of number of needle passes required. It helps visualize vessels and lowers the risk of intravascular injection of anesthetic. This is further avoided by repeated aspiration prior to injection and observing for small volume dispersion into tissue. It optimizes the placement of the anesthetic drug, leading to faster time to achieve surgical anesthesia. Nerve stimulation may be used in combination with US guidance. It used to avoid intraneural placement of the needle tip. Remember to

involve patients by asking them to speak up if they feel any paresthesia or signs of toxicity previously advised. Patients should be continuously monitored by trained personnel throughout the procedure. This does not require any special monitoring equipment.[13] Anxious patients may be given light sedation. After the surgery, patients can go home after a few hours of observation in the postanesthesia care unit or general ward.

Regional anesthesia has a major advantage of providing more than adequate postoperative analgesia. This prolonged pain-free period improves the patient's trust in the surgical team and gives the patient confidence to start early mobilization of the operated limb when this is appropriate. Patients are educated regarding care for their anesthetized upper limb. This includes wearing a sling properly until they regain active control of the upper limb and avoiding contact with temperature extremes until sensation recovers. All patients are given a prescription for oral analgesics and specific instructions for when to start taking them upon discharge.

Advantages of Regional Anesthesia

Pain Relief

The effect of a well-administered peripheral nerve block can be appreciated even before surgery. It allows for pain-free radiologic examination and removal of dressings in trauma cases. The patient is pain free when transferred over to the operating table. It works as a preemptive analgesia and provides the most effective postoperative pain relief. It attenuates the surgical stress response and causes vasodilation, thus improving blood flow in the extremity. Early passive mobilization under regional anesthesia when appropriate can also accelerate the return of function to the operated limb.

General Anesthetic Risk Reduction

During surgery, regional anesthesia reduces the risk of regurgitation and aspiration pneumonia in patients who have not fully fasted. Dental problems, pharyngeal pain and hoarseness of the voice are avoided when regional anesthesia is successful. Malignant hyperthermia, barotrauma and atelectasis are nonexistent. The risk of severe allergic reaction is lower with regional anesthesia.

Postoperatively, regional anesthesia reduces the risk of drowsiness, respiratory distress, nausea and vomiting. People are more alert right after surgery and have less hemodynamic instability. Hyperalgesia, an increased sensitivity to pain often seen with patients with chronic use of opiates, can be reduced or avoided. Postoperative urinary retention due to bladder dysfunction is significantly lower with the use of peripheral nerve blocks. Volatile anesthetics and sedative hypnotic agents suppress the micturition reflex and decrease detrusor contractions. In regional anesthesia the immune response is preserved.[3,5,8,11,34]

Early Discharge

The length of hospital stay is considerably reduced. Patients can be discharged a few hours after surgery. While the arm is still numb, patients benefit from the prolonged analgesic effect. This "prolonged sleeping" of the limb gives patients less stress and reduces the demand for additional pain medication.

Economic Considerations

Regional anesthesia reduces cost of care by decreasing the time spent in the operating room, the amount of disposable materials used, the duration and level of monitoring required and the duration of postoperative hospital stay. This translates to better quality of care for the patient.

Anesthesia for the Young, the Pregnant and the Elderly

US-guided regional anesthesia can be used in patients of any age, even in small children. In our hospital, children as young as 4 years old have had surgery under regional anesthesia. In children, anxiety caused by the thought of receiving an injection is prevented by a very light and ultrashort sedation given before performing the nerve block. For the elderly, regional anesthesia is very well tolerated and is our first choice. Patients are mobilized faster after surgery under regional anesthesia, thus reducing the risks of thromboembolism and cognitive disturbances. Surgery in pregnant patients is not advised unless absolutely necessary. When necessary, the use of local or regional anesthesia minimizes the risk to the developing fetus.

Contraindications for Peripheral Nerve Blocks

Although the use of US-guided regional anesthesia (with or without nerve stimulation) has reduced the risks of inadvertent reactions, some contraindications still need to be mentioned. Patient's refusal should be respected at any time. Peripheral nerve blocks should not be given through sites that appear infected. A needle puncture in an infected area can disseminate and worsen the situation for the patient. One should consider an alternative site to administer the block. Use of certain types of peripheral nerve blocks is not advised for bilateral procedures owing to the risk of drug toxicity. When given on both sides, interscalene or supraclavicular blocks can result in diaphragmatic paralysis and carry the risk of respiratory failure.

Hemostatic disorders, either congenital or acquired, should always be considered when counseling patients regarding the choice of anesthesia. A known allergic reaction to a local anesthetic, though very rare, should also be considered as a possible contraindication. The presence of infection in the operative site is another consideration. It is difficult to achieve dense anesthesia in inflamed or infected tissue. The inflamed tissue is more acidic; thus a smaller proportion of the drug is in the lipid-soluble form that can penetrate nerve membranes. The position of the patient and length of surgery could make the use of regional anesthesia as a sole technique difficult.