Hand Surgery in Japan

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Abstract

Japan has faced the most challenging times in the past. Through precise diligence by stalwarts and doyens of initial hand surgeons, it led an incredible path for the most significant moments of hand surgery. This article describes the early phase of development of Japanese Society for Surgery of the hand, substantial and innovative contributions from surgeons. A noteworthy and significant achievement in the hand surgery is microsurgery and its utilities for all hand-related diseases. The first replantation of the thumb, toe transfers and wrap-around flaps are the effective surgical techniques developed and imparted to the fellow hand surgeons worldwide. We had a particular interest in congenital hand surgery and developed a modification of congenital hand classifications and introduced many surgical techniques. Besides, we grew ourselves refining more in hand and microsurgery, innovating flexor tendon repair, peripheral nerve surgeries, wrist arthroscopy, joint replacements, external fixators, and implant arthroplasty for rheumatoid hand. We share our health care information, insurance working model and hand surgery training schedule in Japan.

Keywords
- hand surgery Japan
- JSSH
- microsurgery
- hand surgery training
- health insurance

Early Phase of Development of Japanese Society for Surgery of the Hand

Japanese Society for Surgery of the Hand (JSSH) was established in 1957 in Kobe, under the first president T. Amako (Kyusyu University) (►**Fig. 1A**). It was 12 years after the establishment of American Society for Surgery of the Hand (ASSH). After the Second World War, Japan was completely devastated; however, recovery in socioeconomical structures was amazingly speedy with support from the world. Among orthopaedic procedures, treatment of hand injuries had remarkably developed in the United States by the instructions of Sterling Bunnel (first president of ASSH). For the establishment of the JSSH, there were strong support from the ASSH, especially Harry Miller visited Amako at Kyushu University in 1956. He brought the message from Bunnel that ASSH would help establishment of JSSH. Following years, Boyes had visited Japan several times. Both Amako and Kashiwagi (Kobe University, president of fourth JSSH) were professor of the entire orthopaedic department, but contribute greatly for the establishment of the JSSH. Kenya Tsuge (Hiroshima University) and Tatsuya Tajima (Niigata University) were the true hand surgeon in first generation. "*The Atlas of Hand Surgery*" written by Tsuge had been translated in English, Chinese, Korean, Germany, and Spanish and became one of the classic textbooks worldwide. Tajima, trained as orthopaedic residence in the United States, also learned hand surgery, extensively from W. Littler at Roosevelt Hospital, New York and from J. Boyes at Southern California University. After returned from the United States, Tajima dedicated himself to spread what he learned from the stream of Bunnel and to educate Japanese hand surgeon. With their effort, Niigata and Hiroshima became two important hand centers for long time until now. There were two important international events for the development of hand surgery in Japan. The first was "the joint meeting of Japanese and American Hand surgeons

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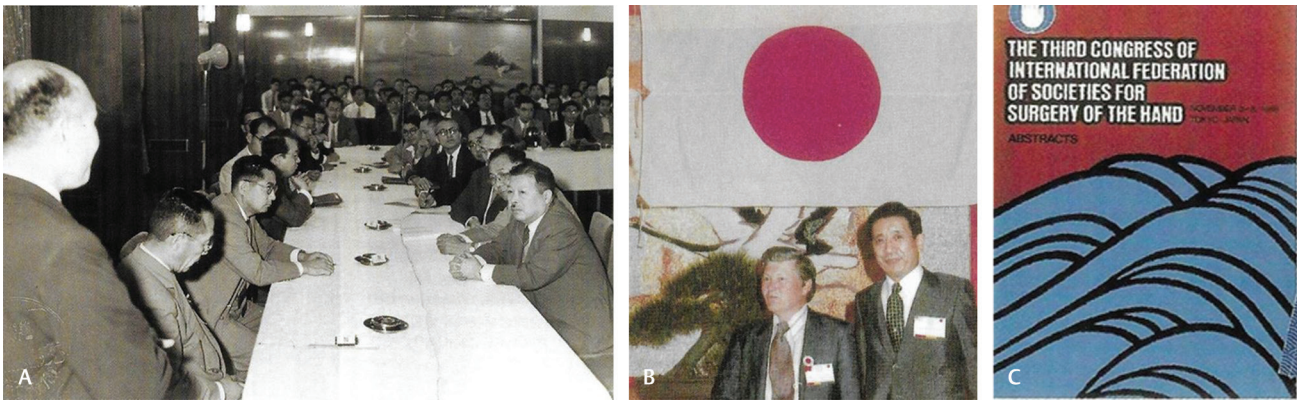

Fig. 1 (**A**) First congress of JSSH performed at Kobe in 1957. (**B**) The joint meeting of Japanese and American Hand surgeons in 1974. Dr. Milford (American chair) and Dr. Tajima. (**C**) Abstract book of the Third IFSSH congress at Tokyo in 1986.

in 1974. Attendees from the United States, with the chair L. Milford (Cambell Clinic) (►**Fig. 1B**) were 36 doctors mostly accompanied with spouses. This large group traveled four different cities: Tokyo, Niigata, Hiroshima, and Kyoto where the meeting took place with instructional courses, scientific presentations, and case discussion under the direction of Y. Itami (Jikei University), the chair of JSSH side. Another big event was the third meeting of the International Federation of Society for Surgery of the Hand (IFSSH). The meeting was held at Keio Hotel, Tokyo between November 3–8, 1986, under the presidency of Tajima (►**Fig. 1C**). There were more than 900 participants from 35 hand surgery constituting the International Federation and 40 countries throughout the world. After this congress, about 200 participants moved to Kyoto for the post congress meeting (under the local host Y. Ueba (Kyoto University). When the IFSSH was established in 1966 for communication of eight societies in the world, JSSH was the fourth society after American, British, and Scandinavian. The official journal of JSSH was issued since 1984 with English abstract and legends and tables. Annual meeting of the JSSH has been continued once a year, the 63rd annual meeting of the JSSH meeting in 2020 was performed online due to COVID-19. Several foreign guest speakers have been invited each year and attendance from Asian countries is increasing. Program of the exchange travelling fellow was started with ASSH in 2000, and now with the society of Hong Kong and Korea. There were three local hand annual meetings, dividing Japan into three locations, Eastern, Central, and Kyushu and had continued over 40 years.

Achievements (Contributions) of JSSH for the Development of Hand Surgery

Microsurgery

Introduction of microsurgical technique was one of the major achievements for hand surgery. Inoue and Toyoshima had success of replantation for complete amputation at the level of wrist in 1963.

Tamai (Nara Medical University) reported first replantation of complete amputation of the finger (at the level of the metacarpophalangeal [MP] level of the thumb) in the world using microscope in 1965.[1] Following this, success microsurgery became most attractive field for young surgeons. Japanese Society for Reconstructive Microsurgery was funded in 1973. Since development of surgical microscope and microsuture and instrument, the success rate of replantation was 50% in 1970 and was reached 90% by 1990. Furthermore, replantation at fingertip, called super microsurgical techniques reported 97.5% (Hiramatsu) and 95% (Yamano) success late in 1983. Tamai performed toe to thumb transplantation in 1974. Y. Ikuta (Hiroshima University), another pioneer of this field reported free muscle transplantation by microsurgical technique to treat severe Volkman's contracture in 1976.[2] Yoshizu (Niigata) performed joint transposition from toe to hand in 1977. Doi (1981) and Katsumi (1982) modified the wrap around flap designed by Morrison et al in 1980[3] and popularized reconstruction for missing thumb and fingers. Free joint and muscle, and soft tissue transplant are utilizing various reconstructions due to trauma, tumor, nerve, and congenital conditions. Harii (Tokyo University), one of the early hand surgeons from plastic surgery, reported free frap reconstruction[4] followed by Shibata (Niigata University) and Hirase (Jikei University) both from plastic surgery energetically performed reconstruction of the upper extremities using various microsurgical technique and flaps.

Peripheral Nerve

Basic research[5–7] and various clinical contributions for the nerve were the top among other area.

Small meeting of "Discussion of (research and clinical issues on) peripheral nerve" started in 1978 during the JSSH meeting. Although it was supported by Eisai Pharmaco Ltd, later officially registered from JSSH and became yearly meeting as an evening session during the JSSH congress, it continued 48 years with average of 300 attendance ever since. In group of Tokyo University, Tsuyama, Hara et al and Nagano et al had great contribution on research and treatment of brachial plexus injury. They presented combined surgery of free muscle transplantation and intercostal nerve crossing as a reconstructive procedure for elbow flexion and wrist extension in brachial plexus injury.[8,9] Doi (Yamaguchi University)

performed free gracilis and quadriceps transfer for elbow and wrist motion in brachial plexus injury.[10] Inada (Nara) developed artificial nerve using polyglycolic acid tube[11] and is now commercially available and used not only bridging the defect but also treating neuroma and causalgia.

Congenital Hand Deformity (Emiko Horii)

Articles related to hand anomaly were first published in 1960's journal of JSSH, one was related to the incidence of hand anomalies, and another was regarding surgical technique for syndactyly. Founders of the JSSH worked on this subject energetically. Swanson reported the classification of hand anomalies in 1964, and this classification was used as basic classification by IFSSH.[12] The JSSH followed that classification, then conducted many experimental and clinical studies. However, there were some cases, which were hardly classified by Swanson classification. Especially, cases with combination of central ray duplication, syndactyly, and cleft hand were occasionally observed in the same patients, and cases with symbrachydactyly showed different clinical manifestation. The JSSH organized congenital hand anomaly committee in 1976, which aimed establishment of Japanese nomenclature, registration of cases with congenital hand anomaly, and education of young doctors. After enthusiastic discussion, Ogino proposed the concept of "Abnormal induction of digital rays," then JSSH committee reported modified Swanson classification in 1996,[13] which was used as official IFSSH classification for a while.[14] None of the classification simply classified various hand anomalies. Embryological molecular studies revealed the mechanism of hand malformations. Recently, Oberg, Manske, and Tonkin classification was advocated as better classification based on the limb development.[15] But, the JSSH classification is still used worldwide as more clinically useful classification. Many surgical reconstruction techniques were advocated by the JSSH hand surgeons, such as microsurgical reconstruction for finger deficit or birth palsy, or mobilization of congenital radioulnar synostosis. The JSSH assessment for radial polydactyly was published in 2007, and this was verified as having the highest interobserver reliability. Congenital hand anomaly study meeting was originally commenced by several hand surgeons as closed meeting, but since 1996, this meeting was started as a part annual meeting regularly, to discuss various problems related to hand anomaly and also to educate young hand surgeons. The 58th "Discussion on the congenital anomalies of the hand and fingers" was canceled this year due to COVID-19. The committee members will continue this meeting to advocate the researches for hand anomaly to the world.

Intrasynovial Flexor Tendon Repair (Yoshitaka Hamada)

Tendon repair of the hand is often complicated by adhesion, gap formation, or bowstring effects leading to inadequate functional recovery. The developments in primary tendon repair include stronger core tendon repair following circumferential suture techniques, and adequate venting of the critical annular pulley to permit smooth tendon excursion by avoiding compression to the repaired tendon and the length of pulley release is decided according to the excursion of flexor tendon at the site of injury (i.e., at the center of proximal phalanx 17 mm and middle phalanx 5 mm). The postoperative rehabilitation protocol is also crucial. In Japan, Tsuge's (Hiroshima) 4–0 loop needle was easy to use to obtain locking stich and became widely used.[16] Moriya et al (Niigata) developed six strand core sutures with early active mobilization. Dynamic release of the pulleys according to zone of injury but not permit negative bowstring effects is their original development.[17,18] ►**Fig. 2** shows the popular technique in Japan.

In the biological aspect of the tendon healing, the fibroblastic cell source was studied by Hamada et al and Churei et al.[19,20] The initial surface union was obtained at epitenon layer (reticular membrane) in the early stage, maturation of the union was delayed at the center of the tendon following activation of endotenon (fascicular membrane). However, now, at this point, growth factors are not sufficient to obtain early healing in clinical practice, the modulation of the cell source seemed to be the key in the future work.

External Fixator for the Hand (Yoshitaka Hamada)

External fixator is a useful and powerful tool for the treatment of certain fractures, contractures, or mutilating hand injuries of the phalanges of the hand. Here, we will introduce two main streams which developed with original progression in Japan.

External Fixator for Intra-articular Fractures and Fracture Dislocations in the Proximal Interphalangeal Joint

Suzuki first reported the pins and rubbers traction system for treatment of comminuted intra-articular fractures and fracture dislocations in the proximal interphalangeal (PIP) joint.[21] This handmade simple traction system by Kirschner wire and rubber band permitting active range of motion has been modified by many authors in the world. Masada developed dynamic distraction apparatus (DDA) system to carry out this concept with convenient. This DDA has developed with some changes (i.e., minimum size, volar or dorsal reduction torque by coil springs, as well as traction by rubber) named DDA2 as shown in ►**Fig. 3A**. This system is custom-made and commercially available (ME system, Tokyo, Japan). Including the chronic dorsal-fracture dislocation of the PIP joint, surgical rehabilitation under the concentric movement with protected distraction of the affected PIP joint more than 6 weeks can promote the remodeling of the cartilage defect at the center of the joint.[22]

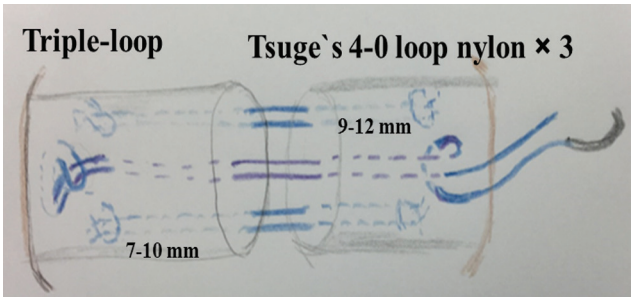

Fig. 2 Popular technique of core suture: 6-strand.

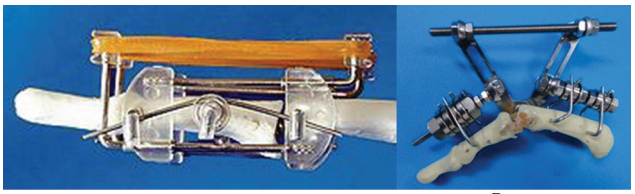

Fig. 3 (**A**) DDA2: Wire at the center of rotation can permit the concentric motion. Rubbers distract the PIP joint. Coil springs make reduction torque on the middle phalanx in volar or dorsal directions. (**B**) Modified Ilizarov minifixator; Hinged type to permit concentric movement under distraction. The moderate flexion contracture or the sever extension contracture are treated by this hardware.

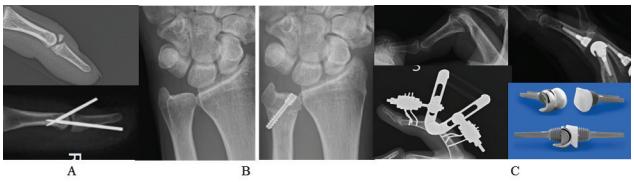

Fig. 4 (**A**) Ishigro method: the angle of temporal DIP fixation in extension found out better outcomes (Image courtesy: Yuko Nakamura, Namba Hand Center). (**B**) TFCC injury with Ulnar plus, Wedge osteotomy at distal ulna performed using headless compression screw (Image courtesy: Dr. Hisao Moritomo, Namba Hand Surgery). (**C**) Rheumatoid Boutonniere deformity with advanced flexion contracture. Application Modified Ilizarov minifixator reduced the joint in 3 weeks. PIP Implant arthroplasty was performed with minimum bone resection (Image courtesy: Yoshitaka Hamada Namba Hand Center).

Modified Ilizarov Minifixator

In Japan, Sawaizumi and Ito introduced Russian Ilizarov minifixator (IMF) in the early 2000s. He also reported original lengthening of the amputation stumps of the distal phalanges using the modified Ilizarov method.[23] Hardware of IMF originated from Russian Ilizarov Center has been developed by enthusiasm of pioneers in mechanics (Arata Corporation, Tokyo, Japan) and following pioneers Gotani and Matsuura et al. There are many original parts for widespread usage and its safety use.

The lengthening of the vigorous phalanges in the hand can be achieved by gradual lengthening more than 3 or 4 cm, but its limit is regulated by excessive skin tension.[24] Therefore, excessive flap coverage for the tip of the hand is desired before lengthening. The elongated phalanges curved to the palm side could be functional by estimating the arc of MP joint including its hyperextension arc. The advantage of modified IMF is its wide application in usage. The IMF can be a most powerful tool for treatment of PIP joint contractures (►**Fig. 3B**).[21] Recently, Hamada et al classified PIP joint contractures according to the severity and type of contractures and selected the hardware and indicated rehabilitation protocol according to the type of contracture.[25] Any severe flexion contracture can be corrected and obtained the extended position using this device. The correction of first web contracture (thumb adduction contracture) or complicated fixed claw deformity is also strong point (good indication) for usage of this device.

Fracture

Extension blocked pinning for mallet fracture. Ishiguro et al reported closed reduction and percutaneous pinning method for mallet fracture in 1988.[26] Although this technique became most popular choice in Japan, English publication delayed until after 2000.[27] With several modification, "Ishiguro method" is spread all over the world (►**Fig. 4A**).

Arthroscopy

It is well known that Watanabe introduced arthroscopy for the knee in 1962, he performed the first arthroscopic meniscectomy using the arthroscopic instruments he developed.[28] After the development of smaller arthroscopy, indication became much wider in other joints, shoulder, wrist even finger joint. Okutsu used arthroscopy first time for the carpal tunnel release in 1989 and now became one of the standard choices worldwide.[29] Wrist arthroscopy is now widely indicated for diagnosis and treatment of acute or chronic wrist pain, especially for triangular fibrocartilage complex (TFCC) lesions, as a gold standard and distal radius fracture, carpal instability, and even to the carpometacarpal arthroplasty.

Study for Kienbock's disease has long history in Japan. Although Tajima reported ulnar variance does not affect the incidence of Kienbock's disease as early as 1966,[30] he presented his good results of wedge osteotomy for Kienbock's disease with ulnar minus in 1977.[31] After this, many different leveling surgeries for Kienbock's disease in different stage have developed.[32] Horii et al force transmission effect across the carpus using two-dimensional articulating force analysis (rigid body spring model) in procedures used to treat Kienbock's disease.[32] They concluded radial shortening or ulnar lengthening significantly unload the lunate and are rationale procedures in the treatment of Kienbock's disease. Nakamura and Moritomo investigated anatomical and pathological details of TFCC injury and demonstrated their surgical procedures (►**Fig. 4B**).[33-36]

Rheumatoid Hand and Implant Arthroplasty

Introduction of surgery for rheumatoid hand was relatively early in Japan compared with other Asian countries, simply because there were several rheumatoid centers where joint surgeries in large joint are already established. During early phase of JSSH, there were not many topics for the congress and surgeries for rheumatoid hand were often chosen for symposium or main topic. Invited speakers, Kauko Vaino from Finland, and Swanson and Linscheid from the United States influenced JSSH member with great attention. Y. Yamauchi (Juntendo University) and R. Ogawa (Kansai Medical University), both recognize as so-called second generations of hand surgeons, energetically operated rheumatoid hand in 1970s; however, they concluded results of the surgery for rheumatoid hand were not as good as expected and advised surgical intervention should be abolished. After 20 years of vacancy, a group of hand and rheumatoid surgeons, Minamikawa, Masada, Mizuseki, Ishikawa, Ryu, Minami, and Beppu funded "Rheumatoid Hand Surgical Society," in 1999, completely separated from JSSH and annual meeting has continued as the evening seminar of Japanese College of

Rheumatology until now. They also organized International Symposium of Rheumatoid Hand Surgery in Tokyo (2013) and Osaka (2018) to discuss this difficult knowledge (field) which relatively limited access to Asian doctors. Although many types of finger implant had developed, very few are published in English[37,38] and not popularized. Cementless surface implant invented by Minamikawa has over 20 years' clinical experience and has been delivered in part of Asian countries, China, Hong Kong, and Singapore[39,40] (►**Fig. 4C**).

Health Insurance Systems in Japan

Nearly all Japanese residence are covered either Social Health Insurance (SHI) or National Health Insurance (NHI). Full-time employees are usually enrolled in SHI through their employers. The family of the covered employer can join as dependents. NHI is mainly aimed at students, freelance workers, self-employed, and after retirement until covered by pension plan. Half of the price of the SHI premiums is responsible for employer. Monthly premium is depend on income but are about 100 USD to 750 USD (divided 50 levels). NHI payment also controlled about the same amount. Patients are required to pay 10 to 30% (depend on house hold, dependent, or age) of the total cost of care including dental, the high medical costs of surgery, and hospitalization, birth allowances. Maximum payment out of the pocket from the patient is also setting depending on incomes at ~200 USD to 2,000 USD. Health insurance system is equally beneficial to every patient residing in Japan, including foreigners staying more than 3 months with local address are eligible for NHI. Since the government is responsible for the systems, budget for social benefits has been increasing parallel to increasing silver residents. To suppress this, the cost of any medical procedure including surgery, hospital fees are determined by the government in every detail and are equally paid through health insurance regardless of physicians' qualification. On the other hand, patients are essentially free to receive care from the facility of their choosing. According to guidelines, a referral letter is required to be seen at a large hospital; however, as is often the case, patients pay a fee of a few thousand yen (25 USD) to be able to be seen without a referral. Physicians, as well, have the freedom to open medical practices. Furthermore, a physician who has a license to practice medicine can open a specialty medical practice in any medical specialty regardless of whether or not the physician holds a license in that area of medicine.

Systems of Hand Specialist in Japan

The system of hand specialist (board certified hand surgeon) in Japan was started in 2007. Candidate of the hand specialist required either board certified orthopaedic surgery or plastic surgery, both need 6 years resident period. Furthermore, 5 years' experience of hand surgery including minimum of 3 years hand fellow at qualified hand institute before board examination. Additional requirement to take board examination may make it difficult to become hand specialist. At 2020, numbers of hand specialist are 1,023 that is less than one-third of 3,400 JSSH members. According to the website of ASSH, there are ~3,000 hand specialists out of 4,300 ASSH members. Modern medicine and educational systems in Japan had been introduced from Western countries (especially Germany and the United States). Specialty board in each medical field had been built mainly by scientific societies (internal medicine, general surgery, orthopaedic surgery, etc.). According to rapid progress, each main society needed adding subspecialty fields. Unfortunately, reality of the systems is still under progress, taking specialist required time and long effort without financial benefit. Many specialists give up to maintain their specialty. In 2018, Japanese government finally organized official organization for Japanese Medical Specialty Board to control previously existed board systems and build newer systems, expecting to overcome the discrepancy of ideal systems for both patients and physicians and the reality.

Conflict of Interest
None declared.

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