

Hand surgery without tourniquet as a model for the development of surgical service innovation for competitive advantage-based service readiness

Theddeus Octavianus Hari Prasetyono



In various parts of our bodies, like other organs, the hand requires special attention when experiencing functional disturbances, without neglecting the importance of aesthetic considerations. Hand trauma not only disrupt its primary functions but also impedes the social interactions of those affected. Epidemiological records from the Basic Health Research (*Riskesmas*) survey in 2018 indicated that hand trauma constitutes 32.7% of total trauma cases, encompassing various injuries such as lacerations, tendon ruptures, fractures, dislocations, nerve injuries, finger injuries, and amputations.¹ This incidence is comparable to that in several other countries, such as the United States, where the incidence of hand trauma is recorded at 182 per 10,000 people.^{2,3}

Despite being a subset of trauma, burn injuries deserve special attention in the medical field and are recognized as the most devastating and debilitating injury.⁴ The hand is estimated to be involved in burn injuries when an individual experiences extensive burns, covering at least 25–60% of the total body surface area. In the management of patients with extensive burn injuries, the healing of the hand is often accompanied by functional impairments and significant disabilities, greatly reducing the patient's performance in physical and social activities. On average, patients with hand burn injuries require 12 months to return to their original occupation, and some may even need job adjustments or face job loss.⁵

In addition to trauma, medical issues related to the hand include tumors, both benign and malignant, affecting various tissues such as skin, fat, blood vessels, lymphatics, nerves, bones, and synovial tissue. Benign lesions represent 99% of all hand tumors, with 98% being soft tissue tumors.^{6,7} Ganglion cysts, which are cystic lesions containing mucinous gel formed

by the synovial layer of joints or tendon sheaths, are commonly associated with joints such as the scapholunate or radiocarpal.⁷ While ganglion cysts generally do not cause pain, patients may experience discomfort due to compression or pressure on specific nerves. Patients with bothersome ganglion cysts often require operative therapy despite the high recurrence rate.⁷ Although surgery for ganglion cysts takes a relatively short time, surgery is commonly performed under general or regional anesthesia, through brachial or Bier block techniques.⁸ In fact, the tourniquet, used to ensure a clear and clean operative field, necessitates general or block anesthesia to prevent patient discomfort resulting from ischemia during the surgery.

The conditions of ischemia and reperfusion create an opportunity to question whether ganglion surgery can be performed without the complexities of preoperative preparations, as the operation must be conducted in the operating room under general or regional anesthesia. The complexity of ganglion surgery, involving the possibility of surgeons dealing with efforts to trace the ganglion capsule to its base, reaching the scapholunate ligament by exposing extensor tendons, is undeniable. Typically, ganglion cysts are situated between the extensor pollicis longus and extensor digitorum communis tendons. In cases of volar wrist ganglion, surgeons may require good dissection skills to avoid injuring the radial artery when maneuvering to reach the radiocarpal ligament. This raises the question of whether surgery can be performed without a tourniquet to avoid the challenges of operating in an environment that facilitates general or regional anesthesia. The possibility of achieving a clear and clean operative field without a tourniquet is also considered.

Hand surgery without tourniquet

Dr. Don Lalonde pioneered a technique for hand surgery without using a tourniquet. His research focused on the safety of injecting adrenaline or epinephrine into fingers and hands.⁹ A comprehensive literature review covering incidents of necrosis and gangrene post-local anesthesia injections from 1880 to 2000 revealed no cases caused by local anesthesia mixed with epinephrine.¹⁰ Instead, expired procaine was identified as a potential cause of finger death due to its high acidity. Clinical studies demonstrated the safety of using epinephrine, with concentrations ranging from 1:1,000 to 1:400,000, in hand surgeries without a tourniquet.^{11–19}

The technique, known as wide awake local anesthesia no tourniquet (WALANT), involves mixing epinephrine with a local anesthetic solution, typically lidocaine.²⁰ This allows surgeries to be performed with the patient fully awake. WALANT has been successfully applied to various hand surgeries, including carpal tunnel syndrome (CTS) and tendon repairs. The method eliminates extensive preoperative preparations, making it efficient and time-saving.

Moreover, the approach has been extended to address scar tissue management in burn injuries, particularly for children. By categorizing burn scars based on thickness and pliability, the use of the tumescent technique without a tourniquet has shown promising results in creating a clear, bleeding-free surgical field. Clinical studies initiated at Cipto Mangunkusumo Hospital, Jakarta, demonstrated advancements, with international research publications supporting the technique's efficacy.^{21–26}

The presentation also highlighted challenges faced in the global plastic surgery community regarding using epinephrine in certain surgeries, emphasizing the safety measures adopted in Jakarta, where awareness gained through experimental research contributed to clinical success.²⁷ The surgical innovation of hand surgery without a tourniquet has proven effective, offering advantages in safety, efficiency, and good and excellent patient experience across various hand surgeries.

Development of full awake hand surgery (FAHS)

The FAHS technique, essentially a form of WALANT, represents a unique approach to hand and extremity surgeries traditionally performed under general or regional anesthesia. FAHS, illustrated through clinical

cases like ganglion cyst removal, utilizes tumescent fluid injection similar to tourniquet-free surgeries under general anesthesia. This technique addresses the challenge of administering large volumes of local anesthetic focusing minimizing pain during injection while providing a clear operative field.

For surgeons unfamiliar with tumescent techniques, the substantial injection volume of ≥ 50 ml for surgeries like CTS may sound unusual. Tumescent involves injecting a substantial amount of local anesthetic into the potential incision and dissection areas, causing local tissues to swell. This injection technique also requires an optimal waiting period for the vasoconstrictive effect of epinephrine to take effect.²³

FAHS revolutionizes hand and extremity surgeries by providing a pain-free approach with minimal bleeding during surgery. Clinical transformations have been observed in complex procedures, such as the repair of multiple tendon lacerations resulting from sharp trauma, known as “spaghetti wrist”.^{28,29} The technique has enabled successful microsurgical procedures, including replantation of amputated fingers, under conscious conditions.³⁰

Furthermore, FAHS has expanded to elective microsurgical procedures involving two anatomical regions, such as donor and recipient sites. Examples include the reconstruction of finger defects using free flaps taken from the toe and dorsum of the foot. The innovation of FAHS has transformed the landscape of hand surgery, offering efficiencies while ensuring patient safety and quality of life.

A surgeon at Cipto Mangunkusumo Hospital, who is affiliated to the Faculty of Medicine, Universitas Indonesia, also introduced a tumescent mode with a one-per-mil solution, featuring epinephrine concentration at 1:1,000,000 and lidocaine at 0.2%. The safety and efficacy of this super low concentration of epinephrine solution have been demonstrated, challenging the myth of its prohibition in end arterial organs. The dosage of epinephrine is notably lower than that used for treating anaphylactic shock, emphasizing the safety of FAHS.³¹

Advanced development of surgery with tumescent technique

Advanced utilization of the one-per-mil tumescent solution containing the active vasoconstrictor at its lowest concentration reported in the literature for open surgeries can be applied to various operations

in different body areas. A significant example of the benefits of creating a relatively clean operating field is the excision-reduction surgery for neurofibromas in the face and extremities. Literature data, along with past clinical experiences, some still ongoing in our plastic surgery unit, highlight the massive bleeding requiring blood transfusion.³² Reduction and the potential ability to eliminate the need for transfusion are advantages that deserve positive attention, although, on the flip side, the tumescent technique requires patience for injecting and safely introducing a large amount of solution and waiting for 7–10 min before starting the operation.

The tourniquet-free technique with the one-per-mil solution can also be applied to vascular malformation surgeries with a slow-flow or lymphatic and venous component besides capillaries.²³ Although vascular anomalies are rich in vascularization in the head and neck and hand regions, the potential vasoconstriction and hydrostatic pressure generated through the tumescent injection technique can demonstrate its effectiveness and provide a clear operating field. For conditions of arterial flow vascular malformation (arteriovenous malformation [AVM]), the tumescent solution has not yet been used as the mainstay. Surgery still relies on preoperative embolization assistance. However, its potential remains open for exploration in further clinical studies in the future, given that, so far, there have been no reports in scientific publications. Although currently based on a single case due to limited case opportunities, we have performed below-elbow amputation to address intractable AVM problems that affect the entire hand. The amputation surgery can be carried out with an operating field almost comparable to standard work with tourniquet assistance.

The one-per-mil tumescent solution has subsequently been used for practically all surgeries throughout the body. A clear operating field can be facilitated for slow-flow vascular malformation surgeries on the scalp up to the dissection of free perforator flaps, as explained earlier. Notably, the one-per-mil solution can be very well utilized for aesthetic surgeries. The one-per-mil solution is applied not only for eyelid surgeries but also to facelift surgeries, breast augmentation, gynecomastia, and others. The injected solution volume can be extensive, considering the high safety level provided by its active drug concentration.

Development of services with a competitive advantage

FAHS plays an integral role in the evolution of medical services by focusing on customer satisfaction, serving as a transformative approach. FAHS, by avoiding sedative and opioid drugs, not only minimize side effects but also reduces operational costs by eliminating the need for a main operating room.²⁹ This method allows for converting various surgeries into 1-day care procedures, eliminating the necessity for full sterility and facilitating field sterility.³³ Patients undergoing FAHS experience streamlined preoperative processes, avoiding extensive screenings and preparation examinations. The method proves safe for patients with comorbid conditions, emphasizing the safety of minimal sedation or no sedation at all. FAHS eliminates the need for fasting and the discontinuation of blood thinners, offering potential advantages in terms of patient convenience and safety.²³

The adoption of FAHS is anticipated to significantly reduce patients' hospital or clinic stays, eliminating the need for post-anesthesia recovery. This outpatient approach allows for fulfilling patients' FAHS-mode surgery needs on the same day after consultation, offering particular benefits to those traveling from out of town or abroad for medical tourism. The flexibility of FAHS extends to the management of hand trauma, enabling procedures like tendon rupture or phalanx and metacarpal fractures during regular working hours, eliminating the requirement for night-time interventions. However, successful implementation requires public education to prevent misunderstanding the emergency concept, ensuring that doctors are not perceived as compromising their altruistic nature by being unprepared for emergencies. The text projects that most hand surgeries in the next 1–2 decades will be conducted using the FAHS mode, emphasizing the transformative shift from traditional anesthesia methods, and urging surgeons to adapt to this evolving approach.

This review focuses on achieving a competitive advantage in the medical and health services sector through service transformation, adopting Michael Porter's Diamond Model.³⁴ This model comprises four key components—Firm strategy, structure, and rivalry; Factor conditions; Demand conditions; and Related and supporting industry—that mutually influence each other, alongside two crucial elements, Government and Chance. Collaboration among stakeholders is emphasized for effectively

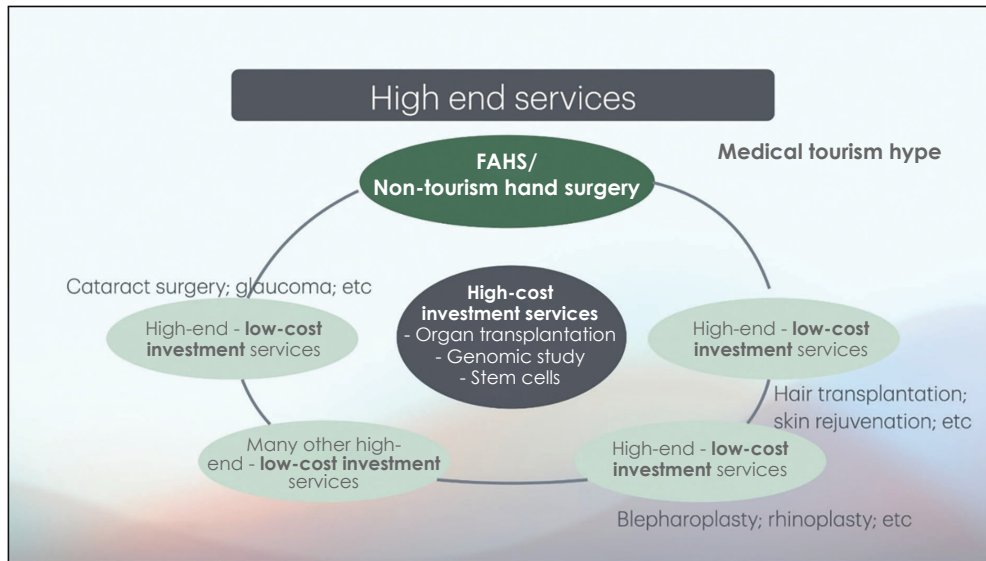


Figure 1. Equivalent standpoint of high- and low-cost investment-based medical services in the promotional point of view. FAHS=full awake hand surgery; MCU=medical check up

leveraging these components. The same model, adaptable with a positive mindset, can extend to the health service industry, specifically in the context of doctorpreneurship, positioning doctors as ethical service providers and entrepreneurs. The author advocates for directing superior value not only to customers but to all stakeholders, including the government.³⁵ The government's pivotal role in facilitating superior health services is highlighted through collaborative initiatives with various ministries, especially the Ministry of Health and the Ministry of Tourism and Creative Economy. The cost-effective and convenient approach of hand surgery centers using FAHS mode aligns with the competitiveness concept, with the author emphasizing a philosophical equivalence between low-cost and high-cost investment-based services (Figure 1). This underscores the potential for cost-effective services to advocate for competitive and high-end services based on their superior value and satisfaction.

FAHS services align with the evolution of aesthetic plastic surgery, drawing inspiration from successful models in South Korea, Singapore, Thailand, and Malaysia. The focus is on the top five aesthetic procedures, including liposuction and breast augmentation, which, despite requiring minimal investment, serve as competitive benchmarks.³⁶ South Korea's journey to international prominence underscores the significance of domestic success and research in setting trends. Utilizing Porter's

Diamond Model, competent human resources and robust educational centers are identified as vital factors in achieving competitiveness. Despite ongoing debates, there is optimism regarding the positive response to the government's initiative to revamp specialist doctor training in 2023.³⁷ The text emphasizes the need for healthy competition and cooperation among domestic health service providers, fostering a cooperation (cooperation and competition) attitude.³⁸ Addressing challenges like academic envy, the author advocates for a wise attitude by being authentic and not pretentious; and for creative development to prevent hindrances to collective progress. However, equal cooperation among interprofessionals in the field is highlighted, recognizing the distinction between formally trained professionals and those without formal education (dilettante or tinkerer) in healthcare as foundational to healthcare advancements.³⁹

In Indonesia, dental services in Bali have successfully embodied cooperation, representing a harmonious combination of healthy competition and cooperation.^{40,41} These dental services have not only garnered trust among domestic patients but have also emerged as a positive factor in medical tourism, drawing international patients. Demonstrating the ability to establish trust within their domestic audience before venturing internationally, the author advocates for cooperation in education and participation in scientific forums as a means of mutual

support. Considering Porter's Diamond Model and the demand conditions component, patients are recognized as key stakeholders, underscoring the significance of cultivating positive perceptions and trust among domestic patients, akin to the benchmark set in Korea. The text emphasizes the importance of delivering excellent FAHS procedures facilitated by communicative doctors to ensure comfort and high satisfaction levels. It addresses challenges faced by the Indonesian medical community, including perceptions of doctor arrogance, and stresses the need for positive responses. Establishing trust among domestic patients is viewed as a precursor to gaining international trust, particularly with government initiatives to attract foreign players in the health industry. This shows the robustness of clinical services demonstrated through research presented at international conferences and underscores the importance of meeting the five dimensions of public services, encompassing responsiveness, reliability, psychological trust, empathetic service, and physical evidence.⁴²

Acknowledgment

The author thanked dr. Taufiq Akmal Sungkar who provided great assistance with the manuscript preparation along with his excellent English editing.

Part of this paper was presented at Professor Theddeus Octavianus Hari Prasetyono's inauguration, October 7, 2023, Jakarta.

From Medical Journal of Indonesia; Department of Surgery, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia; Indonesian Clinical Training and Education Center (ICTEC), Cipto Mangunkusumo Hospital, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia
pISSN: 0853-1773 • eISSN: 2252-8083
<https://doi.org/10.13181/mji.com.247399>

Med J Indones. 2024;33:3–8

Published online: March 04, 2024

Corresponding author:

Theddeus Octavianus Hari Prasetyono

E-mail: teddyohp@yahoo.com

REFERENCES

1. Ministry of Health of the Republic of Indonesia. [2018 *Riskesdas* national report]. Jakarta: Ministry of Health of the Republic of Indonesia; 2019. Indonesian.
2. Crowe CS, Massenburg BB, Morrison SD, Chang J, Friedrich JB, Abady GG, et al. Global trends of hand and wrist trauma: a systematic analysis of fracture and digit amputation using the Global Burden of Disease 2017 Study. *Inj Prev.* 2020;26(Suppl 1):i115–24.
3. Gordon AM, Malik AT, Goyal KS. Trends of hand injuries presenting to US emergency departments: a 10-year national analysis. *Am J Emerg Med.* 2021;50:466–71.
4. Wang Y, Beekman J, Hew J, Jackson S, Issler-Fisher AC, Parungao R, et al. Burn injury: challenges and advances in burn wound healing, infection, pain and scarring. *Adv Drug Deliv Rev.* 2018;123:3–17.
5. Hwang YF, Chen-Sea MJ, Chen CL. Factors related to return to work and job modification after a hand burn. *J Burn Care Res.* 2009;30(4):661–7.
6. Tang ZH, Rajaratnam V, Desai V. Incidence and anatomical distribution of hand tumours: a Singapore study. *Singapore Med J.* 2017;58(12):714–6.
7. AbuMoussa S, Roshan MP, Souza FF, Daley D, Rosenberg A, Pretell J, et al. Soft tissue masses of the hand: a review of clinical presentation and imaging features. *Curr Oncol.* 2023;30(2):2032–48.
8. Vaughn N, Rajan N, Darowish M. Intravenous regional anesthesia using a forearm tourniquet: a safe and effective technique for outpatient hand procedures. *Hand (N Y).* 2020;15(3):353–9.
9. Lalonde D. Wide awake local anaesthesia no tourniquet technique (WALANT). *BMC Proc.* 2015;9(Suppl 3):A81.
10. Fitzcharles-Bowe C, Denkler K, Lalonde D. Finger injection with high-dose (1:1,000) epinephrine: does it cause finger necrosis and should it be treated? *Hand (N Y).* 2007;2(1):5–11.
11. Chowdhry S, Seidenstricker L, Cooney DS, Hazani R, Wilhelmi BJ. Do not use epinephrine in digital blocks: myth or truth? Part II. A retrospective review of 1111 cases. *Plast Reconstr Surg.* 2010;126(6):2031–4.
12. Wilhelmi BJ, Blackwell SJ, Miller JH, Mancoll JS, Dardano T, Tran A, et al. Do not use epinephrine in digital blocks: myth or truth? *Plast Reconstr Surg.* 2001;107(2):393–7.
13. Lalonde D, Martin A. Epinephrine in local anesthesia in finger and hand surgery: the case for wide-awake anesthesia. *J Am Acad Orthop Surg.* 2013;21(8):443–7.
14. Lalonde D, Bell M, Benoit P, Sparkes G, Denkler K, Chang P. A multicenter prospective study of 3,110 consecutive cases of elective epinephrine use in the fingers and hand: the Dalhousie Project clinical phase. *J Hand Surg Am.* 2005;30(5):1061–7.
15. Farhangkhoei H, Lalonde J, Lalonde DH. Teaching medical students and residents how to inject local anesthesia almost painlessly. *Can J Plast Surg.* 2012;20(3):169–72.
16. Lalonde DH. Evidence-based medicine: carpal tunnel syndrome. *Plast Reconstr Surg.* 2014;133(5):1234–40.
17. Lalonde DH. Wide-awake flexor tendon repair. *Plast Reconstr Surg.* 2009;123(2):623–5.
18. Lalonde DH, Martin AL. Wide-awake flexor tendon repair and early tendon mobilization in zones 1 and 2. *Hand Clin.* 2013;29(2):207–13.
19. Lalonde DH. Reconstruction of the hand with wide awake surgery. *Clin Plast Surg.* 2011;38(4):761–9.
20. Al Youha S, Lalonde DH. Update/review: changing of use of local anesthesia in the hand. *Plast Reconstr Surg Glob Open.* 2014;2(5):e150.
21. Prasetyono TO. Tourniquet-free hand surgery using the one-per-mil tumescent technique. *Arch Plast Surg.* 2013;40(2):129–33.
22. Prasetyono TO, Koswara AF. Linear hand burn contracture release under local anesthesia without tourniquet. *Hand Surg.* 2015;20(3):484–7.
23. Seretis K, Boptsi A, Lykoudis EG. The efficacy of wide-awake local anesthesia no tourniquet (WALANT) in common plastic surgery operations performed on the upper limbs: a case-control study. *Life (Basel).* 2023;13(2):442.
24. Sardenberg T, Ribak S, Colenci R, Campos RB, Varanda D, Cortopassi AC. 488 hand surgeries with local anesthesia with epinephrine, without a tourniquet, without sedation, and without an anesthesiologist. *Rev Bras Ortop.* 2018;53(3):281–6.
25. Fouché TW, Bond SM, Vrouwe SQ. Comparing the efficiency of tumescent infiltration techniques in burn surgery. *J Burn Care Res.* 2022;43(3):525–9.
26. Shahid S, Saghir N, Saghir R, Young-Sing Q, Miranda BH. WALANT: a discussion of indications, impact, and educational

- requirements. *Arch Plast Surg*. 2022;49(4):531–7.
27. Prasetyono TO, Pribadi S. Systematic injection patterned-technique of one-per-mil tumescent solution for perforator-based skin flap: is it better than the random patterned-technique? *Int Surg*. 2015;100(9–10):1308–14.
 28. Zeng Q, Zou D, Hu YG, Yu BF. Is full-awake local anesthesia no-tourniquet hand surgery more suitable for major flexor tendon trauma? *Ann Plast Surg*. 2020;85(2):202.
 29. Meals CG, Chang J. Ten tips to simplify the spaghetti wrist. *Plast Reconstr Surg Glob Open*. 2018;6(12):e1971.
 30. Huang HF, Matschke J. Digit replantation under wide-awake local anesthesia. *Plast Reconstr Surg*. 2022;149(1):143–9.
 31. Klein JA. Anesthetic formulation of tumescent solutions. *Dermatol Clin*. 1999;17(4):751–9, v–vi.
 32. Thomas AB, Shammam RL, Orr J, Truong T, Kuchibhatla M, Sergesketter AR, et al. An assessment of bleeding complications necessitating blood transfusion across inpatient plastic surgery procedures: a nationwide analysis using the national surgical quality improvement program database. *Plast Reconstr Surg*. 2019;143(5):1109e–17e.
 33. Lalonde DH. Conceptual origins, current practice, and views of wide awake hand surgery. *J Hand Surg Eur Vol*. 2017;42(9):886–95.
 34. Porter ME. *The competitive advantage: creating and sustaining superior performance*. New York: Free Press; 1985.
 35. Sigalas C. Competitive advantage: the known unknown concept. *Manag Decis*. 2015;53(9):2004–16.
 36. International Society of Aesthetic Plastic Surgery (ISAPS). Global survey 2022: ISAPS international survey on aesthetic/cosmetic procedures performed in 2022 [Internet]. International Society of Aesthetic Plastic Surgery (ISAPS); 2022 [cited 2023 Oct 6]. Available from: https://www.isaps.org/media/aoqfm4h3/isaps-global-survey_2022.pdf.
 37. Lecture of the President of KSPRS in the 15th Japan-Korea Congress of Plastic Reconstructive Surgery, Fukuoka, Japan. May 29–31, 2023. Personal Communication.
 38. Heidhues P, Kőszegi B, Murooka T. Inferior products and profitable deception*. *Rev Econ Stud*. 2017;84(1):323–56.
 39. Maijala H, Munnukka T, Nikkonen M. Feeling of ‘lacking’ as the core of envy: a conceptual analysis of envy. *J Adv Nurs*. 2000;31(6):1342–50.
 40. Akbar FH, Krishnan V, Yusoh MP. Dental tourism in Bali Province, Indonesia. *Neuroquantology*. 2022;20(1):340–7.
 41. Prithari GA, Setiawan I, Kuswoyo C. [The effect of service quality on expatriate patients’ satisfaction at Bali International Dental Center]. *Padjadjaran J Dent Res Student*. 2018;2(2):80–6. Indonesian.
 42. Clerkin RM, Cogburn JD. The dimensions of public service motivation and sector work preferences. *Rev Public Pers Adm*. 2012;32(2):209–35.