Plastic Surgery Innovation through War, Disaster, and Pandemic

The coronavirus disease of 2019 (COVID-19) pandemic has impacted the practice of medicine. Historically, the field of plastic surgery has been influenced by catastrophic events. Modern warfare in World War I resulted in mass casualties and survivors with deformities. Plastic surgery arose as a distinct specialty to restore deformed soldiers in World War I. In 1917, he developed his tubed pedicle flap, which provided the ability to close difficult wounds with poor local options. Berkman inserted wires laterally through meta-carpals, allowing patients to have enough extension and flexion to carry out minor duties the next day. Ralph Millard, whose cleft repair is still widely performed, was also shaped by his experiences in the Korean conflict. War is not the only disaster to influence changes in our practice. More recently, terrorist attacks have led to new ways of organizing surgical staff during mass casualties.

Eighteen articles met inclusion criteria (Table 1). Eleven papers described innovations during war, including percutaneous fixation of hand fractures with use of Kirschner wires, delayed wound closure, cleft lip repair, vascular repair of traumatic injuries, mafenide acetate dressing, and portable negative-pressure wound therapy. Two publications described surgical staff collaboration modeling and recruitment from terrorist attacks. Our results show war was a significant contributor during the first half of the twentieth century; however, the last few decades show a shift toward other disaster types.

Sir Harold Gillies became a dedicated reconstructive surgeon to restore deformed soldiers in World War I. In 1917, he developed his tubed pedicle flap, which provided the ability to close difficult wounds with poor local options. Berkman inserted wires laterally through metacarpals, allowing patients to have enough extension and flexion to carry out minor duties the next day. Ralph Millard, whose cleft repair is still widely performed, was also shaped by his experiences in the Korean conflict. War is not the only disaster to influence changes in our practice. More recently, terrorist attacks have led to new ways of organizing surgical staff during mass casualties.

The modern field of plastic surgery originated from the global catastrophic events of World War I and continues to progress from innovations devised during disasters. Our study has highlighted advancements that have arisen from tragedy. We found war has been the greatest motivator of ingenuity. Terrorism and natural disasters have emerged as events leading to innovation during the last few decades. The current COVID-19 pandemic may alter practice as well. An electroceutical fabric dressing designed for chronic wounds was adapted as a face mask effective at eliminating COVID-19. The widespread use of telemedicine from COVID-19 will expand the reach of plastic surgical evaluation to smaller communities. Plastic surgery procedures that may have resulted in a short admission may become outpatient on a more universal level as a result of attempts to limit hospitalizations during COVID-19. Our field must do what it has always done: use a major crisis to spark innovation to improve the care of patients.

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Table 1. Articles Documenting Origination of Plastic Surgery Ideas during a Disaster

| Innovation                                                                 | Disaster               | Date of Disaster |
|---------------------------------------------------------------------------|------------------------|------------------|
| Tubed pedicle skin flap graft (Gillies, 1932; PMID: 20777210)             | WWI                    | 1914–1918        |
| Techniques for gender affirmation surgery (Gillies H, Millard DR. The Principles and Art of Plastic Surgery, Volume 2. Boston: Little, Brown; 1957) | WWII                   | 1939–1945        |
| Delayed wound closure in compound hand fractures (Cleveland and Grove, 1945; ISSN: 0375-9229) | WWII                   | 1939–1945        |
| Internal fixation of metacarpals with k-wire (Berkman and Miles, 1943; ISSN: 0375-9229) | WWII                   | 1939–1945        |
| Hand surgery becomes distinct specialty (Carter, 2003; PMID: 12671847)     | Korean War             | 1950–1953        |
| Millard cleft lip repair (Baker, 2012; PMID: 22594134)                    | Korean War             | 1950–1953        |
| Vascular Repair of Acute Trauma in Upper Extremities (Jahnke and Seeley, 1953; PMID: 13066006) | Vietnam War            | 1955–1975        |
| K-wire bayonets (Brown, 1995; PMID: 7642952)                              | Vietnam War            | 1955–1975        |
| Sulfamylon (mafenide acetate) antibiotics for burns (Lindberg et al., 1965; PMID: 5318146) | Vietnam War            | 1955–1975        |
| Artery anastomosis debridement to grossly normal tissue (Whelan, 1975; PMID: 1101399) | Vietnam War            | 1955–1975        |
| Portable negative-pressure therapy (Couch and Stojadinovic, 2011; PMID: 21200282) | War in Afghanistan     | 2001–Present     |
| Collaboration model of surgical staff for mass casualties (Caterson et al., 2013; PMID: 23851738) | Boston Marathon bombing | 2013             |
| Social networking for rapid recruitment of surgical staff (Gregory et al., 2016; PMID: 27578051) | Paris, France, terrorist attack | 2015             |
| Leap motor control improves hand function in burn victims (Wu et al., 2019; PMID: 30522737) | Fun Coast dust explosion | 2015             |
| Cultured epithelial autograft in mass disaster (Matsumura et al., 2016; PMID: 2655956) | Fun Coast dust explosion | 2015             |
| Cultured epithelial autograft device for resource-poor areas (Serena et al., 2015; PMID: 25658645) | Haiti earthquake       | 2010             |
| Telemedicine as novel plastic surgery tool (Giunta et al., 2020; PMID: 32592587) | COVID-19               | 2019–Present     |

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DISCLOSURE

None of the authors has a financial interest to declare in relation to the content of this article.

REFERENCES

1. Battle R. Plastic surgery in the two world wars and in the years between. J R Soc Med. 1978;71:844–848.
2. Gillies HD. Plastic Surgery of the Face. London: The Joint Committee of Henry Frowde, Hodder and Stoughton; 1920. Available at: https://www.archive.org/details/plasticsurgeryofgilluoft/mode/2up. Accessed July 3, 2020.
3. Berkman EF, Miles GH. Internal fixation of metacarpal fractures exclusive of the thumb. J Bone Joint Surg. 1943;24:816–821.
4. Caterson EJ, Carty MJ, Weaver MJ, Holt EF. Boston bombings: A surgical view of lessons learned from combat casualty care and the applicability to Boston’s terrorist attack. J Craniofac Surg. 2013;24:1061–1067.
5. Sen A, Khona D, Ghatak S, et al. Electroceutical fabric lowers zeta potential and eradicates coronavirus infectivity upon contact. ChemRxiv. Preprint posted online May 15, 2020.