Chapter 1

Fuzopuncture: A New Therapeutic Approach to Treat Joint Disorders

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Abstract

Acupuncture has beneficial roles in the treatment of various musculoskeletal disorders and therefore is thought to be a potential therapy replacing generally accepted pharmacological intervention. Efforts to investigate the characteristic of acupuncture points have revealed that loci with dense neurovascular complexes coincided with the acupuncture points. Stimulation of acupuncture points seems to generate and transmit neural activation signals in a facilitative manner to modulate various disease symptoms. Fuzopuncture is a prominent acupuncture point injection technique used practically in Korea. Fuzopuncture utilizes specific acupuncture points localized on the joints, muscles acting in concert with the joints, and spinal regions innervating the joints. In this chapter, we describe Fuzopuncture theory and therapeutic use of Fuzopuncture in treating joint diseases. The pathophysiology of 10 joint diseases including the temporomandibular joint to ankle joint is extensively investigated.

Keywords: Fuzopuncture, Acupuncture point injection, Joint, Muscle, Paravertebral region.

1. What are Acupuncture Points?

History of acupuncture goes back for more than three thousand years in China. Over 3,000 years, 361 classical acupuncture points were employed for the treatment of various diseases based on the theories of Qi, the body's vital energy and meridians.

Based on the observation that some areas of body have abnormally higher or lower conductivity, Nakatani and Yamashita [1] suggested that a close relationship exists between meridian lines and cutaneous abnormal conductivity. There are some studies supporting that meridian lines are real anatomical structure in human. The unique thread-like structure of Bong-han ducts running along the traditional acupuncture meridians were reported in the main blood vessels and lymphatic ducts [2,3]. Perivascular space was demonstrated along the traditional roadmap of acupuncture meridians [4,5]. However, further evidence for this novel structure and its physiological function is needed.

The neural activation by acupuncture was investigated by using functional magnetic resonance imaging. With the stimulation of vision-related acupuncture points, visual cortices of the brain were found to be stimulated [6,7]. Post-stroke aphasia patients were more sensitive to stimulation of language-deficit-implicated acupuncture points than their counterpart control, implicating direct links between the acupuncture points and the cortices [8]. Studies by Liu et al. and Li et al. [9,10] reported that antidromic stimulation of C- fibers in the deep tibial nerve produced spots of the extravasation of Evan's blue dye from plasma into interstitial fluid. They showed that the C- fiber rich afferents of the deep tibial nerve coincided with acupuncture points, implying rich distribution of nerve fibers/ reflex complexes at acupuncture points [9,10]. Langevin et al. [11] reported that more force was required to remove a needle from an acupuncture point than from a control point. They further suggested that the connective tissues are more tightly arranged near acupuncture points than non-acupuncture points. Abraham et al. [12] also proved that the acupuncture points contained a significantly higher number of transient receptor potential vallinoid type 1- positive Aδ- and C-fibers as compared with non-acupuncture points.

At present, it is considered that acupuncture points are the specialized points where neurovascular complexes are densely distributed than non-acupuncture points. Stimulation of acupuncture points seems to trigger the activation of peripheral neural receptors beneath the acupuncture points and transmit the activation signal to the central nervous system, resulting in the modulation of various diseases.

2. Are Acupuncture Points Same as Trigger Points?

Trigger point therapy has been primarily used for the treatment of pain disorders, and gains its popularity in contemporary medical practice by Western physicians. Trigger points had been first characterized by Travell and Rizler in 1946 [13]. They were described as palpably reactive points when pressed and have similar distribution among different patients. Pain specialists have attempted to incorporate trigger points release into their practice by inserting needles both with and without injection of pharmacological substances [14]. The locations and use of these trigger points, as compared with those of acupuncture points for the treatment of pain were well documented. Melzack et al. [15] found that all of the 56 trigger points and acupuncture points were within the distance of 3 cm from each other and 40 (71%) of the trigger points had the same pain indications as acupuncture points. Based on these findings, they advocated that trigger points and acupuncture points may functionally associated with the same physiology though trigger points and acupuncture points were discovered independently and regarded as discrete points.

Conversely there is a report implicating that trigger points and acupuncture points are independent. Through the extensive literature studies, Birch [16,17] has led to a conclusion that trigger points better agree with the another class of acupuncture points, a-shi points with defining characteristics of pressure pain but no fixed anatomical locations. Dorsher and Fleckenstein [18] have used a graphic software to evaluate the anatomical relationship between the locations of classical acupuncture points and trigger points. They superimposed the locations of 255 common trigger points described in the Trigger Point Manual onto the layers of 361 channel acupuncture points, and found 238 (93.3%) trigger points contain anatomically corresponding classical acupuncture points [19-21]. They also revealed that the earlier study by Birch [16] failed to report marked clinical correspondences of common trigger points and classical acupuncture points in both somatovisceral and pain disorders. Moreover, the a-shi points frequently coincide with classical acupuncture points primarily in the treatment of pain conditions [18,22].

In Western countries, dry needling is typically used to manage a variety of neuroskeletal pain syndromes [23-25]. The long list of target structure of dry needling includes muscular trigger points, ligaments, scar tissues, tendons, bones, and teno-osseus insertion sites [26]. A high density of neurovascular structures has also been found at the target sites of dry needling [27]. Recent literatures display dry needling encompasses stimulation of neural, muscular, and connective tissues, in addition to trigger points only [28-33]. Since acupuncture is most commonly used to describe dry needling [34-36], it seems that the classical channel acupuncture points provide a good therapeutic tool to treat muscles, ligaments, tendons, subcutaneous fascia, peripheral nerves, and neurovascular bundles.

3. Does Acupuncture Induce Regeneration?

Tissue injury initiates a complex repair process, a process that can lead to a complete regeneration of the tissues in some organisms. The regeneration and repair are both orchestrated by a highly coordinated interplay of different growth factors and cytokines. The repair process generally comprises three phases including inflammatory, proliferative, and remodeling. After injury, cells in the immune system, neutrophils and macrophages in particular, rapidly invade the site of injury. There is good evidence that injured muscle actively attracts neutrophils and macrophages by the production of several chemo-attractants [37]. Depletion of macrophages by irradiation impairs muscle regeneration by transplanted myogenic cells, and conditioned media from macrophage cultures increases the rate of proliferation of muscle progenitor cells in vitro [38-40].

Various growth factors present at the site of injured tissues exert overlapping biological functions. Many platelet-derived growth factors have been identified to be up-regulated during zebrafish heart regeneration [41]. Hepatocyte growth factor (HGF) is a potent mitogen for primed hepatocytes, and the analysis of mice lacking the HGF receptor c-met confirms that HGF signaling is required for the liver regeneration [42]. Epithelial growth factor and transforming growth factor also induce proliferation of hepatocytes in vitro and in vivo [43,44]. Fibroblast growth factors (FGFs) stimulate cultured muscle progenitor cells [45]. FGF6 knock-out mice showed the reduction of satellite cell activation after injury and impaired regeneration [45,46]. Nevertheless, FGFs appear to be universal regulator of regeneration, despite of the different cellular mechanisms for the regeneration of different systems or different cell types. FGFs were initially discovered for their ability to induce fibroblast proliferation. The role of FGF signaling in promoting proliferation in cells and tissues beyond fibroblasts has been consolidated by data from embryogenesis, tissue regeneration, and cancer [47,48]. FGF signaling has been shown to function through the mitogen-activated protein kinase pathway to regulate a variety of cellular processes that also include epithelial to mesenchymal transition and cell migration [49]. FGFs additionally influence the expression of other factors involved in the regenerative response.

Experimental results have revealed the positive roles of acupuncture on injury-induced regeneration. Electro-acupuncture was shown to promote the differentiation of endogenous oligodendrocyte precursor cells into oligodendrocytes in the demyelinated spinal cord in rats [50]. In a rat tendon healing model, mechanical stimuli by acupuncture stimulation at the juxtaposition to tenotomised locus appeared to transduce mechanical stimulation to biological changes [51]. The mechanical stimulation by acupuncture has also proposed to lead to an increase in small leucine-rich proteoglycan synthesis by fibroblasts close to the injury sites [52]. Clinical application of electro-acupuncture increased total cell counts, transforming growth factor-β1 and basic FGF positive cell counts, and the mechanical strength of repaired tendon than the control groups received no treatment [53].

There are reports indicating that needling may induce injuries and promote regenerative processes. Baris et al. [54] asserted that the micro-needling with roller device increases the viability of random skin flaps in rats. The percentage of flap necrosis in the skin treated with micro-needling was lower than the control group. The amount of neovascularization and the number of vascular structures within the papillary dermal layer treated with micro-needling was also significantly increased [54]. According to the case series of prolotherapy in which the injection of proliferant solution triggers the body's wound healing cascade, intra-articular injection of dextrose solution to zygapophyseal joints improved the chronic whiplash related neck pain [55]. Maxwell et al. [56] also reported that the subjects received ultrasound-guided dextrose prolotherapy showed a reduction of pain by 80-90% during light activity and sports after 6 week treatment.

Besides, acupuncture per se can make injuries in the course of passing of needles through the external surface to the internal target sites. Acupuncture involves the insertion and manipulation of thin needles in the skin and subsequent tissues at acupuncture points. There existed a dense distribution of connective tissues and neurovascular complexes underneath acupuncture points. Degrees of injuries might depend on the thickness of needle, depth of needle penetration, and intensity of manual or electrical stimulation of needle. We use a quite inclusive definition of regeneration or repair as a process that allows an organism to gain the function of an organ or structure damaged by injuries or disease. As a needle of acupuncture penetrates from the skin to target sites such as tendons, ligaments, muscles, teno-osseus insertion sites, and capsular membranes of joints, layers of connective tissues are injured and thus trigger regenerative events; i) a local immune activation is induced at the site of needle penetration, ii) plural growth factors conduct concerted regenerative duties in healing the damaged tissues, and iii) the injured tissues recover their normal functions.

4. What is Fuzopuncture?

As acupuncture is increasingly used for the treatment of pain and other conditions [57,58], manipulation of acupuncture needle attracts much concern among medical experts. Manual needle manipulation or electrical stimulation after needle insertion has been commonly used to strengthen the effects of acupuncture [59,60]. Studies have shown that manual acupuncture (back-and-forth motion or up-and-down motion) or electrical stimulation in specific frequencies applied to acupuncture points can facilitate the release of specific neuropeptides in the central nervous system, eliciting profound physiological effects and even activating self-healing mechanisms [61-63]. Although manual acupuncture or electro-acupuncture appears to be as effective as non-steroidal anti-inflammatory drugs and opioid analgesics for postoperative pain control or inflammatory pathogenesis reversal [64,65], maintenance of needles might be cumbersome, particularly in agitated animals. In recent years, the injection of pharmacological medication or purified herbal medicine to acupuncture points is widely used to enhance and prolong the effects of stimulation of acupuncture points [66,67]. It is a new acupuncture therapy that combines acupuncture and medication [68]. This technique is much similar to wet needling except that the locus for injection of medication is confined to acupuncture points. In contrast to dry needling, wet needling refers to local injection therapy, and uses hollow-bore needles to deliver corticosteroids, anesthetics, or other medication [69,70].

The fusion of medication (Fuzo) and acupuncture (puncture) coined the word Fuzopuncture. Fuzopuncture is one of most prominent acupuncture point injection (API) techniques which combine acupuncture and medication in Korea [71,72]. Fuzopuncture utilizes the injection of medication to specific acupuncture points which have advantages for modulation of joint functions. The acupuncture points used in Fuzopuncture are located on the articular cavity, muscles responsible for the articular movement, and spinal segments innervating the articular cavity. In the case of frozen shoulder syndrome, clinically known as adhesive capsulitis, patients with frozen shoulder exhibit significant deficits in shoulder kinematics, including increased elevation and upward scapular rotation due to lack of capsular extensibility [73,74]. Corticoid injection to the shoulder joint is generally considered as a therapeutic intervention to improve joint mobility and relieve pain [75]. Intra-articular injection of medication is widely applied to reduce joint pain and increase joint mobility in knee osteoarthritis [76,77]. Therefore, injection of medication into the acupuncture points localized on the joint cavity seems to have therapeutic advantages to attain the alleviation of pain and facilitation of mobility.

Shoulder complex muscle imbalances often lead to an altered shoulder motion. In adhesive capsulitis, the upper trapezius tends to be more activated than the lower trapezius, and cause an imbalance of scapular stabilizers which is known to cause restrictions in the range of motion [78]. Engaging the proper shoulder kinetic chain is accomplished by trigger points release with injection of pharmacological substances to dynamic motor muscles. Local injection therapy to myofascial trigger points is also reported to be an effective therapy with chronic radiculopathy derived pain symptoms [79,80]. As a needle penetrates trigger points of the muscles responsible for the movement of the joints, muscular knots become untangled and, thus, joint mobility smoothly progresses. A correlation between the progression of knee osteoarthritis (OA) and lumbar spine OA was proposed in a family study [81]. This correlation was supported by the higher prevalence of lumbar spine degeneration in patients with generalized OA at other sites [82]. Furthermore, the facet capsules and adjacent tissue are rich in nociceptive receptors, which causes pain when the capsules are irritated by mechanical stimulation or inflammation [83,84]. Manipulation of the acupuncture points located on paraspinal muscles whose contraction blocks off the passage of spinal nerve to their assigned joints is necessary to resume a functional joint activity.

In this study, we propose that injecting medications into three types of acupuncture points employed in Fuzopuncture technique offers a potential therapeutic tool to improve joint functions.

5. What Should be Considered in Fuzopuncture?

Acupuncture point injection (API) utilizes aqueous herbal extracts, herbal distillate, vitamins, bee venom, normal saline solution, placental extracts, and Western medication [85-88]. Results from recent studies revealed that effects of API were ranged from anti-nociception, anti-inflammation, immune regulation to nourishment [87-89].

API has two advantages; acupuncture stimulation per se and pharmacological effect of chemical agent injected. According to Wang et al. [90], the effect of API with carbamyl-β-methylcholine chloride (CMCC) was stronger than that of intramuscular injection and longer-lasting than that of intravenous injection, which correlated with the blood concentration of CMCC. [90]. A faster onset of action and a comparatively stronger effect of API as compared with intramuscular injection might reflect the dense distribution of neurovascular complexes in acupuncture points.

Chen et al. [91] reported that injections of bee venom, normal saline, and vitamins B1 and B12 into acupuncture point ST36 activated neuronal signaling than a dry needling does. They suggested that both the spatial configuration changes and liquid substrate stimulate the acupuncture point and activate neuronal signal transmission system. Moreover, Chao et al. [92] demonstrated that the plasma concentrations of injected drug were significantly affected after API. Mechanisms for the therapeutic effects of API have been focused in animal experiments. The action of API, at least animal studies, implies that both volume effect and chemical stimulation of the injected substrates stimulate the acupuncture points and evoke more profound neurovascular effects than acupuncture alone.

In respect to needling method of acupuncture, there are two methods; one is superficial needling to a depth of 2 mm and the other is deep needling to a depth of 20 mm or more. Several studies have compared the therapeutic effects of superficial and deep dry needling [93,94]. Ceccherelli et al. [95] suggested that muscular afferents are more important for the transmission of acupuncture analgesic signals than the skin afferents. Because the blockade of nervous afferent fibers from the skin does not eliminate the acupuncture analgesia whereas the anesthetic blockade in deep tissue eliminates acupuncture analgesia [94], the deep needling is known to be more effective than the superficial one for the treatment of trigger point-associated pain [96]. Moreover, needle stimulation into the anterior tibial muscle in healthy subjects increases both skin and muscle blood flow as compared with superficial insertion [97].

It is necessary to consider the types of pain that patients suffer. Is the pain of a nociceptive, neuropathic, or nerve root compression type? If the pain is persistent dull aching quality, it is a primary somatogenic tissue damage-evoked trigger point nociceptive pain and hence can be relieved by superficial injection. For a burning or electrical shock-like pain, which is neuropathic or nerve root compression pain, clinical results show that deep stimulation has a better analgesic effect when compared with superficial stimulation [95]. Because trigger points are supposed to be the site where nociceptors such as the polymodal-type receptors have been sensitized by various factors [94], the drug injection to trigger points localized in muscle may produce greater activation of sensitized polymodal-type receptors, resulting in stronger effects in pain relief.

Fuzopuncture employs the same principle as API with the choice of specific acupuncture points. Medication is injected into the acupuncture points localized on the joints, muscles responsible for the movement of the joints, and paravertebral segments responsible for the innervation of the joints in Fuzopuncture. As needles pass through the skin down to the muscle, the polymodal receptors distributed in the skin, fascia, and muscle are altogether activated. Deep stimulation of acupuncture points, in Fuzopuncture, seems to elicit more profound effects during the course of disease control.

6. Methods

6.1. Temporomandibular Joints

The temporomandibular dysfunctions (TMD) is one of the most common conditions of chronic orofacial pain [96]. Patients with TMD are most sensitive in the chewing muscles, pre-auricular area, or in the temporomandibular joint [97]. It has been suggested that between 40% and 75% of the population presents at least one sign of TMD, such as the presence of joint sounds in temporomandibular joint (TMJ) and 33% have at least one symptom such as facial or TMJ pain [98]. TMD may be muscular and/or articular, but the literature has shown that the types of muscular origin are more prevalent [99]. Recent studies have reported a higher prevalence of TMD in women [100,101]. The etiology of TMD is multifactorial, originated by association between psychological, structural, and postural factors that unbalance the occlusion, masticatory muscles, and TMJ. Parafunctional habits, emotional tension, and stress also act as etiological factors related to alterations in TMJ [102].

As with any joint aspiration or injection procedure, sterile technique must be followed. The needle is inserted into the identified acupuncture points and proceeded in correct direction. Reduced resistance will be felt at the acupuncture points of entering the joint space. If aspiration precedes the injection, the needle is held with a hemostat while the syringe is changed. The acupuncture points for treating TMD are SI19, ST7, ST6, GB3, and TE16. Acupuncture points SI19 and ST7 are localized on peri-auricular region; SI19 **(Figure 1A)** is located in the depression between the anterior border of the center of the tragus and the posterior border of the condylar process of the mandible [103]. SI19 is easily accessible by tip of needle in the depression anterior to the center of the tragus with the mouth opened. ST7 **(Figure 1B)** is located in the depression between the midpoint of the inferior border of the zygomatic arch and the mandibular notch [103]. When the mouth is closed, ST7 is located at the depression inferior to the zygomatic arch. Through SI19 and ST7, sterile 16 mm-long 26 gauge needles are inserted and each 0.2 mL of drug solution is delivered to TMJ of the patients whose mouths are open.

ST6 **(Figure 1B)** is located on one fingerbreadth (middle finger) anterosuperior to the angle of the mandible [103]. When the mouth is closed and the teeth are clenched, ST6 is located at the prominence of the masseter. GB3 **(Figure 1B)** is located on the depression superior to the midpoint of the zygomatic arch [103]. GB3 is the point on which the temporalis is originated and the masseter is inserted. Using 1 mL syringes with sterile 16 mm-long 26 gauge needles, each 0.2 mL of drug solution is delivered to ST6 and GB3 when patient's mouth is closed. Injection into ST6 and GB3 then enables to facilitate the opening of the mouth, thereby releasing pain induced by the contraction of the masseter and the temporalis muscles.

TE16 **(Figure 1C)** is located in the depression anterior to the sternocleidomastoid muscle, posterior to the angle of the mandible [103]. Stimulation of TE16 enables to relax paravertebral muscles which influence the contraction of the muscles engaged in the opening of mouth. With a sterile 40 mm-long 25 gauge needle, 1 mL of drug solution is delivered to TE16. Injection to TE16 also provides stimulation of the accessary nerve which is often used to deliver the local anesthesia for all procedures in mandibular teeth [104].

6.2. Neck Facet Joints

Neck pain is a common problem with an episodic course that affects a large proportion of the population. Neck pain may originate from intervertebral discs, facet joints, ligaments, fascia, muscles, and nerve root dura [105,106]. The facet joints are formed by the superior and inferior processes of each vertebra. Each facet joint is positioned at each level of the spine to provide the necessary support especially with rotation. Facet joints also prevent each vertebra from slipping over the one below. A small capsule surrounds each facet joint providing a nourishing lubricant for the joint. Also, each joint has a rich supply of tiny nerve fibers that provide a painful stimulus when the joint is injured or irritated [107]. Inflamed facets can cause a powerful muscle spasm.

The symptoms of facet joint syndrome entirely differ on the location of the degenerated joints, the severity of the damage, and pressure on the surrounding nerve roots. In symptomatic facet syndrome, the location of the degenerated joints plays significant roles in the symptoms that are experienced. Patients with degenerated joints in the upper spine often feel pain radiating throughout the upper neck and shoulders. The pain is worsened by stress on the facet joints by diffraction into hollow back (retroflexion) or lateral flexion but also by prolonged standing or walking.

The set of acupuncture points recommended are Ex-HN15, GB21, SI14, and BL10 for neck pain. Sterile 40 mm-long 23 gauge needles are inserted into acupuncture points Ex-HN15, GB21, SI14, and BL10 at the same time as patients are seated. Ex-HN15 **(Figure 2)**, a member of extra channel acupuncture points, is localized on the facet joints between the cervical vertebra 6 (C6) and 7 (C7). From the injury mechanisms during stimulated whiplash, it was revealed that capsular ligament strain reached a maximum at C6-C7 [108]. Through Ex-HN15, 1 mL solution of medication is infused to the facet joint cavity between C6 and C7.

Injection to Ex-HN15 cavity alleviates pain and immobility caused by the irritation of the facet capsules and adjacent tissues.

With a facet joint-evoked pain, injection to the trigger point-related muscle areas is a good choice for eliminating shortened sarcomeres including contraction knots. Usually, 1 mL of drug solution is injected to the acupuncture points while needles are inserted to a depth of 25 mm, which is deep enough to penetrate the body of the muscle mass. GB21 **(Figure 2)** is the midpoint of the line on the posterior neck connecting the spinous process of C7 and the outer margin of the acromion [103], and coincides with the trigger point of the upper trapezius muscle. The upper trapezius originates at the external occipital protuberance, the medial third of the superior nuchal line, the ligamentum nuchae, and the spinous process of C7. Thus, tightness or pain in the upper trapezius is associated with range of motion limitation in neck joint. SI14 **(Figure 2)** is located 4.5cm away from, horizontally, the lower margin of spinous process of the first thoracic vertebrae (T1) [103], and corresponds to the active trigger point of levator scapular muscle. The levator scapula is attached to the posterior tubercles of transverse processes of C1-C4, and its tightness or pain is associated with limitations in the upper cervical motion [109].

BL10 **(Figure 2)** is located on the paravertebral region of the neck, at the same level as the superior border of the spinous process of C2, in the depression lateral to the trapezius muscle [103]. BL10 has an advantage to stimulate the semispinalis capitus as well as relax the spinal nerve hypersensitivity. It was demonstrated that injection to BL 10 enables the tension of the nape of the neck detangled, resulting in relief of pain such as migraine [110].

6.3. Shoulder Joints

Shoulder pain is a common musculoskeletal problem that causes disability, pain, and sick leave expenses for the patient [111,112]. The most frequent shoulder diagnosis is subacromial pain syndrome (also called shoulder impingement syndrome) [113] and adhesive capsulitis.

Magnetic resonance imaging has become a frequently used diagnostic tool for the evaluation of structural abnormalities in the shoulder including the rotator cuff and the subdeltoid/subacromial bursa, and other structural abnormalities [114]. Prevalence of rotator cuff or bursa abnormalities is weakly related to symptoms, and similar findings are often found in asymptomatic persons. Changes (grade 1) in 80% of the supraspinatus tendons of asymptomatic baseball pitchers with no significant difference between the throwing and the non-throwing arm were reported [115]. Conversely, no significant differences for the prevalence of partial tears, acromioclavicular joint degeneration, or tendinopathy were shown in symptomatic vs asymptomatic Ironman Triathletes [116]. There is a review reporting that partial thickness tears of the rotator cuff are more common in asymptomatic volunteers than in individuals with painful shoulders [117]. Other studies show that enhancement of the subacromial/subdeltoid bursa was not found to be related to shoulder symptoms in symptomatic and asymptomatic rotator cuff tears [118,119]. In contrast, another study found that subacromial bursal effusion was correlated to the reported severity of the shoulder disability in patients with subacromial impingement syndrome [120].

Adhesive capsulitis is characterized by pain, stiffness, and impaired function at the glenohumeral joints [121]. Patients of adhesive capsulitis typically experience onset of shoulder pain followed by a loss of motion especially in the motion of flexion, abduction, and external rotation [122]. As adhesive capsulitis is generally related to a shortening and fibrosis of the joint capsule surrounding the shoulder joint, the contracture of shoulder ligaments actually decreases the volume of the capsule, thus limiting range of motion [123]. The average range of motion in the frozen stage of patients is documented to be 98º of abduction, 117º of flexion, and 33º of external rotation with shoulder abducted to 90º [73]. It is likely that limitations in range of motion and pains associated with adhesive capsulitis are not only related to capsular and ligamentous tightness but also fascial restrictions, muscular tightness, and trigger points within the muscles.

Acupuncture points SI10, LU1, GB21, SI11, SI12, HT1, and Ex-HN15 are recommended for the treatment of shoulder joint pain. Usually 1 mL of drug solution is injected to each acupuncture point while a 40 to 60 mm-long 23 gauge needle is inserted to a depth of 25 to 40 mm. SI10 **(Figure 3A)** is localized on the posterior scapulohumeral joint while LU1 **(Figure 3B)** is localized at the medial margin of coracoid process. In order to successfully infuse medication into the anterior scapulohumeral joint, the tip of needle should be entered LU1 and proceeded towards the anterior scapulohumeral joint.

SI11 **(Figure 3A)** is localized on the upper third of the line connecting the midpoint of the spine of scapula and the lower margin of scapula [103], and coincide with the trigger point of infraspinatus muscle. SI12 **(Figure 3A)** is located in the scapular region, in the supraspinatus fossa, superior to the midpoint of the spine of the scapula [103]. Clinically meaningful improvements were reported in pain and disability while trigger points of upper trapezius, supraspinatus, and infraspinatus musculature were intervened by needling [124]. As SI11, SI12, and GB21 **(Figure 3A)** coincide with the trigger points of the infraspinatus, supraspinatus, and trapezius respectively, injection of medication to SI11, SI12, and GB21 relieves tightness or pain in these muscles which are associated with range of motion limitation in neck and shoulder joints. Through HT1 **(Figure 3C)** on axillary fossa, the tip of needle can be finally placed on subscapularis muscle which plays a key role in the development of adhesive capsulitis [125].

Ex-HN15 **(Figure 3A)**, a member of extra channel acupuncture points, is selected for spinal modulation of shoulder joint innervation.

6.4. Elbow Joints

Lateral epicondylitis (LE), commonly called tennis elbow, is one of the most common enthesopathies in sports medicine. The primary symptoms include persistent pain and tenderness over the lateral epicondyle with the inability in carrying out activities of daily living. LE affects about 1–3 % of the general population and peaks in the fourth and fifth decades of life [126-128]. Most specialists think that the pathology of LE is degenerative because the non-inflammatory, chronically degenerative changes in the extensor carpi radialis brevis muscle origins were identified during surgery [129]. The nature of the disease is common extensor tendon injuries aggravated by active and resisted wrist extension and/or repetitive rotation, extension, and flexion of the forearm [130].

The set of acupuncture points recommended are LI11, TE10, LU5, TE12, SI15, and Ex-HN15 for elbow pain. LI11 **(Figure 4A)** is located in the depression on the lateral end of the cubital crease while the elbow is fully flexed [103]. TE10 **(Figure 4B)** is located on the posterior aspect of the elbow, 1 B-cun apart from the prominence of the olecranon, where 9 B-cun is determined as the distance from the anterior axillary fold to the cubital crease [103]. Injection of 1.5 mL of drug solution to LI11 or TE10 is done using 3 mL syringes with 30 mm-long 23 gauge needles.

TE12 **(Figure 4B)** is located on the posterior aspect of the elbow, 5 B-cun apart from the prominence of the olecranon [103]. LU5 **(Figure 4A)** is located on the anterior aspect of the elbow at the cubital crease, in the depression lateral to the biceps brachii tendon [103]. It is noticeable that skipping elbow syndrome, an uncommon cause of pain in the posterior-medial elbow area, is caused by the dislocation of the abnormal insertion of the medial triceps head over the medial epicondyle during flexion and extension movements [131]. Injection to TE12 and LU5 which are located on the triceps and brachialis respectively enables to release contraction knots made in these muscles. With sterile 40 mm-long 25 gauge needles, each 1 mL of drug solution is delivered to TE12 and LU5.

For spinal stimulation of the elbow joint, SI15 and Ex-HN15 are selected. SI15 **(Figure 4C)** is located at the same level as the inferior border of the spinous process of C7 in the upper back region [103]. SI15 is 3 centimeters lateral to the posterior median region. With sterile 25 mm-long 23 gauge needles, each 1 mL of drug solution is delivered to SI15 and Ex-HN15.

6.5. Wrist Joints

Distal radioulnar joint (DRUJ) pain is a frequent cause of ulnar sided wrist pain and is a common indication for steroid injection of the wrist. DRUJ arthritis has a number of causes, including accrued stress over a life time, traumatic injury, and rheumatologic conditions [132]. Initial therapy for DRUJ pain usually consists of conservative therapies such as rest, nonsteroidal anti-inflammatory medications, static and/or dynamic splinting, and steroid injections [133]. When combined with a local anesthetic, steroid injections have the added utility of helping clinicians diagnose the DRUJ as the site of ulnar sided pain [134].

The set of acupuncture points recommended are LI5, TE4, LI10, PC4, and EX-HN15 for DRUJ pain. LI5 **(Figure 5A)** is located at the radial side of the dorsal wrist crease, distal to the radial styloid process, in the depression of the anatomical snuffbox [103]. TE4 **(Figure 5A)** is located in the depression ulnar to the extensor digitorum tendon, on the dorsal wrist crease [103]. Through LI5 and TE4 which are located on the posterolateral aspect of the wrist, each 0.5 mL of drug solution is reached in the joint cavity by sterile 25 mm-long 26 gauge needles.

LI10 **(Figure 5A)** is located on the line connecting the radial styloid process with lateral epicondyle of the humerus, 2 B-cun inferior to the cubital crease where the distance from the cubital crease to the wrist crease is assigned to 12 B-cun [103]. As the radial tunnel pressure is increased on moving the wrist from neutral to a flexion-pronation position, the lengthening of supinator muscle gets shorter [135]. Injection to LI10 relieves contraction of the brachialis, the extensor carpi longus, the extensor carpi brevis, and the supinator simultaneously. PC4 **(Figure 5B)** is located between the tendons of the palmaris longus and the flexor carpi radialis, and 5 B-cun proximal to the palmar wrist crease on the anterior aspect of the forearm [103]. Injection to PC4 contributes to the relief of the knotted flexor muscles. Each 1 mL of solution can be infused to LI10 and PC4 using syringes with 30 mm-long 25 gauge needles.

Injection to Ex-HN15 (Fig. 5C), localized on the facet joint between C6 and C7, is selected to provide the spinal modulation on the wrist joint.

6.6. Thoracic Facet Joints

The pain generators of the thoracic spine follow the same pattern as the lumbar spine. Namely, chronic thoracic or chest wall pain may also be transmitted by intervertebral discs, facet joints, ligaments, fascia, muscles, and nerve root dura [136]. The spinal facet joints have been shown to have an abundant nerve supply [107] and are known to be susceptible to arthritic changes, degenerative changes, inflammation, and injury all of which can lead to a restriction in range of motion and pain upon movement [137-139].

The therapeutic spinal facet joint interventions generally used for the treatment of axial spinal pain of facet joint origin are intra-articular facet joint injections, facet joint nerve blocks, and radiofrequency neurotomy [140,141]. Despite interventional procedures being common as treatment strategies for facet joint, there is yet a limited systematic review assessing the effectiveness of various therapeutic facet joint interventions.

The set of acupuncture points recommended are BL13, BL15, and BL43 for thoracic pain. Usually, 1 mL of drug solution is injected to the acupuncture points with 40 mm-long 25 gauge needles. BL13 and BL15 **(Figure 6)** are 2.5 cm lateral to the posterior median line in the upper back region and located at the same level as the inferior border of the spinous process of T3 and T5, respectively [103]. They also lie on the paravertebral muscles including longissimus, rotator, and multifidus. For the percutaneous treatment of thoracic pain, the entering point of needle is 2.5 cm lateral from the median line, with a needle depth of 2.5 to 4 cm.

BL43 **(Figure 6)** is located at the same level as the inferior border of the spinous process of T4 [103]. BL43 is 4.5 cm lateral to the posterior median line. By injecting medication to BL43, the muscular knots which are formed by the contraction of the trapezius and the rhomboid major are detangled.

6.7. Lumbar Facet Joints

Multiple structures in the lumbar spine including discs, facet joints, and sacroiliac joints have been considered the major sources of pain in the low back and/or lower extremities. Lumbar facet joints are paired synovial joints between the superior and inferior articular processes of consecutive lumbar vertebrae and between the fifth lumbar vertebra and the sacrum. In 21% to 41% of a heterogenous population with chronic low back pain, lumbar facet joints have been implicated as the source of chronic pain [142-144]. The facet capsules and adjacent tissue are rich in nociceptive receptors, which causes pain when the capsules are irritated by mechanical stimulation or inflammation [145,146]. There has been much discussion about appropriate managements of lumbar facet joint pain, encompassing multiple therapeutic techniques such as lumbar intra-articular injections [147], lumbar facet joint nerve block [148], and lumbar radiofrequency neurotomy [149].

The set of acupuncture points recommended are BL23, BL25, BL26, and BL30 for low back pain **(Figure 7)**. A sterile needle with 90 mm-long 23 gauges is used for injection of medication to the respective acupuncture points. BL23 **(Figure 7A)**, BL25 **(Figure 7B)**, and BL26 **(Figure 7B)** are localized on the facet joints of the lumbar vertebrae at the second (L2), fourth (L4), and fifth (L5) levels, respectively [103]. They lie on the paravertebral muscles including longissimus, rotator, and multifidus. For the percutaneous treatment of low back pain, the entering point of the needle is 2.5 cm lateral from the median line, with a needle depth of 2.5 to 8 cm.

Meanwhile, the sacroiliac joint is regarded as a potential source of low back pain, affecting 15% to 30% of individuals with chronic non-radicular pain [150,151]. The extensive network of strong ligaments maintains the integrity of the joint acting as mechanical stabilizers, and are also involved with limiting the extent of sacroiliac joint motion [152,153]. Posterior pelvic ring ligaments, sacrospinous and sacrotuberous ligaments also contribute pelvic stability. With the use of computational approaches involving finite element modeling, the increased stiffness of sacrospinous and sacrotuberous ligaments was demonstrated to decrease pelvic motion [154]. As BL30 (Fig. 7B) is localized on the sacrotuberous and sacrospinous ligaments, injection to BL30 may alleviate stiffness and contribute pelvic stability.

6.8. Hip Joints

Hip disorders are mainly responsible for the reduced quality of life in terms of pain, loss of mobility and independence, disability, increased use of health care resources, and loss of productivity. The prevalence of osteoarthritis (OA) in the hip increases with age. The young men are more affected than women, while women are the most affected over the age of 45. The success rate of conservative treatment is limited. It is often necessary to consider surgical procedure like total hip replacement. While OA is the most common hip disease, different disorders can affect the hip joint. Rheumatoid arthritis is associated with significant morbidity, increased mortality, and a complex multifactorial pathogenesis [155], resulting in systemic autoimmune destruction of bone and joints [156]. Inflammatory cells and activated macrophages release cytokines which significantly contribute to sustained inflammation and joint destruction [157]. Besides, femoroacetabular impingement (FAI) affects the hip and pelvis with abnormal contact between the acetabular rim and proximal femur [158]. FAI is increasingly recognized as a potential cause of early hip OA and labral cartilage pathology [159].

The set of acupuncture points used for treating hip joint pain is ST31, GB29, GB30, BL36, BL23, and BL24. ST31 **(Figure 8A)** is located on the anterior aspect of the thigh, in the depression among three muscles; the proximal portion of the rectus femoris, the sartorius, and the tensor fasciae latae muscle [103]. ST31 is at the intersection of the line connecting the lateral end of the base of the patella with the anterior superior iliac spine and the horizontal line of the inferior border of the pubic symphysis [103]. GB29 is located in the buttock region. GB29 **(Figure 8B)** is the midpoint of the line connecting the anterior superior iliac spine and the prominence of the greater trochanter [103]. GB30 **(Figure 8B)** is located at the junction of the lateral one third and medial two thirds of the line connecting the prominence of the greater trochanter with the sacral hiatus [103]. Through ST31, GB29, and GB30 which are localized on the hip joint, each of 3 mL of medical solution is infused to deep joint cavity using sterile 5 mL syringes with 100 mm-long 23 gauge needles.

BL36 **(Figure 8C)** is located at the midpoint of the gluteal fold in the buttock region [103]. It was revealed that the gluteal muscle damage lead to higher *in vivo* hip joint loads during sitting down and standing up activities after total hip arthroplasty [160]. Injection to BL36 targets to reduce the contact forces imposed on the gluteal muscle. BL23 and BL24 **(Figure 8D)** are located at the same level as the inferior border of the spinous process of L2 and L3, respectively [103]. BL23 and BL24 are 2.5 cm lateral to the posterior median line. Physical examination findings indicate that hip dysfunction are common in patients presenting with low back pain [161]. Patients with low back pain and positive hip examination findings were demonstrated to have more pain and worse function compared to patients with low back pain without positive hip examination findings [161]. Sterile syringes with 40 to 60 mm-long 25 gauge needles are used for injection to BL36, BL23, and BL24 to infuse 1 mL of drug solution.

6.9. Knee Joints

OA of the knee joints represents the largest group of knee joint diseases. Knee OA is a progressive chronic disease affecting more than 20% of people older than 45 years [162]. With the increase in life expectancy, it seems that the need for knee arthroplasty rises causing significant economic burdens for pain control and rehabilitation of patients. The primary discomfort by patients suffering knee OA are pain, stiffness, instability, and loss of function. In early disease, pain is intermittent and mostly associated with joint use. As symptomatic disease progresses, patients feel the chronic pain at rest and during the night. The joints will feel stiff, resulting in typical pain and difficulty when initiating movement after a period of rest.

OA pain is due to inflammation which may be present in bone tissues, cartilages, joints, discs, ligaments, soft tissues, and muscles [163]. OA affects not only the articular cartilage but also the underlying bone and adjacent joint structures [164]. Inflammation of the synovial membrane may be absent in the earlier stages of OA. However, as the disease progresses, some degree of synovitis usually exists. The targets of knee OA treatment are pain decrement, function and mobility increment, prevention or correction of the deformity, and slowing the progression of the disease.

In regarding pain control and movement rehabilitation, acupuncture points ST35 and LR8 are recommended for knee joint cavity. At the same time, acupuncture points KI10, SP10, ST34, and GB31 are used to ameliorate the muscular tension in knee OA. ST35 **(Figure 9A)** is localized on the lateral margin of patella tendon along the knee joint line [103]. LR8 **(Figure 9B)** is located in the depression medial to the tendons of the semitendinosus and semimembranosus muscles, at the medial end of the popliteal crease [103]. Through ST35 and LR8, each 6 to 8 mL of medication is reached in the synovial joint cavity by using 10 mL syringes with a 40 mm-long 22 gauge needles.

KI10 **(Figure 9C)** is located between the tendons of semitendinous and semimembranous muscles in the region of popliteal fossa [103]. Where the B-cun unit is used in the lower limb, the distance from the superior border of the pubic symphysis to the base of the patella is defined to 18 B-cun. SP10 **(Figure 9D)** is located on the anteromedial aspect of the thigh, 2

B-cun superior to the medial end of the base of the patella [103]. ST34 **(Figure 9A)** is located between the vastus lateralis muscle and the lateral border of the rectus femoris tendon, 2 B-cun superior to the base of the patella [103]. GB31 **(Figure 9E)** is located in the depression posterior to the iliotibial band where the tip of hand rests, when standing up with the arms hanging alongside the thigh [103]. SP10, ST34, and GB31 are localized to the trigger points of the vastus medialis, the rectus femoris, and the vastus lateralis, respectively. Using sterile syringes with 40 mm-long 25 gauge needles, each 1 mL of drug solution is injected to KI10, SP10, and ST34. From our clinical experience, it is proposed that treating muscles around the knee joint is indispensable to improve instability of knee joint.

BL25 **(Figure 9F)** is localized on the facet joints of L4, and lie on the paravertebral muscles including longissimus, rotator, and multifidus. For the percutaneous treatment of low back pain, the entering point of the needle is 2.5 cm lateral from the median line, with a needle depth of 2.5 to 4 cm. Usually, 1 mL of drug solution is injected to BL25 by a 3 mL syringe with 60 mm-long 25 gauge needle.

6.10. Ankle Joints

The ankle joints are formed by the articulation of the talus with the tibia and fibula. The medial and lateral malleoli of the tibia and fibula stabilize the talus. Ankle injuries often result from sport injuries and can cause a painful, debilitating sprain [165]. The ankle injuries include sprains, ligament and bone fractures, and joint damage [166]. Animal models have been used to study ankle joint injuries. However, testing manipulation in animal models appears to be difficult due to the association of endpoint with a number of osteopathic treatments and the lack of objective methods to measure relevant parameters [167,168]. Although the mechanisms underlying the effects of inflammation on the symptoms and recovery of an injured ankle joint remain incompletely elucidated, the involvement of inflammatory cells and their production and secretion of a set of pro-inflammatory cytokines, e.g. interleukin 6, tumor necrosis factor α, and interferon ɤ have been acknowledged [169-172]. Reduction of production and secretion of these pro-inflammatory cytokines may reduce the pain and promote the recovery [173].

The set of acupuncture points recommended are ST41, GB40, GB39, BL56, ST36, BL25, and BL26 for the ankle pain. ST41 **(Figure 10A)** is located on the anterior aspect of the ankle, in the depression at the center of the front surface of the ankle joint, between the tendons of extensor hallucis longus and extensor digitorum longus [103]. GB40 **(Figure 10B)** is located in the depression lateral to the extensor digitorum longus tendon, anterior and distal to the lateral malleolus [103]. Through ST41 and GB40, each 1 mL of medication is infused to the ankle joint successfully using 3 mL syringes with 30 mm-long 23 gauge needles.

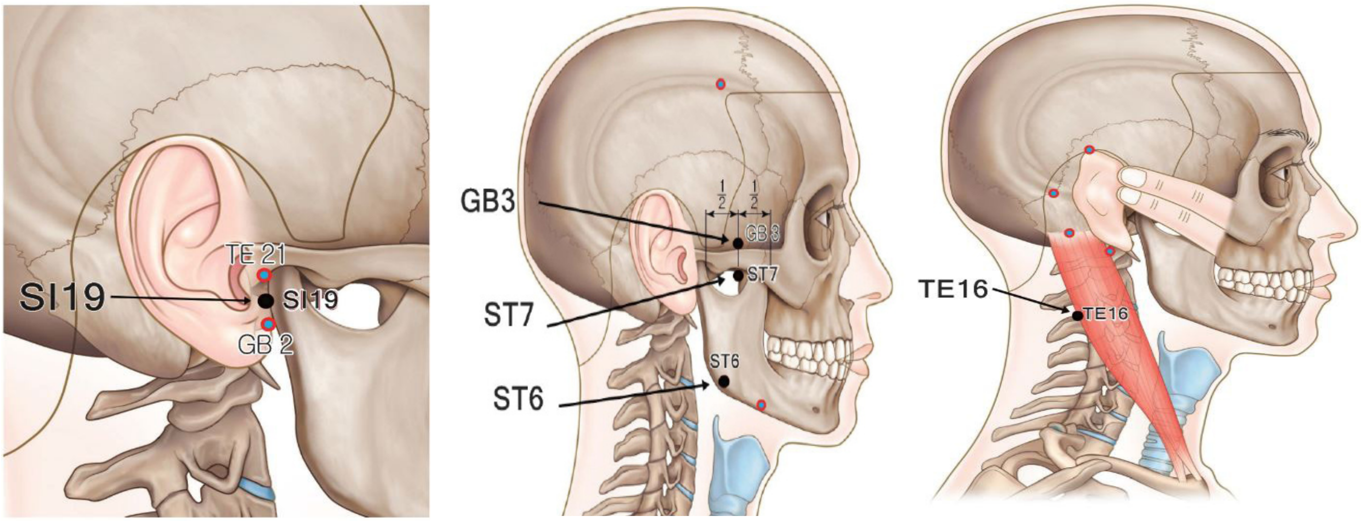
To rehabilitate the ankle joint, GB39, BL56, and ST36 are suitable to be administered with medication. Where the B-cun unit is used in the lower limb, the distance from the popliteal crease to the prominence of the lateral malleolus is arranged to be 16 B-cun. GB39 **(Figure 10C)** is located on the fibular aspect of the leg, anterior to the fibula, 3 B-cun proximal to the prominence of the lateral malleolus [103]. BL56 **(Figure 10D)** is located on the posterior aspect of the leg, between the two muscle bellies of the gastrocnemius muscles, 5 B-cun distal to the popliteal crease [103]. ST36 **(Figure 10A)** is located on the tibialis anterior muscle in the anterior aspect of the leg, 3 B-cun inferior to the lateral margin of patella [103]. Chronic ankle instability (CAI) patients displayed a reduced ankle evertor activation that could place CAI at a high risk of giving way or sprain injury [174]. In the landing phase, an increased tibialis anterior activation of CAI led to increased co-contraction of ankle muscles in the sagittal and frontal plane [174]. Besides, the electromyographic activity of the pronators and supinators is geared to their biomechanical advantage according to their position relative to the subtalar and talocrural joint axes during isometric contractions [175]. Injection to GB39, BL56, and ST36 contributes to reduce a risk of giving away and sprain injury as well as relieves the muscle tension to accomplish the mediolateral stability of the ankle joint complex (i.e. talocrural and subtalar joints). Each 0.5 mL of solution is usually injected to GB39, BL56, and ST36 with 40 mm-long 25 gauge needles.

BL25 and BL26 **(Figure 10E)** are located at the same levels as the inferior border of the spinous process of L4 and L5, respectively. They are situated 2.5 cm lateral to the posterior median line. There is compelling evidence that lower extremity arthrosis is related with lumbar spinal disease [176,177]. Using 710 randomly selected cadaveric specimens, a significant association was found between lumbar disc degeneration and tibiotalar joint arthritis [177]. A cross section study comparing normal subjects and patients with lumbar disc herniation with sciatica revealed that ankle plantar flexion torque was significantly lower in the lumbar disc herniation group than the control group [178]. Moreover, in a preliminary study with collegiate football players, low back dysfunction and suboptimal endurance of the core musculature appear to be important injury risk factors for strains and sprains of foot [179]. Each 1 mL of drug solution is injected to BL25 and BL26 by 3 mL syringes with 60 mm-long 25 gauge needles.

7. Conclusions

One of treatments for joint disorders includes the use of acupuncture stimulation to produce an analgesic effect and to improve the joint mobilization. The classical channel acupuncture points which have marked concordance with pain indications of trigger points could provide a good therapeutic tool to treat muscles, ligaments, tendons, subcutaneous fascia, peripheral nerves, and neurovascular bundles. Due to the combined effects of medication and acupuncture, Fuzopuncture yields dramatic and synergistic effects on degenerative and chronic joint diseases. The loci selected for Fuzopuncture are important variables to improve joint dysfunctions. By using the acupuncture points localized on the joint cavity, muscles acting in concert with the joints, and spinal regions innervating the joints, Fuzopuncture provides good therapeutic outcomes in joint diseases.

8. Figures



1A 1B 1C

Figure1: Acupuncture points for Fuzopuncture in TMJ disorder

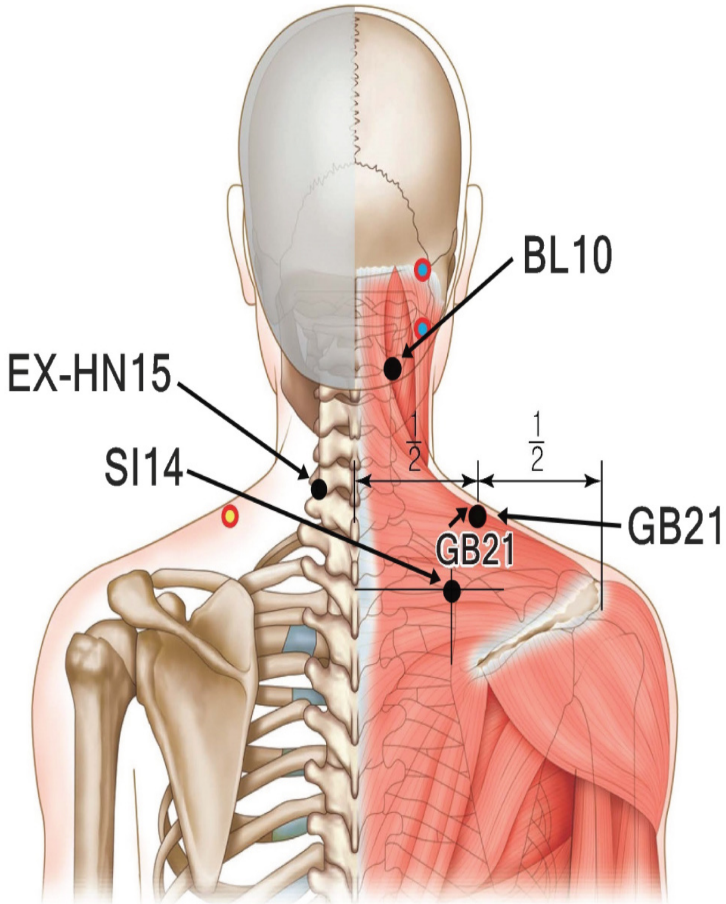
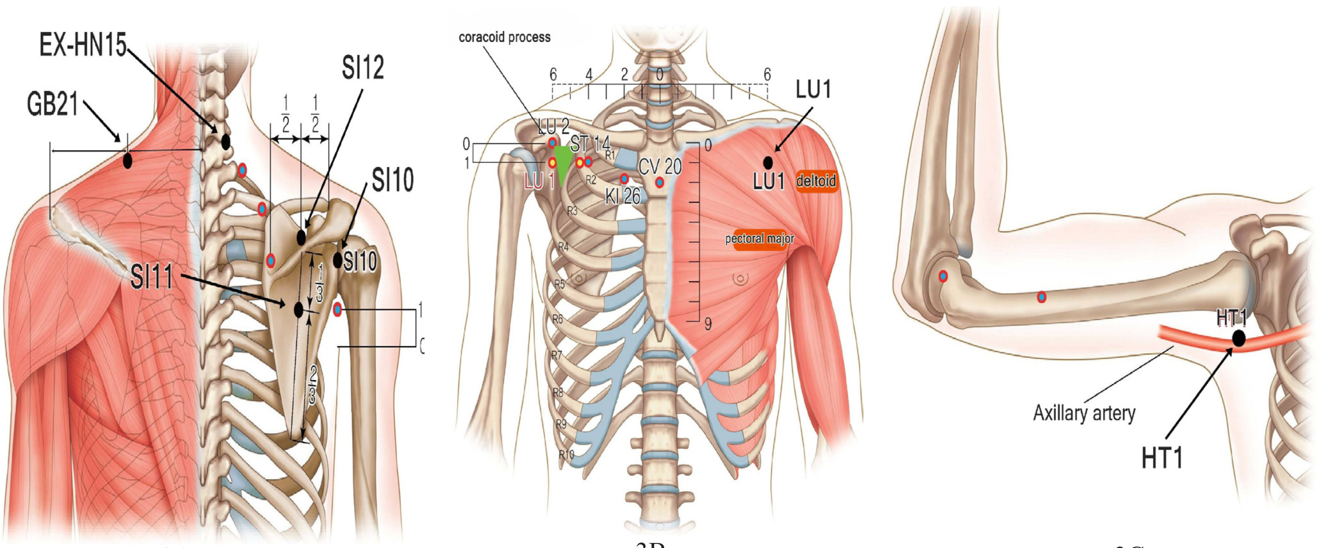
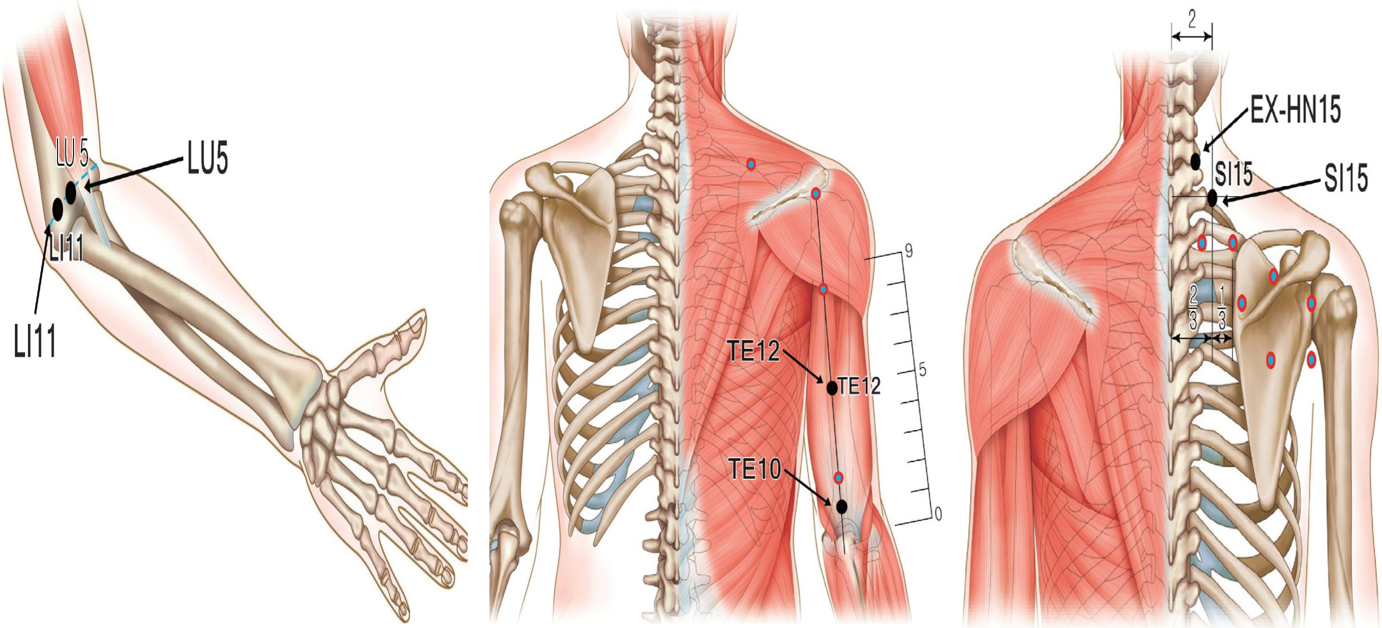


Figure 2: Acupuncture points for Fuzopuncture in neck facet joint disorder



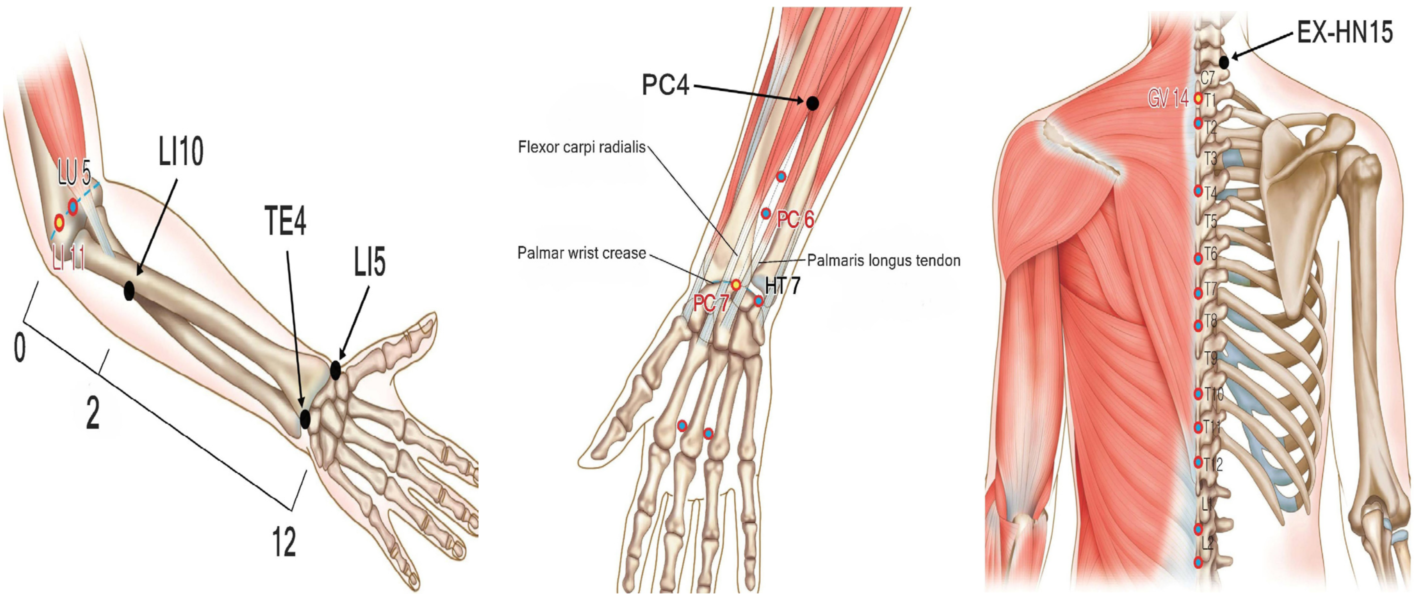
3A 3B 3C

Figure 3: Acupuncture points for Fuzopuncture in shoulder joint disorder



4A 4B 4C

Figure 4: Acupuncture points for Fuzopuncture in elbow joint disorder



5A 5B 5C

Figure 5: Acupuncture points for Fuzopuncture in wrist joint disorder

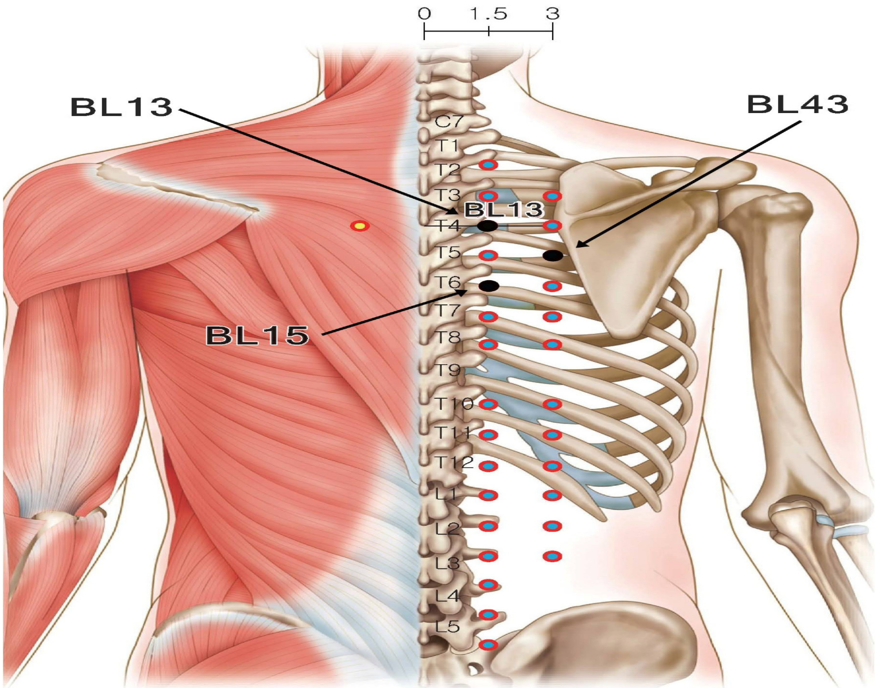
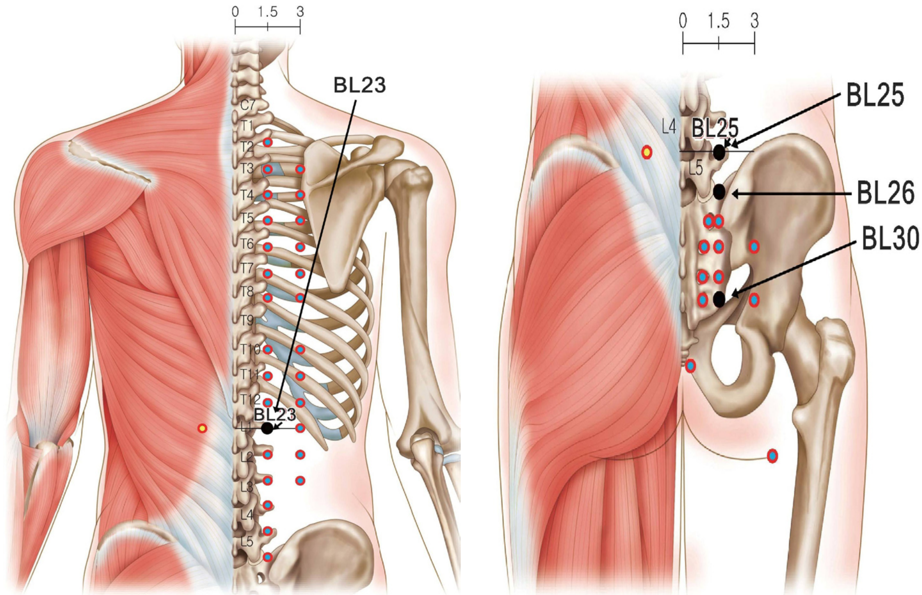


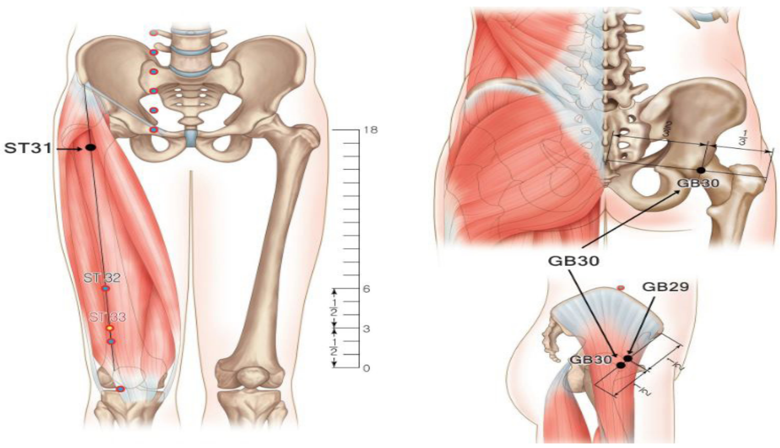
Figure 6: Acupuncture points for Fuzopuncture in thoracic facet joint disorder



7A

7B

Figure 7: Acupuncture points for Fuzopuncture in lumbar facet joint disorder



8A

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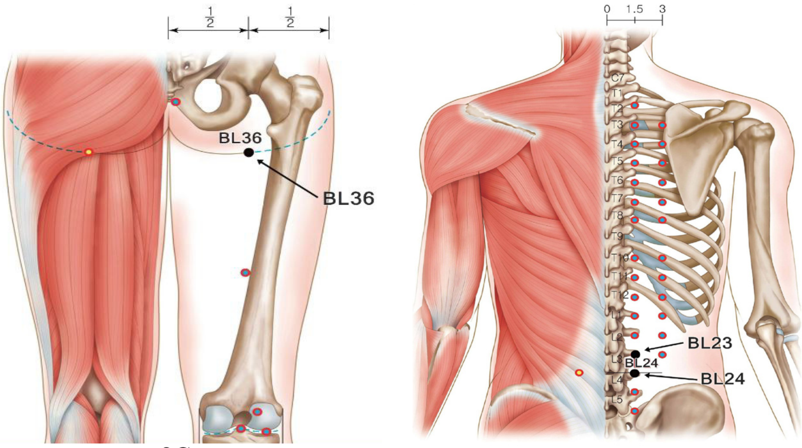
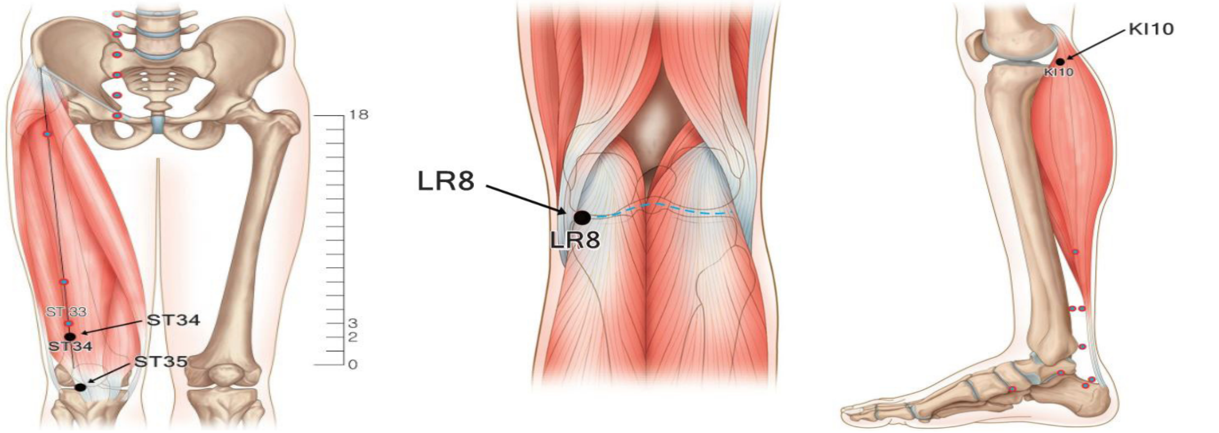
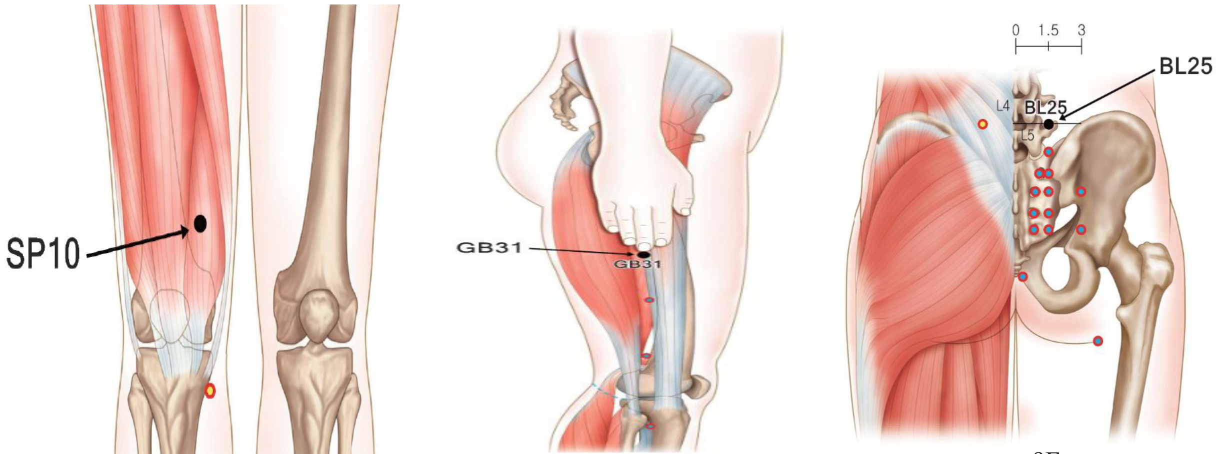


8C 8D

Figure 8: Acupuncture points for Fuzopuncture in hip joint disorder

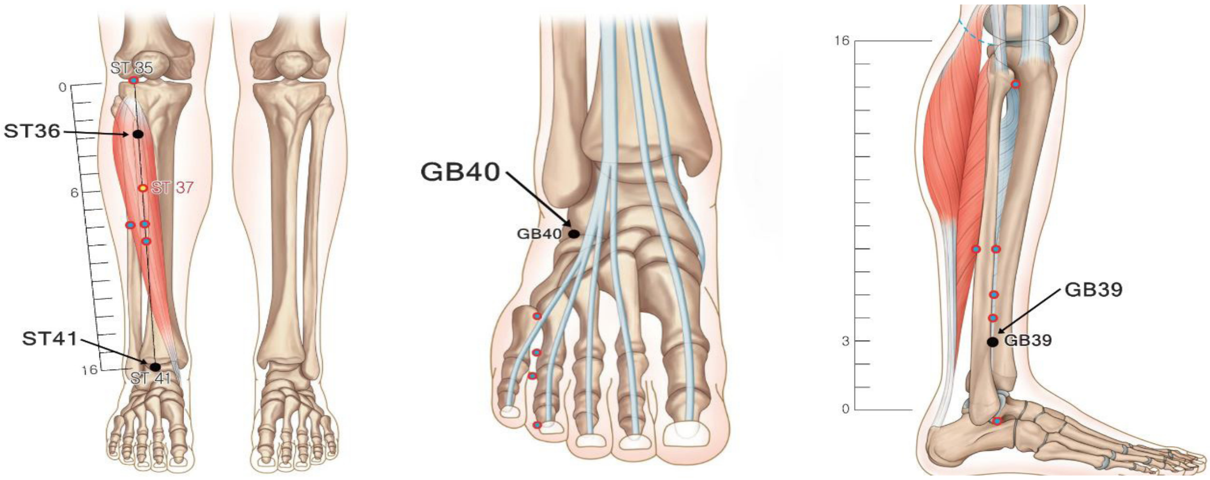


9A 9B 9C

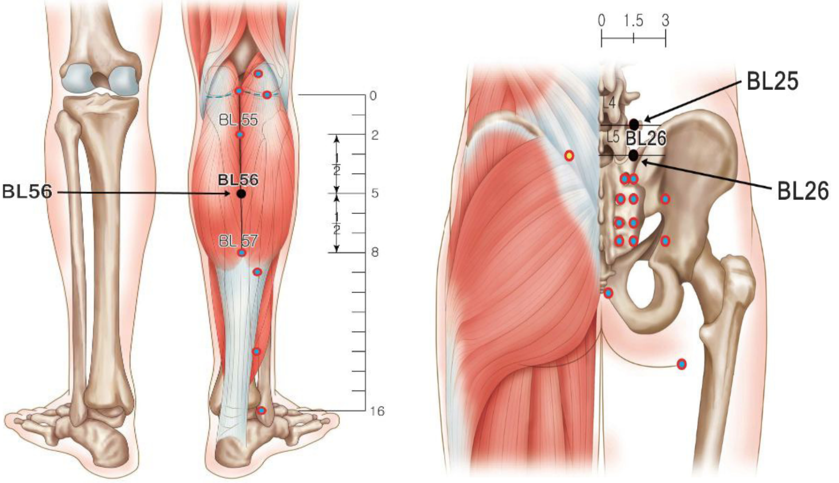


9D 9E 9F

Figure 9: Acupuncture points for Fuzopuncture in knee joint disorder



10A 10B 10C



10D 10E

Figure 10: Acupuncture points for Fuzopuncture in ankle joint disorder

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