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Occipito-Cervical (Whiplash) Injuries Treated by Prolotherapy

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(For Figures 30 to 33, see Appendix.)

Introduction

As more horses leave the nation's highways, and are put, instead, under automobile hoods, the problem of the so-called "whiplash injury to the neck" becomes a greater headache, both literally and figuratively. The term "whiplash injury" is, admittedly, a poor one. It describes, perhaps inadequately, a mechanism of trauma, like the old terms "bumper fracture" and "side-swipe fracture," rather than a specific pathological (changes in tissue due to disease or trauma) entity, which would be more desirable. The injured structures in the neck are generally confined to the soft tissues, among which ligament (a band of flexible, tough, dense white fibrous connective tissue) to bone and musculotendinous (pertaining to both muscle and tendon, the latter a band of dense fibrous tissue forming the termination of a muscle and attaching the latter to a bone) attachment to bone rank as the more frequent causes of prolonged disability.

In each individual case, precise physical examination can serve to localize more accurately the anatomical areas of injury, but the term "occipito-cervical injury," although still on the somewhat primitive descriptive level, is suggested to cover the involved region, as does the use of the expression "low back sprain" for the more caudally (towards the tail) situated multiple soft tissue injuries.

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Prolotherapy

Prolotherapy induces the production of new fibrous (containing fibers) tissue and bone cells at the site of ligament (a band of flexible, tough, dense white fibrous connective tissue) and tendon (a band of dense fibrous tissue forming the termination of a muscle and attaching the latter to bone) attachments to bone by the injection of proliferant or sclerosing (a chemical irritation, producing an inflammatory reaction and subsequent fibrosis) *against bone.* Similar solutions have long been used for varicose vein injections, and, in the past, for selected inguinal (groin) hernia cases where the production of a fibrous tissue barrier by nonoperative means was considered desirable.

Anatomy and Physiology of the Whiplash Injury

It is important to clarify further the confusion between labeling and understanding. Pain is the common denominator in all of the cases presented here. Steindler (1959) stated, *"The examining physician has, of course, no absolute judgment on the existence of pain as such. He can, however, form an opinion as to the plausibility of the patient's complaints provided he is broadminded enough to make due allowance for individual psychic reactions and does not arrogate to himself the opinion that what he cannot explain is nonexistent."*

In most instances of occipito-cervical (whiplash) injuries, the traumatic force exhausts itself in injury to the soft tissue structures without skeletal (bony) lesions (alterations in tissues due to disease or trauma), hence presenting no X-ray evidence of trauma (Steindler, 1959). In the scale of pain sensitivity, periosteum (a fibrous membrane investing the surfaces of bones) ranks first, followed by ligaments (bands of flexible, tough, dense white fibrous connective tissue), fibrous capsular (small box) structures, tendons (bands of dense fibrous tissue forming the termination of a muscle and attaching the latter to bone), fascia (mainly between voluntary muscles and forming the sheaths of such muscles), and finally muscle (Inman and Saunders, 1944; Feindel and others, 1948). Articular (joint) cartilage (gristle) contains no sensory nerve endings.

Although sensory nerve fibers have been demonstrated in cancellous (spongy) bone marrow, their scarcity makes pain from this source unlikely (Steindler, 1959). The rich sensory nerve endowment provides sharp localization of strained or injured ligaments, with points of greatest tenderness at the ligament origin and insertion. "Bone pain" due to trauma is especially distinct at the points of attachment of tendons to bone. The stress on tendons produced by movement often elicits sharp periosteal (a fibrous membrane investing the surfaces of bones) pain. Trauma causes a vasomotor (regulating the contraction and expansion of blood vessels) response with reactive hyperemia (an increased content of blood in a part, with distention of the blood vessels) and edema (fluid swelling) which complicate both the pain picture and the disability (Leriche, 1921). Hyperemia and inflammation lower the pain threshold so that minor, ordinarily non-noxious stimuli applied to inflamed areas frequently produce pain (Wolff and Wolf, 1958). Stiffness and protective muscle spasm, in response to pain, is an extremely common occurrence in many orthopedic (affecting bones, joints, muscles, ligaments, tendons and fascia) conditions. While instituted as a protection against pain, this muscle spasm itself often becomes a source of pain, due to the unphysiological degree of contraction itself, as in muscle cramps, or because of ischemia (local diminution in blood supply). A most frequently encountered headache mechanism is that occurring in association with sustained skeletal (bony) muscle contraction. The involved muscles are chiefly the large neck muscles which attach to the occipital (back of the head) region.

It has long been known that irritation, or injury if you will, of soft tissue attachments to bone can produce not only referral of pain to distant organs (Kellgren, 1939), but also muscle spasm, hypalgesia (diminished sensitivity to pain), and autonomic (involuntary) nervous system phenomena (Feinstein and others, 1954). Inman and Saunders (1944) coined the termed "sclerotomic" to describe these predictable pain patterns which do not follow the better known dermatomic (the areas of the skin supplied with sensory nerves from a single spinal nerve) patterns.

CERVICAL (NECK) SYMPATHETIC (AUTONOMIC) SYMPTOMS

Pain-Producing Lesions

Pain-producing lesions, according to Tarsy (1953) are divided into three groups:

(1) Simple somatic (pertaining to the framework of the body and not to the organs) with pain localized in the area of the primary lesion. These are frequently associated with reflex phenomena such as muscle spasm, hyperalgesia (excessive sensitivity to pain), hyperesthesia (excessive sensibility); sympathetic (involuntary or autonomic nervous system) activity is minor or absent.

(2) Spreading somatic pain with sympathetic activity more pronounced, with local and referred pain, with afferent (carrying toward) and efferent (carrying away) somatic activity both at the initial peripheral lesion and in the spinal cord.

(3) Complex disturbances, associated with sympathetic nervous system disorders, particularly involving the extremities, accompanied by disabling pain and the changes of reflex dystrophy (defective or abnormal development or degeneration).

Referred Pain from Skeletal Muscle

In writing on referred pain from skeletal (bony) muscle, Janet Travell (1955) described a sternomastoid (pertaining to the sternocleidomastoid muscle attached to the sternum or breastplate, the clavicle or collarbone, and the mastoid process behind the ear) reflex syndrome (a special group of subjective symptoms and objective signs, which, when considered together, characterize a certain disease or lesion), with a clavicular (collarbone) trigger point which produces vertigo (dizziness), imbalance, and pain radiating to the mastoid area; a sternal (breastplate) trigger point with reflex phenomena at the forehead, orbit (eye socket) and thorax (chest); lacrimation (tearing of the eye), conjunctival (lining of the eyelids and covering of the visible portion of the eye except for its center) injection, ptosis (drooping of the upper eyelid), and visual (sight) disturbances. Such symptoms are

too frequently considered functional (nonorganic), or ascribed to a "compensation neurosis." They occur, however, just as frequently in occipito-cervical (whiplash) injury cases where there is no possibility of personal gain to the patient.

Areas where Neck Injuries Can Involve Sympathetic Nervous System

Several areas exist where neck injuries can involve the sympathetic (autonomic) nervous system. These are: (1) the recurrent spinal meningeal (brain and spinal cord coverings) nerves with their sympathetic connections passing back through the intervertebral (between the vertebrae) foramina (natural openings) to supply the dura (outer layer of the meninges) and ligamentous (bands of flexible, tough, dense white fibrous connective tissue) structures (Jackson, 1958); (2) the plexus (a network of interlacing nerves) of postganglionic (situated behind, or after a ganglion, which is a group of nerve cell bodies, usually located outside the brain and spinal cord) sympathetic nerve fibers surrounding the vertebral (arises from the artery under the collarbone to supply the back of the neck muscles, cervical vertebrae, cervical spinal cord and its membranes, intervertebral discs, bone and brain of the rear of the head) artery, which passes up through the transverse foramina (natural openings) of the cervical (neck) spine and is very vulnerable to injury with any cervical spine trauma; and (3) the four cervical (neck) sympathetic (autonomic nervous system) ganglia (a group of nerve cell bodies) which provide the sympathetic plexus (a network of interlacing nerves) to the vertebral artery and to the carotid artery (the principle large artery on each side of the neck) and its branches.

The Barré-Lieou Syndrome

What is now called the Barré-Lieou syndrome (a special group of subjective symptoms and objective signs, which, when considered together, characterize a certain disease or lesion), first described in 1926, is based upon the anatomic connections existing between the somatic (pertaining to the framework of the body and not to the organs) and sympathetic nervous systems of the cervical (neck) region (Gay-

ral and Neuwirth, 1954). While cervical arthritic (degenerative or osteoarthritis) changes can be responsible for these symptoms, they are just as likely to appear in the wake of minor injuries of the cervical spine (Steindler, 1959).

The Barré-Lieou syndrome can give rise to many symptoms and signs, including pain reaching almost any part of the head and neck, visual (sight) blurring with ciliary (eyelid) spasm, mydriasis (dilatation of the pupil of the eye), dizziness, loss of balance, tinnitus (noises in the ears), lacrimation (tearing of the eyes), salivation (excessive secretion of saliva), rhinorrhea (running nose), dysphagia (difficulty in swallowing), nausea (sick to stomach), vomiting, forgetfulness, nervousness, swelling and stiffness of the fingers.

Vertebral (arises from the artery under the collarbone to supply the back of the neck muscles, cervical vertebrae, cervical spinal cord and its membranes, intervertebral discs, bone and brain of rear of head) artery spasm disturbs the circulation to the pons (a convex white eminence situated at the base of the brain) and portions of the medulla (the lowest part of the brain extending from the pons to the spinal cord) containing the nuclei (centers) of origin of the lower seven cranial (head) nerves, with resultant farflung symptoms (Seletz, 1960). Aside from any circulatory (circulation of blood) involvement, Seletz (1958) emphasizes the fact that the trigeminal (fifth cranial nerve) sensory nucleus (center) extends down the spinal cord to the C2 (second cervical) level, and there is physiological communication between the second (optic or eye) and fifth (trigeminal) cranial nerves here. Pietrobono and others (1957) reported 100 cases of cervical (neck) strain with 53 percent having suboccipital (below the back of the head) pain, and 28 per cent with concomittant sympathetic symptoms.

Fibro-Osseous (Fibers to Bone) Junction Injury

The occipito-cervical (back of the head and neck) region is more susceptible to injury than is any other part of the spine because of its great mobility. Even with any form of so-called immobilization provided by a cervical cast, brace, or collar, considerable range of motion is still present in the

occipito-cervical region. Aside from the play provided by the skin and subcutaneous (under the skin) tissues moving on underlying bone, the "immobilizing" device is usually applied with room left to permit the patient to eat.

Reporting on 2500 neck injury cases, Jackson (1958) concluded that 90 per cent of these cases had sprain type of injuries to the ligamentous (bands of flexible, tough, dense white fibrous connective tissue) and capsular (small box) structures, and 10 per cent had bony damage as well as sprain injuries. In other words, 100 per cent of the cases of neck injuries do have soft tissue damage.

Shands (1940) wrote of ligamentous and muscular injuries of the low back in terms at least equally applicable to the neck: "The mechanism of injury (to supporting ligaments and muscles) is either an episode of violent trauma or continued mechanical strain of postural or occupational type. In most cases the lesion is presumably a tear or sprain of a ligament. . . . The ligamentous tear may be minute or extensive. Muscle injury may be associated. The hemorrhage and organization which follow an injury may cause the ligaments to lose their normal resiliency and strength and so lead to a state of chronic relaxation which predisposes the joint to further injury."

Stretching or Tearing of the Fibers

The stretching or tearing of the fibers occurs principally at the attachment of ligament to bone, the fibro-osseous junction (Hackett, 1958). These collagenous (the albuminoid substance of the white fibers of connective tissues, cartilage, and bone) perforating fibers, known as Sharpey's (William Sharpey, English physiologist and anatomist, 1802–80) fibers, run perpendicular to the bony surface. Periosteum (bone covering) and tendons (bands of dense fibrous tissue forming the termination of a muscle and attaching the latter to bone) are similarly anchored, but in tendon anchorage there is a narrow transverse zone of calcified (deposit of calcium) cartilage (gristle) which is perforated by Sharpey's fibers before the fibers enter the bone substance (Luck, 1950). Tensile strength is diminished where the collagenous fibers separate to enter the "pores" of bone, so to speak.

Normal Healing Time for Injured Soft Tissues

A rich sensory nerve endowment is found at the junction of soft tissues into bone, so that strained or injured ligaments reveal their points of greatest tenderness at the ligamentous origins and insertions (Steindler, 1959). The symptom of pain occurs when normal tension on an injured ligament stretches the relaxed ligament fibers, resulting in abnormal stimulation of the sensory nerves because the nerve fibers do not stretch.

When normal healing occurs, bone and fibrous tissue proliferate at the fibro-osseus junction. Interference with normal healing due to motion at the site of injury, or to a deficient healing capacity, results in a weak attachment, designated as ligament relaxation (Hackett and others, 1961). Normal healing time for the injured soft tissues under discussion is 3 to 4 weeks, with an additional equivalent time period for further maturing and strengthening of the fibro-osseous bond. Thus, spontaneous repair that has not occurred 1½ to 2 months after the injury is not likely to occur later.

A Simple Analogy

A simple analogy is provided by a careful follow-up study of residual disabilities following acute ankle sprains (Bosien and others, 1955); 133 sprains limited to the external lateral (side) ankle ligaments were treated and followed in a college infirmary for a mean period of 29 months. Gibney-type ankle strapping was used as treatment in 26 cases, elastic bandage immobilization in 100 cases, and walking casts in 4 cases; 72 cases (54%) used crutches for an average period of 9 days. The average convalescent period for the entire group from injury to resumption of full activity was 33 days. In the late follow-up, 55 cases (41%) were considered to have residual abnormal lateral and rotatory mobility of the talus (bone of the ankle which joins with the bones of the leg; the old term is astragulus) in the ankle joint mortise (the space in the ankle joint, between the lateral and medial malleoli, occupied by the talus). One-third of the entire number of patients had residual ankle symptoms.

—But in Occipito-Cervical (Whiplash) Injury

Anatomically, the problem of such an ankle injury is a comparatively simple one, with damage confined largely to ligaments (bands of flexible, tough, dense white fibrous connective tissue) and possibly periosteum. The chronically unstable ankle that turns easily on rough ground is widely recognized as a frequent end-result of an old sprain, even one that was treated in what is considered an adequate manner. One rarely hears the comment applied here, that "enough time has elapsed for adequate soft tissue healing to have occurred, and there is no reason for the patient to have further symptoms." Yet, the occipito-cervical (whiplash) sprain, involving many more structures and a far more complex anatomy in an area where immobilization is less feasible, is often the subject of such an unthinking generalization.

It is quite likely that the majority of these neck injuries are minor and heal satisfactorily with little or no attention paid to them. What the physician and surgeon sees in his office is the sampling error representing patients with more severe injury and disability. Even among this group, many recover while comfort is achieved with the help of anodynes (medicines that ease pain), muscle relaxants, and various types of neck supports. Many such patients, however, remain disabled despite such treatment, with persistent pain as the presenting symptom in all of them.

Background of Prolotherapy

With the opinion that ligament and tendon relaxation is the underlying pathology (alterations in tissues due to disease or trauma) producing the pain in occipito-cervical (back of the head and neck) injuries, as well as in many other spine and joint injuries, I used a variety of injectable medications at painful trigger points during the years from 1950 to early 1956. I used the spectrum of local anesthetics, aqueous (water) and oil-based, and the various parenteral (not via the digestive tract) glucocorticoids (an adrenal cortex hormone which affects the metabolism of glucose sugar), as they became available. Good to excellent relief, sometimes lasting 3 to 4 weeks, was obtained before the pains recurred.

George Hackett's initial monograph, appearing early in 1956, detailed his 16 years of experience in injecting ligaments and tendons, mostly, at that time, in the low back, with a solution of sodium psylliate (the sodium salt of the liquid fatty acid of plantago-seed oil, available as an aqueous solution, commonly of 5 per cent concentration) plus a local anesthetic agent. Not only was the pain relieved but proliferation of new fibrous tissue cells and bone was induced, and the "weld" of soft tissue to bone strengthened (Fig. 30).

Sodium Psylliate Solution

In an undiluted form, sodium psylliate (the sodium salt of the liquid fatty acid of plantago-seed oil) solution has been used for decades to fibrose (harden) varicosities (a varicose-dilated, knotted, and tortuous portion of a vein, usually of definite and limited extent). The safety of sodium psylliate solution was further supported by the work of Schultz (1937) when he began to inject it into subluxating (partially dislocating) temporomandibular (jaw) joints. A selective thickening of joint ligaments, following intra-articular (within the joint) injections, were the only effects obtained.

Case Material

From March, 1956, through March, 1961, I treated 189 cases of occipito-cervical (whiplash) injuries by prolotherapy (to induce the production of new fibrous tissue and bone cells at the site of ligament and tendon attachments to bone by the injection of a proliferant against bone). Eighty-seven (45%) were males; 102 (55%) females; 149 (79%) of the injuries were due to automobile accidents.

TABLE I.

Patients' ages.

10–20 yrs.	21–30 yrs.	31–40 yrs.	41–50 yrs.	51–60 yrs.	61 up
8 (4%)	30 (16%)	57 (30%)	48 (25%)	35 (19%)	11 (6%)

Although I am presenting only the occipital-cervical (back of head and neck) aspects of the injuries, 153 (81%) sus-

tained associated injuries involving the thoracic (chest), lumbosacral (low back), or other areas, with 145 (77%) requiring treatment to these other areas; 98 (52%) had an associated Barré-Lieou syndrome (many symptoms and signs, which, when considered together, characterize a certain disease or lesion). This syndrome can give rise to many symptoms and signs, including pain reaching almost any part of the head and neck, visual (sight) blurring with ciliary (eyelid) spasm, mydriasis (dilatation of the pupil of the eye), dizziness, loss of balance, tinnitus (noises in the ears), salivation (excessive secretion of saliva), rhinorrhea (running nose), dysphagia (difficulty in swallowing), nausea, vomiting, forgetfulness, nervousness, swelling and stiffness of the fingers.

TABLE II.

The duration of pain and associated symptoms before prolotherapy was started.

Duration	Under 1 week	1–2 wks	2–4 wks	1–3 mos	3–6 mos	6–12 mos	Over 1 yr
	12(6%)	13(7%)	16(9%)	44(23%)	33(18%)	30(16%)	41(21%)

121 (65%) had sensory changes following a dermatome (skin segments supplied by spinal nerves) pattern; hypalgesia (diminished sensitivity to pain), hyperalgesia (excessive sensibility to pain), or both. The Baker (William Morrant Baker, English surgeon, 1839–96) esthesiometer (an instrument for measuring sense of touch) used to map out sensory changes (Fig. 31), is far more accurate than a safety pin or a Wartenberg (Robert Wartenberg, American neurologist, 1887–1961) spur. The latter two, the safety pin and the Wartenberg spur, may be pressed by the examiner lightly enough to dent the skin or heavily enough to draw blood. The spring-controlled tension of the esthesiometer needle, set at a pressure of 30 grams (one ounce) for all of these patients, makes an unchanging stimulus.

Upper Extremity Tendon Reflexes

Upper extremity tendon reflexes (the biceps, triceps and radials) also are frequently changed after occipito-cervical

(whiplash) injuries. I did not catalogue the frequency here. However, in virtually all of the cases, these neurological (nerve and nervous system) changes reverted to normal with successful treatment. This makes the clinical diagnosis of protruding cervical (neck) intervertebral (between the vertebrae) disc more difficult to make, unless the examiner uses a modification of the Ruth Jackson (1958) procaine (local anesthesia) test. Her test is based on the premise that local anesthesia injection of any trigger point from the intervertebral foramen (natural opening between each two vertebra for the spinal nerves to emerge from the spinal canal) peripherally relieves pain that is not discogenic (originating or due to the disc). Pain arising from an agent operating within the spinal canal is not relieved in this manner.

Duration of Pain

78% had had pain for over one month and fall well within a group where further spontaneous healing is unlikely to occur. Of the 21% with pain over one year, a number were of many years' duration and 2 of over 30 years' duration. The 22% who had prolotherapy started before the injury was one month old, were all begun first on more conservative forms of therapy. Only when pain was inadequately relieved by other means was prolotherapy initiated early. The pain is relieved rapidly, and often lastingly. Why this occurs is unknown.

Technic of Injection

Two main factors determine the number of injections required to relieve pain: (1) the trigger points found by the examining physician and surgeon; and (2) the proliferant (to grow or produce) solution used. It is necessary to elicit tenderness at the bony attachments of soft tissues carefully and thoroughly. The trigger points are mapped out and marked by pen on the skin most easily with the patient sitting astride a chair, facing the back of the chair, with the patient's neck flexed (bent forward) and forehead resting on his hands which are on top of the chair back.

Each interspinous (between the spinous processes) ligament must be palpated (felt with the fingers), as must each articular (joint) ligament area about one-half inch from the

TABLE III.

The number of injections administered to patients.

	Total number of occipito-cervical injections					
	1–5	6–10	11–20	21–30	31–40	Over 40
Number of Patients	58(30%)	40(21%)	55(29%)	22(13%)	8(4%)	6(3%)

midline, and the tips of the transverse processes (projecting outward, one from each side of a vertebra) of the cervical (neck) spine accessible to palpation. Both suboccipital (below the back of the head) triangles must be mapped out carefully. The many trigger points and their common patterns of referred pain are indicated (Fig. 32). Such an examination takes time and must be done methodically to be of value for accurate anatomical diagnosis and for treatment.

TABLE IV.

Indicates the number of occasions when patients in this series received injections.

	Number of occasions injected		
	1–5	6–10	11–20
Number of patients	144(76%)	37(20%)	8(4%)

A Basic Phenomenon of Pain

A basic phenomenon of pain, early noted by Hippocrates (Father of Medicine, Greek physician, 460–377 B. C.), complicates the picture somewhat (Wolff and Wolf, 1958). The existence of one pain raises the threshold for perception of another. Thus, in the presence of multiple injuries, the patient's greater pains eclipse his lesser pains. Frequently he becomes aware of the latter only after the greater pains are relieved. This is true of tenderness, too. Common examples of the

patient in pain biting his lips, or pinching himself hard when he receives an injection, are well known. As treatment proceeds over a period of several visits, trigger points may be found later that could not be elicited initially. Unless these are taken care of, too, an inadequately treated patient may be dismissed as a poor result.

Needle Tip Must Be in Contact with Bone

The positions for both examination for trigger points and treatment are demonstrated (Fig. 33). In the occipito-cervical (back of head and neck) region, each trigger area is injected with one to two c.c. (cubic centimeters, equivalent here to ¼ to ½ a teaspoonful) of the proliferant solution used. A multiple puncture technic, that is, fanning out with the needle through each single skin puncture, deposits a few drops of the solution at each fibro-osseous junction where the needle tip reproduces pain, and often the pattern of pain referral. Of greatest importance is the fact that the needle tip must be in contact with bone before any injection is made. There are no blood vessels or nerves of any size or importance at the fibro-osseous junction of ligaments and tendons, so that intrathecal (intraspinal) injections are thus avoided. Generally a one-inch-long #22 needle is adequate. Even in well-upholstered patients, a 1½-inch #22 needle is sufficient to reach the tips of the cervical transverse (projecting outward, one from each side of a vertebra) processes. Pain is reproduced momentarily at the time of injection, then disappears rapidly.

TABLE V.

The duration of prolotherapy treatment.

	Duration of Treatment			
	Up to 1 month	1–3 mos	3–6 mos	over 6 mos
Number of patients	53(28%)	50(26%)	33(18%)	53(28%)

Proliferant Solutions

There has been a gradual improvement in the choice of proliferant (to grow or produce) solutions. During 1956,

sodium psylliate (the sodium salt of the liquid fatty acid of plantago-seed oil) solution diluted 1:3 in 0.15 per cent tetracaine (a powerful local anesthetic, under the trademark of Pontocaine®) was used. Skin testing of patients with tetracaine produced 12 positive reactors. One per cent aqueous (water) solution of lidocaine (a potent local anesthetic agent useful for infiltration and block anesthesia, under the trademark of Xylocaine®) has been used since, not only for prolotherapy, with no sensitivity found as yet in several thousand patients on whom it has been injected.

About 75 per cent of patients receiving the sodium psylliate-lidocaine injections experienced a flare-up of pain after 4 to 6 hours, lasting 8 to 72 hours.

In November, 1956, a change was made to a 3 per cent tetradecyl sulfate solution in a 1:3 dilution with 1 per cent aqueous lidocaine. This solution had a neutral pH (a symbol introduced by Svrensen, used in expressing hydrogen-ion concentration, signifying the logarithm, on the base of 10, of the reciprocal of the hydrogen-ion concentration; a pH above 7 represents alkalinity in an aqueous medium, and below 7, acidity) instead of the markedly alkaline pH of sodium psylliate-lidocaine. About 25 per cent of patients now experience a temporary flare-up of pain.

With these proliferants, not infrequently each trigger point would have to be injected 4 to 6 times at intervals of 6 to 8 weeks, especially in the older cases, before complete relief was obtained. Improvement in terms of diminished pain, however, would be present with each series of injections.

A more effective agent, later, was essentially a solution containing .015 per cent zinc sulfate (a white powder that dissolves in water and glycerin, astringent and antiseptic in action) in 1 per cent aqueous lidocaine. At least 90 per cent of patients would experience increased pain in about ½ hour, lasting 6 to 8 hours, but fewer injection repetitions were required. Often two series at intervals of 6 to 8 weeks produced lasting relief, and pre- and post-injection medications made treatment reasonably comfortable.

Virtually No Pain Flare-Up

Recently, a modification of a British proliferant, used there since October, 1946, for varicose vein injections, has provided

a vast improvement. The stock solution of this proliferant contains 2.5 per cent phenol (carbolic acid), 25 per cent glucose (sugar), and 25 per cent glycerin in sterile (bacteria-free) water. This solution is diluted 1:2 (1 part in 2 parts of water) with 1 per cent aqueous (water solution) lidocaine (a potent local anesthetic agent useful for infiltration and block anesthesia, under the trademark of Xylocaine®). A number of American glucocorticoids (an adrenal cortex hormone which affects the metabolism of glucose) frequently used for intravenous (into a vein) and for intra-articular (within the joints) administration contain 0.5 per cent to 0.6 per cent of phenol (carbolic acid) as a preservative.

Starting in 1955, a number of reports have appeared in the British medical literature advocating intrathecal (within the spinal canal) phenol injections in strength varying from 5 per cent (Maher, 1960) to 20 per cent (Nathan, 1959), usually in glycerin, for intractable pain problems. In the United States, the Food and Drug Administration prefers that propylene glycol (1, 2-dihydroxypropane, occurs as a colorless, practically odorless, viscous liquid, completely miscible with water and many organic solvents) be substituted for glycerine. There is virtually no pain flare-up with this solution, except the quasireaction if any trigger points are missed. Repeat injections are infrequent, but may be required occasionally 6 to 8 weeks after the initial injections. Arbitrarily, no more than a total of 30 cc. (cubic centimeters or one ounce) of this diluted solution are administered at any one visit. Of course, until the patient becomes used to the procedure, fewer injections are given initially.

Treatment and Results

A rather convenient dumping ground to which many such patients with disabling occipito-cervical injuries have been relegated is the so-called "suit happy group." Cures are presumably achieved in this group by "cash transfusions."

Such labeling serves to stop effective thinking in the handling of an increasingly common problem. In my group of 189 patients, 93 (49%) had medicolegal aspects. No other person could be blamed in the remaining 51 per cent. The 49

per cent, or 93 cases, breaks down further into 68 (36%) whose cases were settled out of court, 14 (7%) with cases still pending, 6 (3%) who obtained verdicts, and 5 (3%) who lost their suits. Symptoms and clinical findings could not be correlated with the medicolegal status of the patient. Nor did the out-of-court settlement or the obtaining of a verdict affect the cessation or continuation of treatment.

The results of treatment are assessed in terms of pain as the chief index (Table VI).

TABLE VI.

	RESULTS			
	Excellent	Good	Fair	Poor
Number of Patients	113(60%)	15(8%)	34(18%)	27(14%)

Excellent—no residual symptoms or signs.
Good—no pain (neck, head, upper extremities), but some residual limitation of motion or other mild nondisabling symptoms.
Fair—occasional pain in neck, head, upper extremities, and associated mild nondisabling symptoms.
Poor—no relief of pain at all.

All of the first three groups, totaling 86% of the series, are considered by the patients involved to be satisfactory end-results.

Poor Results

Of the 27 patients with poor results, 4 of these were considered by neurosurgical consultants to have ruptured cervical (neck) intervertebral (between the vertebrae) discs. One of these patients was operated for this, for ruptured lumbar (low back) intervertebral discs, and also had surgery on his right shoulder. This patient is also considered to have right brachial (upper arm) plexus (a network of interlacing nerves located in the neck and armpit) damage, all of this resulting from a fall of 12 feet from a diving board to a wooden platform.

Another patient had previous unsuccessful cervical (neck) intervertebral disc surgery, a trial of prolotherapy over a 2-month period, reoperation by another neurosurgeon and post-operative (after the operation) death.

The other 2 patients were offered surgery by the neurosurgeons, refused it, and left this area.

I am not implying that cervical disc protrusion is a contraindication to prolotherapy. Disc protrusions occur only secondary to ligamentous injury, and this is certainly not confined solely to those retaining the nucleus (center) pulposus (jelly-like) of the disc. Concomitant prolotherapy, before or after surgery to the neck, or both, has its place in the treatment of the *entire* injury. Disc surgery, with or without bone fusion (joining together), too often treats just a part of the total occipito-cervical injury.

TABLE VII.

The follow-up time.

	Duration of follow-up				
	Up to 6 mos	6 mo–1 yr	1–2 yrs	2–3 yrs	3–5 yrs
Number of Patients	21 (11%)	34 (18%)	40 (21%)	42 (22%)	52 (28%)

Eight of the 27 patients were treated from one to three times, with the rather potent zinc sulfate (a white powder that dissolves in water and glycerin, astringent and antiseptic in action) proliferant, and discontinued treatment because of the accompanying flare-up of pain or because they were "needle-shy." Aside from these, the last patient with a poor end-result was last treated in April, 1959. Increasing experience and improved proliferant solutions are now providing more satisfactory results. There have been no complications or deleterious effects to date.

Comment

Prolotherapy has a definite place among the forms of treatment available for handling occipito-cervical injuries satis-

factorily. Such treatment fills a large gap that exists between the group of patients who recover either spontaneously or with the aid of simple symptomatic treatment lumped under the term of conservative therapy, and, the small group with damage severe enough to require a surgical approach. The application of prolotherapy extends into the latter group.

Further, prolotherapy can diminish appreciably the number of patients with occipito-cervical injuries now subjected to occipital (back of the head) neurectomies (surgical excision of part of a nerve) and to the various forms of cervical (neck) spine fusion (joining together). The latter procedure is necessary in the grossly unstable cervical spine, but, more often, it is used as a kind of a "shot-gun approach," based on the theory that what doesn't move can't produce pain. Unfortunately, many of the pain-producing soft tissue attachments are not confined to what is essentially a midline zone that is immobilized by the successful bone fusion. Candid late evaluations of post-cervical fusion patients by physicians and surgeons who have a large series of these cases are often not exactly suffused with glowing enthusiasm.

Summary

Prolotherapy is offered as the treatment of choice for patients still bothered by pain and associated annoying symptoms a month or so after sustaining occipito-cervical injuries. Prolotherapy stimulates the production of new fibrous tissue and bone cells at the site of predilection of such injuries, the fibro-osseous junction. The strengthening of this "weld" occurs over a period of 6 to 8 weeks following the intraligamentous injection *against bone* of proliferant solutions which have been described. The anatomy and physiology of the frequently widespread symptoms following occipito-cervical injuries are outlined.

A series of 189 patients, seen over a 5-year period and, treated by this method is presented; 79 per cent were injured in auto accidents. In 81 per cent the injuries were not limited to the occipito-cervical area; 65 per cent had sensory changes involving cervical dermatomes; 52 per cent had associated sympathetic nervous system symptoms as seen in the Barré-Lieou syndrome; 55 per cent had had their pain and concomitant symptoms for more than 3 months, and 21 per cent

for over a year, when prolotherapy was begun. A medico-legal aspect to the cases was present in 49 per cent of the 189 patients.

BIBLIOGRAPHY

1. Bosien, W. R. and others. Residual Disability Following Acute Ankle Sprains, J. Bone & Joint Surg. 37–A:1237, 1955.
2. Feindel, W. H. and others. Pain Sensibility in Deep Somatic Structures, J. Neurol., Neurosurg. & Psychiat. 2:113, 1948.
3. Feinstein, B. and others. Experiments of Pain Referred from Deep Somatic Structures, J. Bone & Joint Surg. 36–A:981, 1954.
4. Gayral, L. and Neuwirth, E. Posterior Cervical Sympathetic Syndrome of Barré-Lieou, N. Y. State J. M. 54:1920 (July 1) 1954.
5. Hackett, G. S. Ligament and Tendon Relaxation (Skeletal Disability) Treated by Prolotherapy (Fibro-Osseous Proliferation), Charles C Thomas, Springfield, Illinois, 1958, 3rd Edition.
6. Hackett, G. S. and others. Back Pain Following Trauma and Disease-Prolotherapy, Military Med., 126:517, 1961.
7. Inman, V. T. and Saunders, J. B. de C. M. Referred Pain From Skeletal Structures, J. Nerv. & Ment. Dis., 99:660, 1944.
8. Jackson, R. The Cervical Syndrome, Charles C Thomas, Springfield, Illinois, 1958.
9. Kellgren, J. H. On the Distribution of Pain Arising from Deep Somatic Structures with Charts of Segmental Pain Areas, Clin. Sc. 4:35, 1939.
10. Leriche, R. Some Researches in the Periarterial Sympathetics, Ann. Surg. 74:385, 1921.
11. Luck, J. V. Bone and Joint Diseases, Charles C Thomas, Springfield, Illinois, 1950.
12. Maher, R. M. Further Experiences with Intrathecal and Subdural Phenol, Lancet, 1:S95 (April 23) 1960.
13. Nathan, P. W. Intrathecal Phenol to Relieve Spasticity in Paraplegia, Lancet, 2:1099 (Dec. 19) 1959.
14. Pietrobono, R. and others. Cervical Strain with Residual Occipital Neuritis, J. Internat. Col. Surg. 28:293, 1957.
15. Schultz, L. W. A Treatment for Subluxation of the Temporomandibular Joint, J.A.M.A. 109:1032 (Sept. 25) 1937.
16. Schultz, L. W. 20 Years' Experience in Treating Hypermobility of the Temporomandibular Joints, Am. J. Surg. 92:925, 1956.
17. Seletz, E. Whiplash Injuries, J.A.M.A. 168:1750 (Nov. 29) 1958.
18. Seletz, E. Whiplash Injuries—A New Concept and the Medicolegal Implications, Medical Trial Technique Quarterly Annual, 1960, page 283.
19. Shands, A. R., Jr. Handbook of Orthopaedic Surgery, C. V. Mosby Co., St. Louis, Missouri, 1940.
20. Steindler, A. Lectures on the Interpretation of Pain in Orthopedic Practice, Charles C Thomas, Springfield, Illinois, 1959.

Appendix

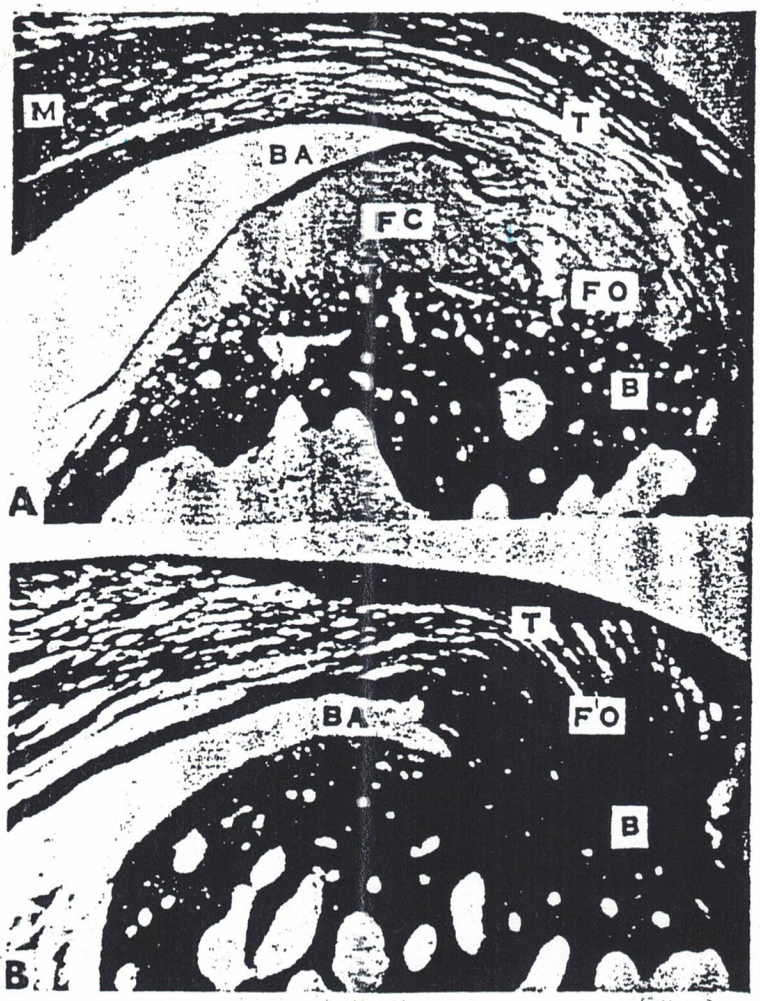

Fig. 30—A. Control leg (above). B. Injected specimen (below). Animal experiment: photomicrographs of induced fibro-osseous proliferation. Bone-B, Tendon-T, Muscle-M, Fibro-osseous junction-FO, Fibrocartilage-FC, Bursal area-BA.

Decalcified specimens of rabbit Achilles tendon attachments, two months after single injection of 0.5 cc of a proliferant solution (sylnasol 1 part, pontocaine 3 parts) was made against bone within the fibro-osseous attachment of the tendon. Right leg [B] was injected. Control left leg [A] was not.

A. Control leg: the tendon fibers (T) blend with the periosteum and continue into bone (B).

B. Injected leg: new, densely trabeculated bone (B) extends distally into the fibro-osseous attachment (B-FO), encroaching on the fibro-cartilage (FC) which is also denser, and also on the "bursal area" (BA) which lies between the tendon of the relaxed muscle and bone (B). The tendon fibers are also thicker. The "weld" of tendon to bone is strengthened. This explains the clinical cures when weak ligament/tendon attachments to bone are permanently strengthened by prolotherapy. (Courtesy of Hackett, G. S.: Military Medicine, 126:517, July, 1961.)

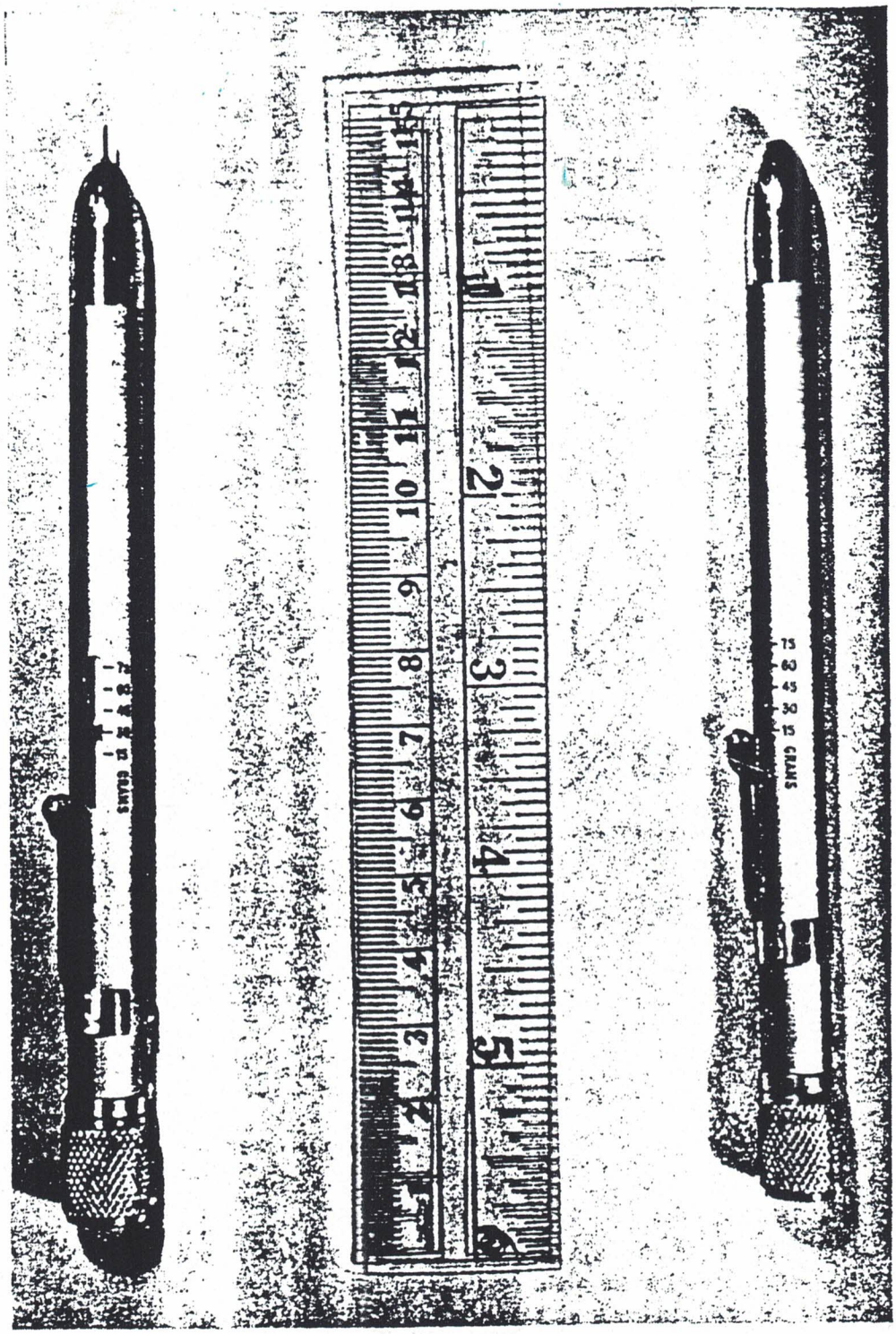

Fig. 31—Baker esthesiometer for testing pain (pinprick) sensation, with spring-controlled pressure settings.

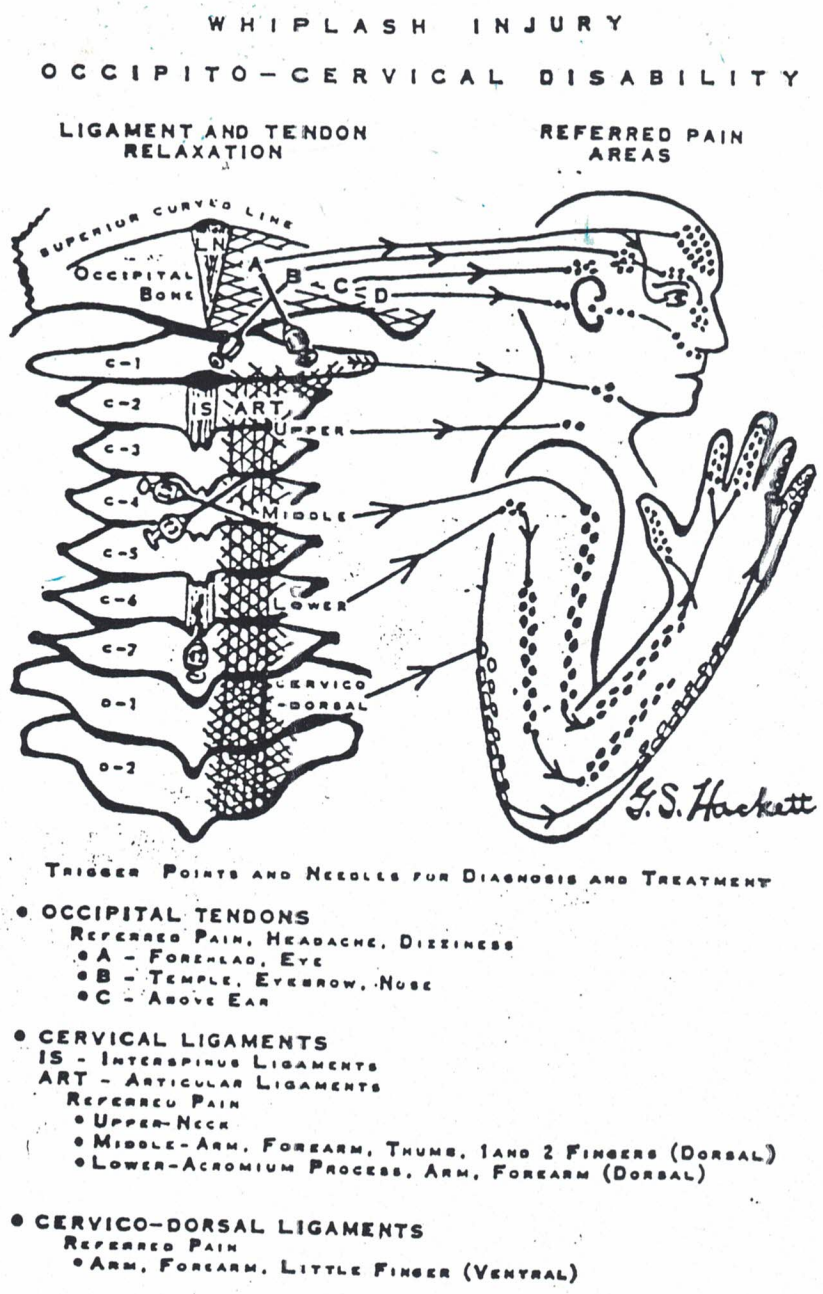

Fig. 32—In occipito-cervical injuries, trigger points (A, B, C and D) in suboccipital area refer pain to face, head, and neck as indicated. Referred pain into the neck, upper extremity and fingers is present with relaxation (insufficiency) of articular ligaments and associated muscle tendon attachments (ART) to cervical and upper thoracic vertebrae. Nuchal ligament attachment (LN) in area of occipital protuberance, when relaxed, often refers pain along a midline strip from the occiput to the midline frontal area. (Courtesy of Hackett, G. S.: Postgraduate Medicine, 27:214–219, Feb. 1960.)

Fig. 33—Patient seated astride chair, facing backwards, for occipital and cervical diagnosis and treatment. Left thumb and index finger astride midline between spinous processes (courtesy of Hackett, G. S.: Ligament and Tendon Relaxation Treated by Prolotherapy, ed. 3, p. 41, Springfield, Thomas, 1958).

Patients presented in this paper seated this way. Many other physicians using prolotherapy prefer the prone position with large pillow placed lengthwise under the chest, distal to the chin, with neck fully flexed.