Referred Visceral Pain: What Every Sports Medicine Professional Needs to Know

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In any type of contact sport, the athlete is susceptible to abdominal trauma. Fortunately, abdominal injuries occur relatively infrequently. Nevertheless, when they do occur, immediate identification, treatment, and medical referral is imperative. The alternative to such action could be disastrous. Thus the athletic trainer or therapist's ability to fully and accurately assess abdominal trauma to the athlete is paramount in avoiding a potential fatality (2).

Abdominal injuries can present misleading symptoms. Specifically, visceral organs are relatively insensitive to pain—even from stimuli such as cutting or burning.

Referred pain may be the only type of pain that is felt when visceral organs are damaged (8). But referred pain can be confusing and may result in the delay of proper medical referral, since a person can feel pain in a part of the body that is well removed from the site of injury (2). It is extremely important to recognize this phenomenon because a number of visceral affections cause no other signs except the referred pain (8).

This article explores the subject of referred pain in some depth so that if it does occur, it can be detected and understood. Early detection and understanding will facilitate a proper evaluation and expedite treatment for the athlete.

The mechanisms for referred pain are discussed. Diagrams are included to clarify these mechanisms. In addition, specific examples of referred pain from visceral organs subject to athletic injury are presented. Finally, basic concepts are summarized and implications for the athletic trainer or therapist are stressed.

Key Points

- Abdominal injuries can present misleading symptoms by referring pain to superficial areas of the body well removed from the injury site.
- Referred pain may be the only indication of injury, thus athletic trainers and therapists need to be aware of this phenomenon.
- By understanding the concept of referred pain, athletic trainers and therapists buy precious time for athletes while securing medical care.

Mechanisms for Referred Pain

The various parts of the human body do not all perceive pain in the same way. An important characteristic of pain relative to visceral injury is its tendency to
irradiate and give rise to referred pain (1, 13). Visceral pain is usually referred to a cutaneous surface. For example, pain due to heart damage may be experienced as pain of the left upper arm or pain passing down the arm into the hand (8, 13). Splenic injury may be referred to the left shoulder and arm, which is known as Kehr’s sign (8). Pain from the liver may be referred to the right shoulder (10).

These misdirections of pain sensation appear to be due to the excitation of a common pool of neurons within the spinal cord, brain stem, or cortex acted on by different afferent sources (13).

Mechanisms for referred pain are illustrated in Figure 1, which depicts the general organization for the afferent pathways of visceral pain at one spinal level.

According to Guyton (8), “It is generally believed that visceral pain fibers may synapse in the spinal cord with certain neurons transmitting pain sensation from the skin” (p. 510). Their synapses may actually cross so that stimulation of visceral pain fibers results in the sensation of cutaneous pain (see Figure 2). Furthermore, according to MacBryde, “referred pain may be due in part to reflex muscle spasm, also mediated through intraspinal nerve connections” (p. 183).

The perception of visceral pain can be extended to many other spinal levels. This fact demonstrates the existence of intermediate neurons connecting the posterior horn cells, as well as interneuronal cells connecting the higher and lower segments of the cord. This may be the mechanism responsible for the characteristic referral of splenic pain.

A main point to understand is that the neurons that supply the skin in the area where the pain is felt enter the same segment of the spinal cord as do the neurons that actually conduct the pain stimuli from the visceral organ. An appreciation of this merger into a common path is essential to an understanding of the distributions of visceral pain. Concisely stated, Visceral pain will be noted in that somatic area with which it shares a final common path.

Figure 3 illustrates the relationship of the visceral organs and their afferent pathways. Exactly where these visceral afferents enter the spinal cord and mingle with somatic afferents is the key to the principle of referred pain. Figure 4, the dermatomes (3) (i.e., segments of cutaneous sensation with respect to each spinal level), directly complements Figure 3 by identifying the corresponding area of somatic sensation due to the intersecting visceral afferents.

Under some circumstances, only slight trauma to the abdomen may result in hemorrhage. Free blood in contact with the peritoneum results in peritonitis, which in itself is a medical emergency. This too presents referred pain corresponding to the location of the incoming afferent impulses.

**Examples of Referred Pain**

Figure 3b illustrates the specific pathologies of referred pain from each selected organ. For example, cardiac pain is experienced by substernal discomfort projected to the neck and left jaw, as well as the left shoulder and arm over the distribution of the ulnar nerve. This is because dermatomes T1–T8 are generally involved.

Less frequently, pain may be referred to the right shoulder and arm or to both shoulders, arms, and hands. Occasionally, anginal pain may be projected posteriorly to the area of the left scapula at the interscapular region (10), as in left ventricular involvement.

With respect to the lungs, extreme damage may occur in the absence of pain until inflammation extends to the parietal pleura. The pleural irritation then gives rise to pain along the dermatomes corresponding to the spinal levels of the incoming afferent impulses C8–T8 (10).

The diaphragm is supplied by somatic nerves that enter C3–C5. Any painful stimulus to the parietal peritoneum is referred along the corresponding cutaneous nerves. Thus diaphragmatic pain is characteristically referred to the shoulder area’s cutaneous distribution of C3–C5 (9).

Trauma to the esophagus gives rise to pain on the sternal region of the thorax corresponding to the site of the lesion (i.e., an upper esophageal lesion yields manubrial pain; a lower esophageal lesion yields xiphoid pain or pain in the epigastrium (8). Esophageal afferent fibers enter the lower cervical and all thoracic levels, but especially T5–T6 (8), which corresponds to the above regions of perceived pain.

**Splenic** afferent impulses course the phrenic nerve at the C3–C5 levels (5), presenting sharp cutaneous pain projecting to the left shoulder and about one third of the way down the arm.

This region does not really correspond to that of the spinal levels of the phrenic nerve. Apparently, as noted earlier, longitudinal intermediate neurons within the spinal cord itself become involved, mediating and projecting the impulses farther
FIGURE 1  Sensory impulses from visceral structures within the abdomen are carried by visceral afferent nerve fibers which pass along the sympathetics to the dorsal root ganglia. There, fibers enter the posterior horn of the spinal cord, along with somatic neurons. There they cross to the opposite side and ascend in the lateral spinothalamic tract—along with impulses from somatic pain pathways—to the thalamus, and finally to the cerebral cortex. (Illustrated by Cindy Morris)

FIGURE 2  Viscera and somatic (skin) afferents are shown to intermingle in the posterior horn, thus demonstrating the theorized mechanism of perceived cutaneous pain due to deep abdominal pain. Motor neurons are also shown to be involved with the afferent impulses, resulting in possible reflex muscle spasm. (Illustrated by Cindy Morris)
Figure 3 (A) Simplified schematic representation of the levels of afferent innervation for selected visceral organs, many of which are subject to trauma. (B) The resulting clinical presentation of referred somatic pain for each organ. (Illustrated by Cindy Morris)

Referred pain depends on the distribution of afferent fibers and their course. Pain fibers from the viscera run to the spinal cord with the sympathetic nervous system, and the impulses are transferred to the neurons of the somatic sensory nerves (see Fig. 4).

Note: Impulses in the parasympathetic afferents are rarely intense enough to produce pain on the conscious level. However, these impulses can be referred to cutaneous regions, resulting in the very real experience of pain.
FIGURE 4 The dermatomes. Pain referred to the skin from a visceral organ tends to be “felt” in a relatively small, circumscribed area, within the compass of the dermatome of the same segment that supplies the viscus (3). (Illustrated by Cindy Morris)
down the cord to the T2–T3 dermatome. Also, the diffuse celiac plexus probably plays a role since it receives splenic fibers and directly or indirectly connects to nearly all of the thoracic levels.

Concerning the pancreas, intense pain may be felt both anteriorly and posteriorly. The pain frequently refers directly behind the pancreas in the back and can be quite agonizing (8). Some afferents enter the vagus nerve, but spinal levels T7–T9 are primarily involved.

Liver and gall bladder pain are referred to the epigastrium and immediately to the right of this area. If the subdiaphragmatic parietal peritoneum is irritated, there may be referred pain over the shoulder due to the phrenic nerve (C3–C5) and the supraclavicular nerves (C3–C4).

Pain from the gall bladder is usually in the region of dermatome T8. The pain follows its course to the back, just below the right scapula, to the right shoulder, to the substernal area, and sometimes to the anterior left chest (6). Knife-like pain is often associated with hyperesthesia of the skin (10).

Pain of gastric origin is most often felt in the epigastrium, usually in the midline or in the left quadrant (10). Spinal levels anywhere from T5 to T10 may be involved. Backache or sharp pain in the back may result from lesions of the intestines. Specifically, the small intestine presents periumbilical pain. For example, duodenal pain is epigastrical, jejunal pain will be referred to the upper left quadrant, and ileal pain will be referred to the right lower quadrant.

Pain from colonic lesions is generally felt in the lower half of the abdomen and is relatively diffuse. Cecal and ascending colon pain is usually felt in the right lower quadrant (10). Pain of the transverse and descending colon is located in the left lower abdomen (10). Sigmoid colon lesions produce suprapubic pain posteriorly in the region of the sacrum (10). Spinal levels T7–T11 are associated with the intestines.

The pain from acute appendicitis is usually localized to the T10–T11 cutaneous nerve distribution on the right (12). A vague referred pain is felt in the region of the umbilicus. It may spread to both flanks.

Later, when the pain shifts to where the inflamed appendix irritates the parietal peritoneum, it becomes precise, severe, and localized to the right lower quadrant. Spinal levels L1–L2 are associated here. Furthermore, lumbar pain may arise from appendicitis, especially if the appendix is retrocaecal (5).

With respect to the kidneys, pain may be felt high in the costovertebral angle, posteriorly, due to hyperesthesia of the corresponding dermatomes (10). Pain may radiate forward around the flank, into the lower abdominal quadrant (T11–L1). Ipsilateral, generalized abdominal pain, spasm of the abdominal muscles, and rebound tenderness may all occur and exceed the posterior pain (10).

Typically, pain of ureteral origin also starts in the costovertebral angle and radiates to the lower abdomen, upper thigh, and testis or labium of the respective side. This presentation is mainly due to hyperesthesia of the associated dermatomes (T12–L1) (10).

Afferent fibers are believed to pass from the bladder (through the hypogastric plexus to the upper lumbar and lower thoracic nerve roots) to the intermediolateral cells of T9–L2 segments of the spinal cord (4). Pain sensation from the bladder may be conveyed along this route, i.e., the lower trunk and upper thigh region, anteriorly, and especially suprapubically. In some bladder lesions, pain may be felt at the distal tip of the urethra (10).

One last note, inflammation of the prostate and seminal vesicles may cause low lumbar or sacral referred pain. This appears to be in agreement with the testicular/prostate/uterus T10–T12 association.

Application

Visceral injury results in the referral of pain to superficial areas of the body which can be well removed from the source of the lesion. This phenomenon may be the only presenting symptom suggesting to the athletic trainer or therapist that internal injury has occurred.

Alone, or along with other signs of visceral damage such as abdominal rigidity and shock, the athletic trainer or therapist's understanding of the concept of referred pain may buy precious time for the athlete while emergency medical care is being secured. (Figure 3 should facilitate this diagnostic process. Note the cutaneous areas in Figure 3b and match the color to the same-colored organ in Figure 3a.)

Summary

The features of referred pain are best summarized in Gray's Anatomy of the Human Body (7):

"Although most physiological impulses carried by visceral afferent
fibers fail to reach consciousness, pathological conditions or excessive stimulation (e.g., trauma and inflammation) may bring into action those which carry pain. The central nervous system has a poorly developed power of localizing the source of such pain, and by some mechanism not clearly understood, the pain may be referred to the region supplied by the somatic afferent fibers whose central connections are the same as those of the visceral afferents” (p. 1007).

An alteration in motor activity may accompany referred pain. This is exemplified by muscle guarding in the region of the referred pain. Such muscular contractions, if prolonged, may become an additional source of pain and tenderness. Therefore, according to Gray’s Anatomy,

“The study of clinical cases of referred pain can be very useful in tracing the path of afferent fibers from the various viscera, and a knowledge of these paths may be of great assistance to the diagnostican in locating a pathological process” (p. 1007).

Hopefully, this article has added another dimension to the athletic trainer’s protocol, enhancing it so that a possible life-threatening situation can be quickly and correctly identified.

Although more pathological situations have been presented here than a single athletic trainer or therapist is likely to encounter, it would behoove one to make a mental note of the principles involved. A more thorough understanding of the common sites of abdominal injury is imperative. One cannot afford to risk the alternative of ignorance when human life is at stake.

References