Acoustic Shock

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*The Journal of Laryngology & Otology (2007) **121**, 301–305.*

doi:10.1017/S0022215107006111
Printed in the United Kingdom
First published online 19 February 2007

Review Article

Acoustic shock

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Abstract

Acoustic shock is a recently recognised clinical entity: following an abrupt, intense and unanticipated acoustic stimulus, usually delivered by a telephone handset or headset, some individuals report a symptom cluster that includes otalgia, altered hearing, aural fullness, imbalance, tinnitus, dislike or even fear of loud noises, and anxiety and/or depression. Symptoms start shortly after the triggering acoustic incident and can be short-lived or can last for a considerable time. If persistent, the condition can lead to significant disability. Proposed mechanisms include involvement of the tensor tympani muscle, hyperexcitability of central auditory pathways, and a precursive state of raised anxiety or arousal. A formal treatment programme has not yet been proposed, but the potential utility of modern therapeutic techniques for tinnitus and hyperacusis are considered. Given the large number of UK residents working in telephone call centres, this condition is of considerable clinical importance.

Key words: Occupational Noise; Hyperacusis; Tinnitus; Serotonin; Ear Diseases

A “new” syndrome: pain, tinnitus, balance disturbance and phobic symptoms following exposure to sudden, unexpected noise.

Introduction

- Acoustic shock is a recently recognised clinical entity
- Call centers workers has developing a pattern of both physical and psychological symptoms arising immediately after or soon after exposure to sudden, unexpected noise from headset or handset.
- The majority of reports of acoustic shock have come from Denmark and Australia

Introduction

- Acoustic shock has become firmly associated with the use of telecommunications equipment
- It is likely that exposure to other forms of sudden, unexpected sound can generate similar symptoms.
  - However, these types of exposure form a much more heterogeneous set
  - Largely excluded from formal definitions of the syndrome.

Introduction

- Acoustic shock is unrelated to noise-induced hearing loss
  - Repeated exposure to sounds of an intensity greater than 85 dB causes cochlear damage.

Definitions

- International Telecommunications Union and European Transmission Standards Institute
  - “Any temporary or permanent disturbance of the functioning of the ear, or of the nervous system, which may be caused to the user of a telephone earphone by a sudden sharp rise in the acoustic pressure produced by it”

International Telecommunication Union, 1998

Definitions

- The Health Services Australia Group
- “Acoustic shock refers to the combination of exposure to a brief, sudden, unexpected, high frequency, high intensity sound emitted (the stimulus) and the subsequent symptoms (the response) which can develop”
  - The causative sound or ‘acoustic incident’:
    - A sudden, unexpected, high-pitched sound of high intensity.
    - It may be emitted from a headset or handset and is commonly reported as a ‘shriek’

Acoustic Shock. HSA Group, 2001

Definitions

- In the United Kingdom, the Acoustic Safety Programme
  - “An acoustic incident is a sudden, unexpected, noise event which is perceived as loud, transmitted through a telephone or headset”
  - “Acoustic shock is an adverse response to an acoustic incident resulting in alteration of auditory function”

National Definitions of Acoustic Shock in Telephone and Headset Users 2006

Acoustic Incidents

- There are many potential ways that such sounds may arise within a call centre workplace.
  - Faulty telephone or headset equipment
  - Transmission faults within the network.
  - Positive feedback with some cordless and mobile phones.
  - Tones from facsimile machines or modems
  - Maliciously generated sounds: shouting or blowing a whistle into their telephone.

Acoustic Incidents

- Characteristics of the sounds.
  - Intensity and Frequency
    - A Danish study:
      - Intensity: 56 to 108 dB; frequency: 100 Hz to 3.8 kHz.

An investigation of the telephone services of the call centre of TeleDanmark in Aabenraa, 1999

    - An Australia study:
      - Intensity: 82 to 120 dB; frequency: 2.3 to 3.4 kHz

Milhinch JC. Acoustic shock injury: real or imaginary.

Acoustic Incidents

- Characteristics of the sounds.
  - Rise time: very short, varying between 0 and 20 milliseconds.
  - Duration: Difficult to estimate
    - Removing a headset from the head takes longer than moving a handset away from the ear
    - It seems likely that wearing a headset carries more risk of incurring acoustic shock.

Clinical Features

- Immediately or soon after exposure to an acoustic incident
  - Ear pain — 81%
  - Tinnitus — 50 %
  - Balance problems — 48%
  - Hearing loss — 18.4 %
    - No statistically significant audiological difference between exposed and non-exposed ears except at a frequency of 1.5 kHz.

Milhinch JC. Acoustic shock injury: real or imaginary.

Clinical Features

- Immediately or soon after exposure to an acoustic incident
  - Pain in the neck or jaw — 11 %
  - Pain in the face — 7 %
  - Sensation of blockage or aural fullness
  - Numbness

Milhinch JC. Acoustic shock injury: real or imaginary.

Clinical Features

- Longer to emerge
  - Anxiety
  - Depression
  - Headache
  - Sensitivity to previously tolerated sounds (hyperacusis)
  - Hypervigilance
  - Anger

Milhinch JC. Acoustic shock injury: real or imaginary.

Clinical Features

- Examination and tests
  - Mostly normal
  - May have sensorineural hearing loss but may be low/mid frequency rather than 4-6 kHz loss of noise-induced hearing loss

Epidemiology

- There are no reliable data available regarding the prevalence and incidence of acoustic shock.
- Call centre workers at increased risk
  - Increased prevalence in those with stress, smoking, neck and shoulder pain
- However, no evidence of pre-existing psychological or psychiatric morbidity

An investigation of the telephone services of the call centre of TeleDanmark in Aabenraa, 1999

Epidemiology

- More women than men even allowing for skewed sex distribution within call centre workplaces
- Exposure to an acoustic incident does not automatically result in the development of acoustic shock symptoms.

An investigation of the telephone services of the call centre of TeleDanmark in Aabenraa, 1999

Pathophysiology

- The pathophysiological mechanisms underpinning acoustic shock remain obscure
- Complex and Multifactorial.
  - Middle ear
  - Cochlear
  - Central auditory pathway
  - Psychological mechanisms

Middle Ear

- Protecting the cochlea from intense sound exposure
  - Stapedius muscle and tensor tympani muscle
- Both of these muscles have been implicated in acoustic shock, with a particularly important role proposed for the tensor tympani muscle.
  - Spontaneous contractions of the tensor tympani (similar to blepharospasm) give rise to a fluttering or beating sensation.
- There is evidence that middle-ear muscle function is influenced by the serotoninergic system
  - There is a potential link between emotional state and middle-ear muscle contraction.

Serotoninergic innervation of stapedial and tensor tympani motoneurons. Brain Res 1998;787:175–8

Tonic tensor tympani syndrome in tinnitus and hyperacusis patients: A multi-clinic prevalence study

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- The tensor tympani reflex
  - Startle reflex
  - The tensor tympani muscle contracts immediately preceding the sounds produced during self-vocalization
  - It has an established protective function to loud sounds, assists in the discrimination of low frequency sounds

Middle Ear: Tonic Tensor Tympani Syndrome (TTTS)

- In 1961, Dr. I. Klockhoff
- An involuntary and anxiety–based condition
- The centrally mediated reflex threshold for tensor tympani muscle activity becomes reduced
- Continually and rhythmically contracting and relaxing.
- Physiological reactions in and around the ear without objectively measurable dysfunction or pathology.

Klockhoff I. Tensor tympani syndrome: A source of vertigo. Meeting of Barany Society; 1978.

Middle Ear: Symptom of TTTS

- Tinnitus
- Rhythmic aural sensations such as clicks and tympanic membrane flutter
- Alterations in ventilation of the middle ear cavity leading to a sense of aural blockage or fullness, a frequent aural “popping” sensation and mild vertigo
- Irritation of the trigeminal nerve innervating the tensor tympani muscle
  - leading to pain, numbness and burning sensations in and around the ear, along the cheek, neck and temporomandibular joint (TMJ) area

Westcott M. Acoustic shock disorder. Tinnitus discovery-Asia and pacific tinnitus symposium, Auckland, September 2009. NZMJ 2010;123:p25.

Acoustic Shock

- Acoustic shock was defined as an acoustic incident trigger for tinnitus/ hyperacusis onset plus the presence of one or more symptoms consistent with TTTS.
  - Without underlying aural or TMJ pathology.

Cochlea

- The high incidence of tinnitus in the acoustic shock population may cause one to consider cochlear dysfunction as a potential mechanism
- Paucity of cochlear damage mitigates against cochlear mechanism

Central Auditory System

- Disturbance of central auditory serotoninergic pathways may result in altered sound tolerance
  - No involvement of the middle-ear muscles
  - Auditory hypersensitivity (such as hyperacusis and phonophobia) is seen to be due to abnormal function within serotonin pathways

Central Auditory System

- Medial efferent system dysfunction has also been suggested as a possible cause of hyperacusis
  - Nerve fibers from the medial efferent system terminate on the outer hair cells in the cochlea
  - This system has been proposed as being important in modulating auditory gain.
  - Dysfunction of this system could result in the auditory system being kept in a state of abnormally high sensitivity.
- Such central auditory system mechanisms have the merit of suggesting how acoustic shock could arise without any evidence of accompanying peripheral auditory deficit.

Psychological Mechanisms

- Auditory startle is potentiated by anxiety and arousal
  - It may be that the onset of acoustic shock is triggered by a hyperintense startle to an unanticipated noise.
- Aversive reaction to sound can occur and that this reaction is independent of the intensity of the sound.
  - Mediated by the limbic system and autonomic nervous system

Tinnitus habituation therapy (THT) and tinnitus retraining therapy (TRT), 2000

Psychological Mechanisms

- Fear-avoidance pathway
  - Fear of sound can result in avoidance of sound, which in turn causes increased central auditory sensitivity, thereby enhancing the fear.

Prevention

- Output limiters
  - Reducing level too much causes intelligibility problems – operative strains to hear and raises central auditory gain.
    - Potentially counterproductive as if high central auditory gain may be more prone to acoustic shock.
- Acoustic incident filtering — awaited firm scientific proof

Prevention

- The call centre environment
  - To design low impact working environments
  - To utilise working practices that do not cause or exacerbate stress.
- Staff education
  - Set the output level of their headset to the lowest level commensurate with satisfactory speech intelligibility.

Treatment

- One of the common complaints of patients who have experienced an acoustic shock is that their symptoms are ignored or minimised by medical staff.
    - Following normal audiological tests, many patients are simply reassured that no damage has been sustained and are dismissed.

Treatment

- Avoid sound by protecting their ears with plugs and muffs.
  - Counter-productive
  - Reducing the amount of incoming auditory information—increasing the hypersensitivity of the auditory system.
- Tinnitus and hyperacusis model—tinnitus retraining therapy
  - Explanation, counselling, desensitization using low level sound
- Psychological therapies
  - Conventional psychological tools including cognitive behavioural therapy
- Job

A neurophysiological approach to tinnitus: clinical implications. Br J Audiol 1993;27:7–17

Summary

- A pattern of symptoms has emerged in people who are exposed to sudden, intense, unexpected noises from telecommunications equipment
- Clinical picture is often not recognised.
    - Therefore under-reported.

Summary

- Distinct from NIHL/acoustic trauma
- Tests often within normal range
- Information is difficult to find and nothing published to date meets evidence based medicine criteria.
- Pathophysiology and management uncertain

Thank You