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An expert system for shoulder problems using CLIPS

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Abstract

The shoulder joint is consist of bones detained in position by muscles, tendons, and ligaments. Tendons are hard cords of tissue that grasp the shoulder muscles to bones. They assist the muscles move about the shoulder. Ligaments grip the three shoulder bones with one another and aid compose the shoulder joint steady. In this paper an expert system was designed to help out users to properly diagnose shoulder problems. Many shoulder problems are caused by the collapse of soft tissues in the shoulder area. Using the shoulder in excess of may cause the soft tissue to break down earlier as people get elder. Doing physical labor and playing sports can reason shoulder problems. Shoulder tenderness can be felt in one small smudge, in a larger region, or down the arm. Pain that moves all along nerves to the shoulder may be caused by diseases such as: Gallbladder disease, Liver disease, Heart disease, Disease of the spine in the neck, with some information about the disease and how to treat it. CLIPS expert system language was used to design and implement this expert system.

Keywords: Artificial Intelligence, Expert Systems, CLIPS language, Shoulder Problems

Introduction

The shoulder is one of the biggest and the focal compound joints in the body. The shoulder joint is shaped where the humerus (upper arm bone) fits into the scapula (shoulder blade), like a ball and socket. Other important bones in the shoulders as follows[1,2](see Fig. 1) :

- The acromion is a lanky projection off the scapula.
- The clavicle (collarbone) congregates the acromion in the acromioclavicular joint.
- The coracoid progression is a hook-as bony projection from the scapula.

The shoulder has quite a few other significant structures[1,2]:

- The rotator cuff is a compilation of muscles and tendons that enclose the shoulder, providing it hold up and permitting a broad variety of motion.
- The bursa is a tiny bag of fluid that cushions and guards the tendons of the rotator cuff.
- A cuff of cartilage identified as the labrum forms a cup for the ball-like head of the humerus to settle inside it.

The humerus settles comparatively insecurely into the shoulder joint. This gives the shoulder a broad variety of motion, however it makes it susceptible to damage.

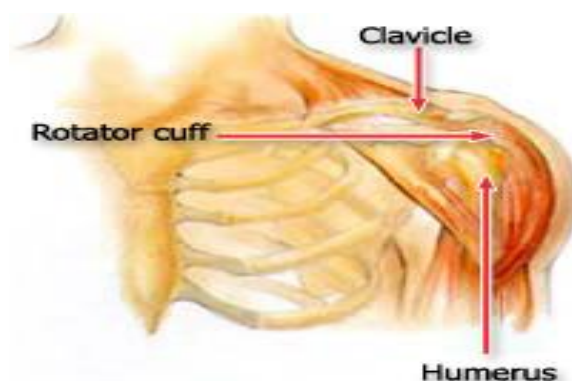


Fig 1: Shows the human shoulder

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Expert System Language

Expert Systems language is a set of programs which allow the building of an expert system through the creation of knowledge and rules, see figure 2 for details. Expert systems have three essential components[15-17]:

1. User interface : presents questions to the user and accepts inputs from them
2. Knowledge base: contains data and facts, rules and objects in a specific knowledge domain. The knowledge base obtained from the human expert is prepared by a knowledge engineer as most human experts are not skilled at computer programming
3. Inference engine: this is software that matches the users input with data contained in the knowledge base to reach appropriate answers. This is done using inference rules e.g. If conditions Then rules.

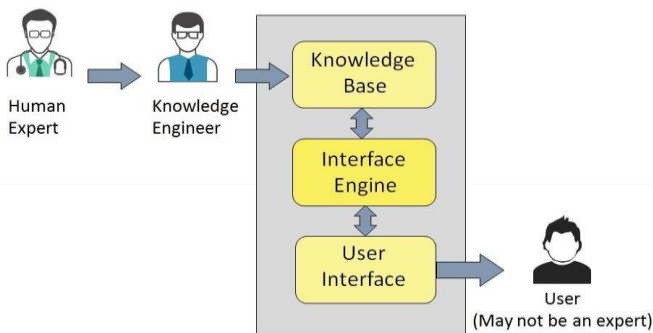


Fig 2: Components of an expert system

The proposed expert system for Shoulder problems diagnosis was designed and implemented using CLIPS which was developed at NASA's Johnson Space Center in 1996. CLIPS stands for C Language Integrated Production System. CLIPS is a rule-based programming language useful for creating expert systems and other programs where a heuristic solution is easier to implement and maintain than an algorithmic solution. CLIPS has been written in C for portability, it can be installed and used on a wide variety of platforms[15-17].

Materials and Methods

The proposed expert system will ask the user a few questions about the symptoms of the patient and end up with the diagnosis and a recommendation for self caring. Then this expert system shows the user some information about the disease and some advices telling him/her how to deal with The patients.

Literature Review

There is no dedicated expert system for shoulder diagnosis and treatment in the literature; however, there are many expert systems that were designed to help facilitating diagnosing and managing a lot of diseases and medical problems like: Foot problem, Male fertility problems, Ear problems, Hearing Problems, neck pain problems, low back pain problems, eye problems, and endocrine problems [3-9,11-14,18-27] which considered as a part of applying Artificial Intelligence and computer science in order to help doctors, hospitals and health care facilities decision making to enable them to offer their health services in the right way.

Our propose expert system is dedicated to the diagnosis of Shoulder problems. Currently the expert system diagnosis 12 Shoulder Pain problems. The proposed diagnostic expert system is offering an easy way, helping people to know how to diagnose and deal with their patients Shoulder problems by giving them some advices about what to do and when to ask for medical help. We give a description and management for 9 Shoulder problems (upper arm bone, collarbone, separated shoulder, torn rotator cuff, inflammation, rheumatic fever, rheumatoid arthritis, rotator cuff syndrome, adhesive capsulitis) affecting People, and especially the elderly worldwide.

Knowledge Representation

The main source of the knowledge for this expert system are physicians and specialized websites. The captured knowledge have been converted into Clips Knowledge base syntax (facts and rules). Currently the expert system has about 14 rules which cover 9 Shoulder problems. Here is a brief identification of each of the 9 Shoulder problems that the expert system can help the user with[1,2,10]:

A. upper arm bone

The bones of the arm and hand have the significant works of aiding the upper limb and granting attachment points for the muscles that move about the upper limb. These bones form joints that give a wide range of movement and flexibility wanted to control objects neatly with the arm and hand. They also offer strength to resist the tremendous forces and stresses affecting the arms and hands during sports, work out, and intense labor.

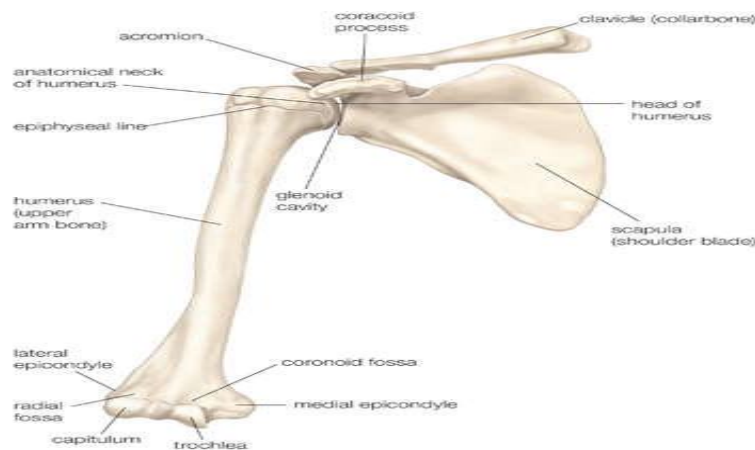


Fig 3: upper arm bone

B. Collarbone

A busted collarbone is as well recognized as a clavicle fracture. This is a extremely general fracture that happens in people of all ages all the time as seen in figure 4.



Fig 4: shows a person with busted collarbone

C. Shoulder may be Separated

Alienated shoulder injury doesn't in a straight line influence the shoulder joint. On the other hand, a fall or blow rips one of the ligaments that connects the collarbone to the shoulder blade. While it's any more anchored, the collarbone can go out of position and move forward against the skin close to the top of one's shoulder. Even though alienated shoulders may cause deformity, people habitually get well completely with time.

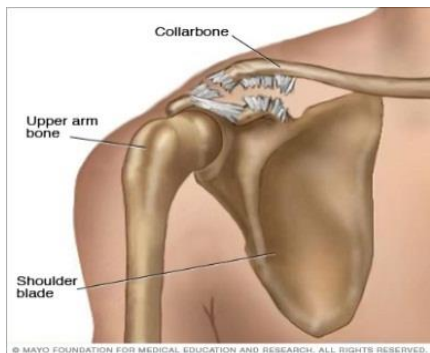


Fig 5: Shoulder may be Separated

D. Torn rotator cuff

A rotator cuff rip is a ordinary reason of pain and disability amongst adults. In 2008, nearly 2 million people in the United States went to their doctors due to a rotator cuff problem. A ragged rotator cuff can deteriorate one's shoulder. This indicate that a lot of daily activities, like coiffure your hair or putting dressed on, can become agonizing and difficult to do.



Fig 6: Torn rotator cuff

E. Inflammation

Inflammation is a procedure by which the body's white blood cells and materials they generate defend us from infection with unfamiliar organisms, such as bacteria and viruses.



Fig 7: Inflammation

F. Rheumatic fever

Rheumatic fever is an provocative disease that may expand as a difficulty of ineffectually treated strep throat or scarlet fever. Strep throat and scarlet fever are attributed to an infection with group A streptococcus bacteria.

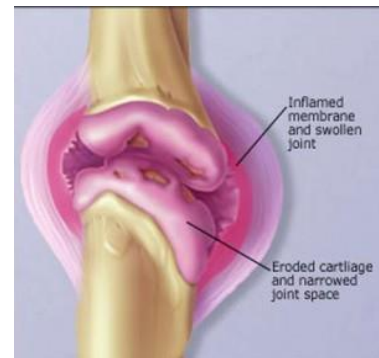


Fig 8: RHEUMATIC FEVER

G. Rheumatoid arthritis

Rheumatoid arthritis is a constant inflammatory commotion that may distress further than just one's joints. In various people, the condition further may damage a great variety of body systems, in addition to the heart, lungs, eyes, skin and blood vessels.

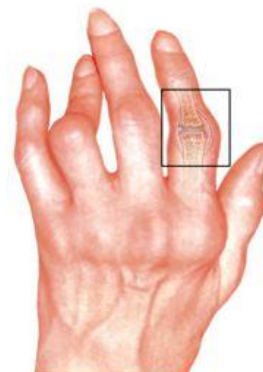


Fig 9: Rheumatoid arthritis

H. Rotator cuff syndrome

Tendons and muscles that assist in moving the shoulder joint. If one has tendinitis, it means that his/her tendons are reddened or annoyed. Rotator cuff tendinitis is as well known as impingement syndrome.

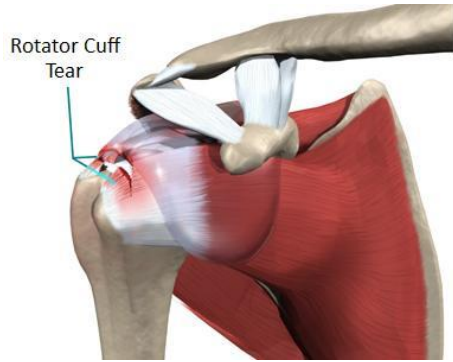


Fig 10: Rotator cuff syndrome

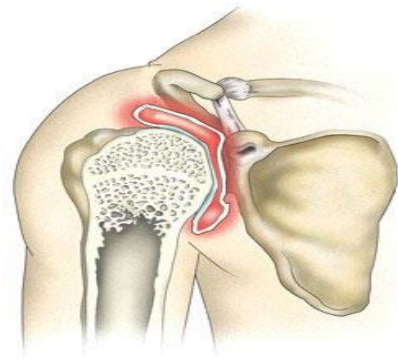


Fig 11: Adhesive capsulitis

Adhesive Capsulitis

Frozen shoulder, as well recognized as adhesive capsulitis, is a situation distinguished by hardness and pain in one's shoulder joint. Signs and indication normally start slowly, get worse over time and then doggedness, frequently within one to three years.

Expert System interface

Figure 13, 14, and 15 shows a few screen shots about the execution of the shoulder problems in Human diagnosing expert system. The first one contains some information about the purpose of the expert system. The second one contains the diagnosis of the patients after asking his/her a few question related to him/her condition. The last one contains the recommendation for the self care of the patients.

```

=====
|                               Shoulder Expert System Diagnosis                               |
=====
|
| This expert System diagnosis Shoulder problems and at
| end of the expert system session, the expert System
| give the user the proper diagnosis of his problem andes
| the proper selfcare for his case.
| This expert System is written in CLIPS Language.
|
=====

```

Fig 12: Introductory Screen of the expert system

```
=====
|                               Shoulder Expert System Diagnosis                               |
=====
|
| The diagnosis of the expert system as follows:
|
| Your SHOULDER may be or may have been DISLOCATED.
|
=====
```

Fig 13: shows the diagnosis that is given by the expert system

```
=====
|                               Shoulder Expert System Diagnosis                               |
|=====|
|
| The proper self care of the expert system as follows:
|
| See your doctor right away.
|
```

Fig 14: shows the self-care that is given by the expert system

Conclusion

In this paper, a proposed expert system was designed and developed using Clips expert systems language in order to help physicians and parents in diagnosing their shoulder

problems in an easier and more precise way than before. This expert system is simple, fast and easy to use.

Expert system source code

```

;;;=====
=====
;;; Shoulder Expert System
;;;
;;; CLIPS Version 6.0 Example
;;;
;;; To execute, merely load, reset and run.
;;;=====
=====

..*****
;;
;;* DEFFUNCTIONS *
;;
..*****

(defun ask-question (?question $?allowed-values)
  (printout t ?question)
  (bind ?answer (read))
  (if (lexemep ?answer)
      then (bind ?answer (lowercase ?answer)))
  (while (not (member ?answer ?allowed-values)) do
    (printout t ?question)
    (bind ?answer (read))
    (if (lexemep ?answer)
        then (bind ?answer (lowercase ?answer))))
  ?answer)
(defun ask-no (?question ?a1 ?a2 )
  (printout t ?question)
  (bind ?answer (read))
  (while (or ( < ?answer ?a1) ( > ?answer ?a2)) do
    (printout t ?question)
    (bind ?answer (read))
  )
  ?answer)
(defun yes-or-no-p (?question)
  (bind ?response (ask-question ?question yes no y n))
  (if (or (eq ?response yes) (eq ?response y))
      then TRUE
      else FALSE))

...*****
;;
;;* QUERY RULES *
;;
...*****
(defrule question-no-1 ""
  (not (Did-you-hit,-injure-or-fall-on-your-upper-arm-or-
shoulder-recently? ?))
  (not (diagnosis ?))
  (not (self-care ?))
  =>
  (if (yes-or-no-p "Did you feel your shoulder pop out of
place and/or pop back into place? (yes/no)? ")
      then
      (assert (diagnosis "Your SHOULDER may be or may
have been DISLOCATED."))
      (assert (self-care "See your doctor right away." ))
    else
      (assert (Is-your-upper-arm-swollen-or-misshaped? no))
  ))

(defrule question-no-2 ""
  (Is-your-upper-arm-swollen-or-misshaped? no)
  (not (diagnosis ?))
  (not (self-care ?))
  =>

```

```

  (if (yes-or-no-p "Is your upper arm swollen or
misshaped? (yes/no)? ")
      then
      (assert (diagnosis "Your HUMERUS (upper arm bone)
may be FRACTURED."))

      (assert (self-care "EMERGENCY Call your doctor or
go to the emergency room right away." ))
    else
      (assert (Is-your-collarbone-tender,-or-do-you-have-a-
bump-on-it? no))
  ))
(defrule question-no-3 ""
  (Is your collarbone tender, or do you have a bump on it?
no)
  (not (diagnosis ?))
  (not (self-care ?))
  =>
  (if (yes-or-no-p "Is your collarbone tender, or do you
have a bump on it? (yes/no)? ")
      then
      (assert (diagnosis "Your CLAVICLE (collarbone) may
be FRACTURED."))
      (assert (self-care "Call your doctor right away. Use a
sling to restrict movement of your arm and use an
analgesic, such as acetaminophen or ibuprofen, to relieve
pain until you see your doctor." ))
    else
      (assert (Is-there-tenderness-or-pain-near-the-shoulder-
end-of-your-collarbone,-and-does-lifting-your-arm-with-
your-uninjured-arm-help-the-pain? no))
  ))
(defrule question-no-4 ""
  (Is-there-tenderness-or-pain-near-the-shoulder-end-
of-your-collarbone,-and-does-lifting-your-arm-with-your-
uninjured-arm-help-the-pain? no)
  (not (diagnosis ?))
  (not (self-care ?))
  =>
  (if (yes-or-no-p "Is there tenderness or pain near the
shoulder-end of your collarbone, and does lifting your arm
with your uninjured arm help the pain? (yes/no)? ")
      then
      (assert (diagnosis "Your SHOULDER may be
SEPARATED."))
      (assert (self-care "Call your doctor right away. Use a
sling to restrict movement of your arm and use an
analgesic, such as acetaminophen or ibuprofen, to relieve
pain until you see your doctor." ))
    else
      (assert (Does-pain-come-with-a-twisting-motion-of-
your-arm,-or-does-a-throwing-motion-cause-pain,-and-
does-your-shoulder-seem-weak? no))
  ))
(defrule question-no-5 ""
  (Does-pain-come-with-a-twisting-motion-of-your-arm,-
or-does-a-throwing-motion-cause-pain,-and-does-your-
shoulder-seem-weak no)
  (not (diagnosis ?))
  (not (self-care ?))
  =>
  (if (yes-or-no-p "Does pain come with a twisting motion
of your arm, or does a throwing motion cause pain, and

```



```

does your shoulder seem weak? (yes/no)? ")
  then
    (assert (diagnosis "You may have a TORNROTATOR
CUFF or SHOULDER INSTABILITY"))
    (assert (self-care "See your doctor." ))
  else
    (assert (Do-you-have-a-fever? no))
))
(defrule question-no-6 ""
(.      Do-you-have-redness-or-swelling-around-your-
shoulder? no)
(not (diagnosis ?))
(not (self-care ?))
=>
(if (yes-or-no-p "Do you have redness or swelling around
your shoulder? (yes/no)? ")
  then
    (assert (diagnosis "You may have INFLAMMATION
in or around a joint, also called BURSITIS, or a serious
INFECTION of the bone, the joint or the skin."))
    (assert (self-care "URGENT
See your doctor right away." ))
  else
    (assert (Within-the-last-month-have-you-had-a-sore-
throat-or-a-skin no))
))

(defrule question-no-7 ""
(Within-the-last-month-have-you-had-a-sore-throat-or-a-
skin no)
(not (diagnosis ?))
(not (self-care ?))
=>
(if (yes-or-no-p "Within the last month have you had a
sore throat or a skin ? (yes/no)? ")
  then
    (assert (diagnosis "These symptoms may be from
RHEUMATIC FEVER, a reaction to a "))
    (assert (self-care "URGENT See your doctor right
away." ))
  else
    (assert (diagnosis "Do-you-have-redness-and-swelling-
in-more-than-one-joint,-including-your-shoulder?"))
))

(defrule question-no-8 ""
(Do-you-have-redness-and-swelling-in-more-than-one-
joint,-including-your-shoulder? no)
(not (diagnosis ?))
(not (self-care ?))
=>
(if (yes-or-no-p ". Do you have redness and swelling in
more than one joint, including your shoulder? (yes/no)? ")

```

```

(printout t crlf crlf)
(printout t "===== " crlf)
(printout t "|      Shoulder Expert System Diagnosis      |" crlf)
(printout t "===== " crlf)
(printout t "|      |" crlf)
(printout t "| This expert System diagnosis Shoulder problems and at |" crlf)
(printout t "| end of the expert system session, the expert System |" crlf)
(printout t "| give the user the proper diagnosis of his problem and |" crlf)
(printout t "| the proper selfcare for his case. |" crlf)
(printout t "| This expert System is written in CLIPS Language. |" crlf)

```

```

then
  (assert (diagnosis "You may have RHEUMATOID
ARTHRITIS, a disease affecting the immune system, or
GOUT, an inflammation of the shoulder joint. "))
  (assert (self-care "See your doctor. Apply heat to the
affected area and take an anti-inflammatory medicine, such
as ibuprofen, for pain." ))
else
  (assert (diagnosis "Do-you-feel-pain-when-you-move-
your-shoulder-but-there's-no-swelling-or-redness?"))
))

(defrule question-no-11 ""
(Do-you-feel-pain-when-you-move-your-shoulder-but-
there's-no-swelling-or-redness? no)
(not (diagnosis ?))
(not (self-care ?))
=>
(if (yes-or-no-p "Do you feel pain when you move your
shoulder but there's no swelling or redness? (yes/no)? ")
  then
    (assert (diagnosis "You may have BURSITIS or
ROTATOR CUFF SYNDROME "))
    (assert (self-care "Use an anti-inflammatory medicine,
such as ibuprofen, and apply heat to the affected area. If
your symptoms do not improve, see your doctor." ))
  else
    (assert (diagnosis "Do-you-have-increasing-stiffness-
and-inability-to-move-your-shoulder?"))
))

defrule question-no-10 ""
(Do-you-have-increasing-stiffness-and-inability-to-move-
your-shoulder no)
(not (diagnosis ?))
(not (self-care ?))
=>
(if (yes-or-no-p "Do you have increasing stiffness and
inability to move your shoulder ? (yes/no)? ")
  Then (assert (diagnosis "You may have ADHESIVE
CAPSULITIS, also called a FROZEN SHOULDER."))
  (assert (self-care "See your doctor. This condition is usually
treated with special exercises you can do on your own." ))
  else (assert (diagnosis "For-more-information,-please-talk-
to-your-doctor.-If-you-think-the-problem-is-serious,-call-
your-doctor-right-away."))
))

*****
*** STARTUP AND DIAGNOSIS RULES *
*****
(defrule system-banner ""
(declare (salience 10))
=>

```

```

(printout t "|"
(printout t "===== " crlf)
(printout t crlf crlf))

(defrule print-repair ""
(declare (salience 10))
(diagnosis ?item1)
(self-care ?item2)
=>

(printout t crlf crlf)
(printout t "===== " crlf)
(printout t "|" Shoulder Expert System Diagnosis "|" crlf)
(printout t "===== " crlf)
(printout t "|" "|" crlf)
(printout t "|" The diagnosis of the expert system as follows: "|" crlf)
(printout t "|" "|" crlf)
(printout t "|" ?item1)
(printout t " "|" crlf)
(printout t "|" "|" crlf)
(printout t "===== " crlf)
(printout t crlf crlf)
(printout t "===== " crlf)
(printout t "|" Shoulder Expert System Diagnosis "|" crlf)
(printout t "===== " crlf)
(printout t "|" "|" crlf)
(printout t "|" The proper self care of the expert system as follows: "|" crlf)
(printout t "|" "|" crlf)
(printout t "|" ?item2)
(printout t " "|" crlf)
(printout t "|" "|" crlf)
(printout t "===== " crlf)
)

```

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