Original Research Paper Engineering/Anatomy

Wrist Prosthesis

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ABSTRACT

Here in this article, I have explained the human wrist, including all the movements, given a brief idea of how muscle stimulations work and finally have given a design of a wrist unit which I think can solve the conundrums related with regular wrist prosthesis. In this article, the researcher has explained how the muscle stimulations work, all the five movements of the human wrist and finally a wrist prosthesis design has been suggested to overcome wrist handicaps and injuries.

KEYWORDS

Introduction

India, a developing country has a total population of 1.252 billion people contributing to the nation's well being. Out of the 1.252 billion people, 12.6 million people sadly are handicapped and if we just take 50% of these people we get 6.3 million people who may have handicaps in the upper limb and many more with upper limb injuries. Not everyone is as lucky as a healthy human being, not everyone is blessed with a fully functioning human body and not everyone is able to move their hands and fingers. Not everyone can do the daily chores we as healthy human beings can do so easily.

According to me the worst injury a human can have in the upper limb, lies in the wrist. Just because of a wrist injury, a human gets handicapped for life and is not able to move the palm and thus has to live life completely dependent on others or has to find other ways to do these daily activities, which is extremely strenuous.

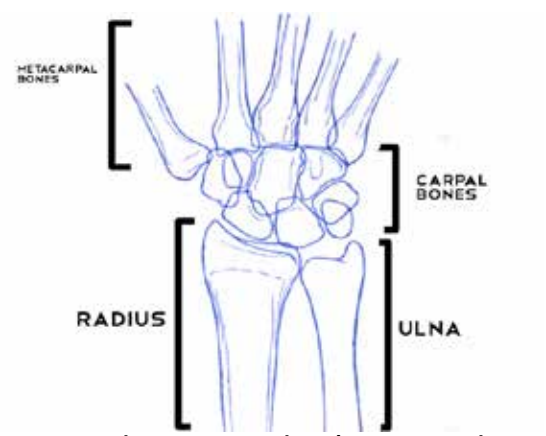
Flashbacking to 2008, I was in Haridwar and was doing a puja on the banks of river ganga when I saw a beggar who had no hands at all and thus couldn't even hold his begging bowl, the plight in his eyes touched my soul and I couldn't help but being young felt so much pity for the beggar that I started crying.

A second instance occurred in Haridwar again two days later where I saw another beggar with one fully functioning hand but his other hand had been cut off from the elbow. To earn money, he was playing a drum by tying a stick on the cut off part and using his second fully functioning hand to create beats. I could see the plight in his eyes- having to live with just one fully functioning hand thus he must have been compelled to beg for money and try to play the drum. I wanted to help the beggars but not temporarily just by giving him money. I wanted to help the beggars for life, sadly being young I couldn't do anything at that time and haven't done anything since.

It was in the third year of engineering when I got a wrist injury playing squash which basically stopped my career as a squash player before it even began and I decided that something had to be done related to the wrist injuries, as the humankind advances, no more humans should face being handicapped due to an injury in this carpal joint. So I studied all about the wrist movements so that I could understand and eventually help humans who had upper limb amputations.

Introduction To The Human Wrist

The human wrist contains 8 carpal bones, 5 meta-carpal bones and 5 phalanges. These bones supported by the radius and ulna form the wrist joint. Each movement of the wrist joint thus depends on the movement of the radius, the ulna and the carpal bones.



Important Diagrams Portraying The Human Wrist Movements

A fully functioning human wrist undergoes these five basic movements:

i) Radial Deviation
ii) Ulnar Deviation
iii) Palmer Flexion
iv) Dorsi Flexion and
v) Rotation

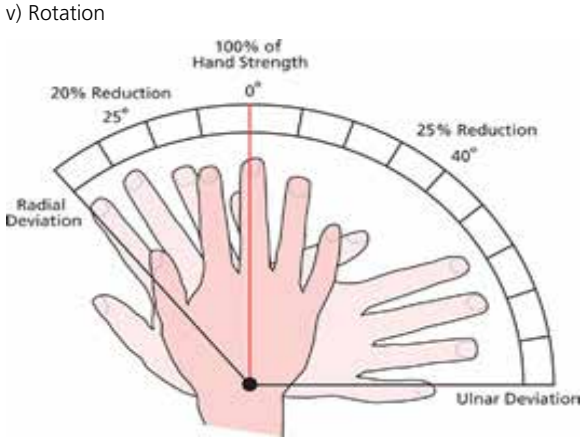


Diagram1

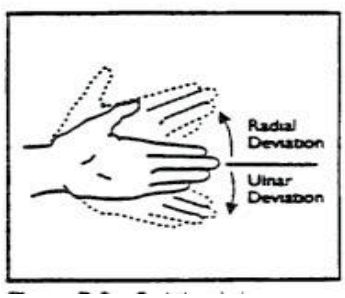


Diagram 2

In Diagrams 1 and 2, the researcher has tried to show the radial and ulnar deviations of the human wrist.

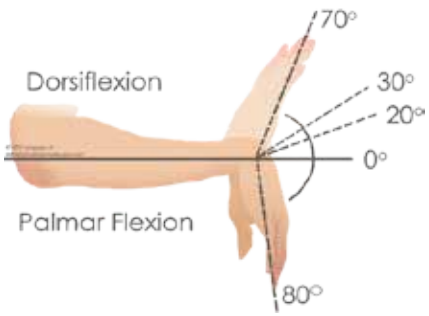


Diagram 3
In Diagram 3 the researcher shows the dorsi and palmer flexion movements of the human wrist.

4) Rotation
Rotation is divided into 2 parts:
a) Pronation and
b) Supination

Diagram 4

In the Diagram 4 the researcher shows the two rotations of the human wrist.

Diagram 5
In Diagram 5 the researcher has summarized all the movements of a right hand human wrist.

By undergoing all these movements, the human body can do all the basic to strenuous tasks, which include the use of the wrist.

Muscle Stimulations
Before we go directly into the proposed design, we have to understand some basics related to how the upper limb works and how the wrist works so efficiently in a fully healthy and fully functioning human body.

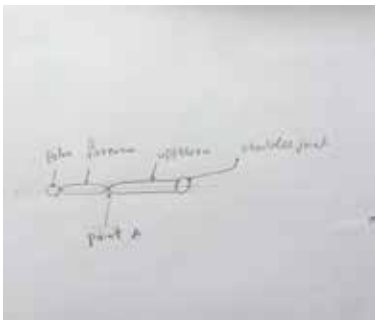


Diagram 1.1

Shown in **Diagram 1.1** is a schematic drawing of the upper arm from the shoulder joint to the palm. The point A is the target point wherein the wrist unit can be installed. Each human body movement takes place due to muscle stimulations and just like any other human body part so does the upper arm. For any wrist movement, the muscle stimulation begins at the spinal chord via the signals sent by the brain. Muscles set up next to one another stimulate the movement through the nerves connecting them and eventually the movement is accomplished.

We can understand this better by thinking of the muscles as blocks

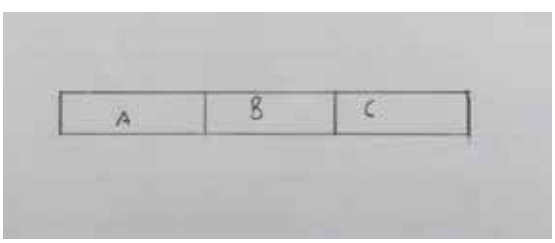


Diagram 1.2

As shown in **Diagram 1.2** the arm is made up of 3 blocks: A, B and C and the stimulation occurs from C to A. So when a hypothetical wave passes from inside block C, it pushes all the atoms of block B and eventually block of A. Hence, the wave gets transmitted from block-to-block thus creating a long wave, which will lead to the movement.

To understand the mechanism of muscle stimulation, consider a pipe filled with marbles.

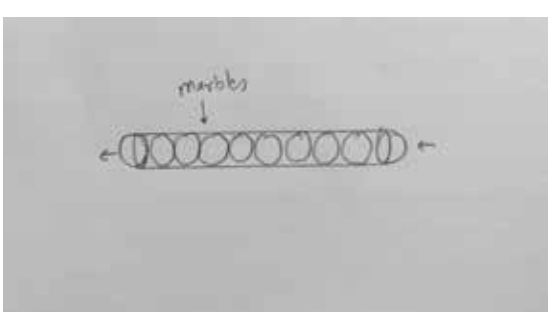


Diagram 1.3

As shown by the researcher, on pushing the marble at the right end in **Diagram 1.3**, the marble on the left comes out of the pipe. That is basically how muscle stimulations work, the marble being the wave of stimulation coming from the

spine and in this case goes it all the way up to the wrist where the desired movement is executed.

So coming back to **Diagram 1.1**, at point A, which is near the elbow joint, we can pick up the muscle stimulations using electro sensors (used in the Ottobock prosthesis which are already in use) and thus all the movements can be done easily.

Proposed Wrist Prosthesis Design

In this section, the researcher has given his idea as to how a wrist unit should be designed so that it can easily accomplish all the movements with an easy mechanism so as to get over handicaps and injuries related to the wrist.

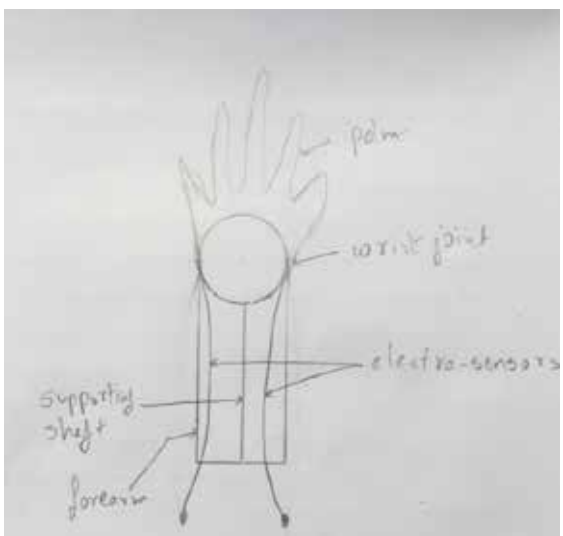


Diagram 1.4

As shown by the researcher in **Diagram 1.4**, the wrist joint is a metal sphere connected to an artificial forearm through a supporting shaft. The palm is artificial too but here we would just go into the wrist movements. The wrist joint is a sphere which is rotated or moved by the electro sensors that are attached to the muscles near the elbow joint so that they can pick up the stimulations passed on by the muscles (as explained earlier). To keep the wrist joint attached to the forearm shaft, a secondary supporting shaft has been provided inside the forearm shaft which keeps the wrist joint intact with the body at all times. By using this intrinsic and simple design, the researcher aims at attaining all degrees of freedom related to the movements of a normal and fully functioning human wrist.

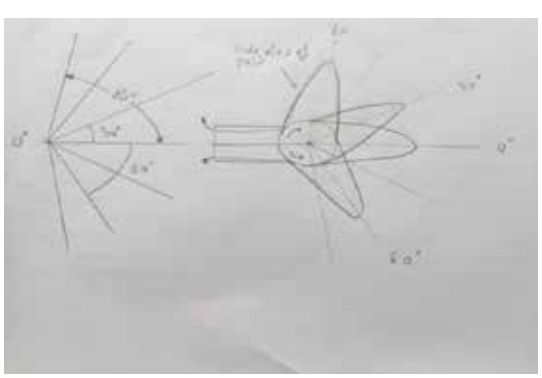


Diagram 1.5

Diagram 1.5, as shown by the researcher shows the spectrum of the movements that are done by the wrist unit proposed by the researcher, this is the side view of the palm. As shown, all movements from 0-30-60-80 degrees can be attained by the wrist joint just by stimulations picked up by the the electro sensors. By locking the wrist unit at 0-30-60 and 80 degrees above and below as shown, all normal activities can be done. This is because all normal activites are done within this range alone and hence the design proposed by the resarcher is perfect at accomplishing the range.

Diagrams showing how the proposed wrist unit can attain all the movements

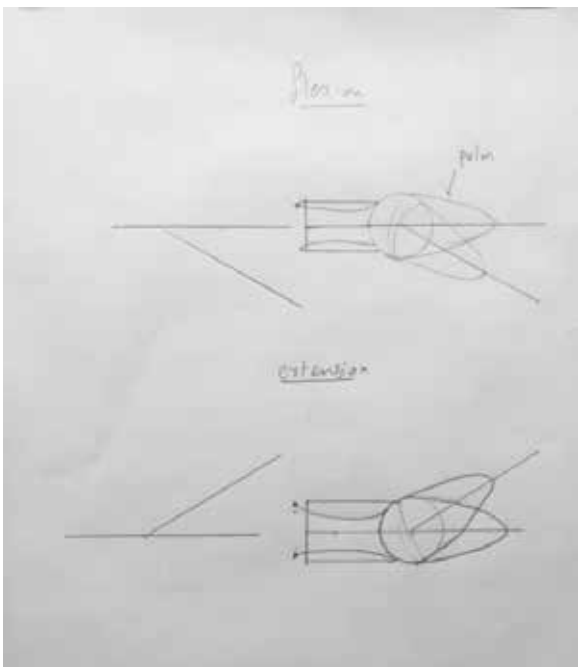


Diagram 1.6

In **Diagram 1.6,** the researcher has tried to show the side view of the attached palm which can thus attain the Flexion and Extension movements of the human wrist. Flexion and Extension are amongst the fundamental movements related to the human wrist. As shown in the diagram, the wrist unit proposed by the researcher attains both the movements and hence all the movements including flexion and extension i.e. beating a drum, playing any racquet sport, lifting any load, etc can be done with ease thus removing the handicap related with these movements.

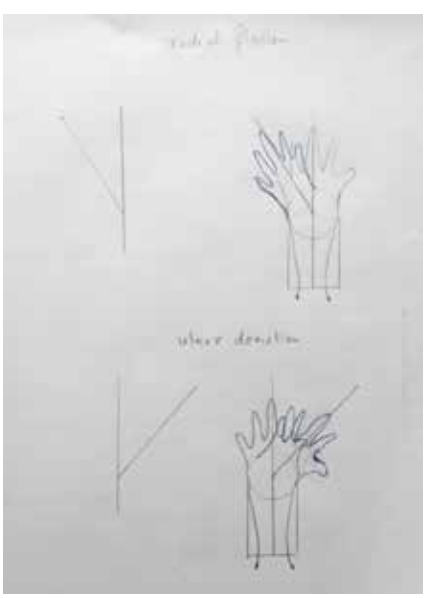


Diagram 1.7

Other rudimentary movements in the human wrist are deviations i.e. Radial and Ulnar deviation. The wrist unit proposed by the researcher, as shown in **Diagram 1.7** attains these two deviations with ease thus eliminating the problems which include these movements for example wiping a glass window, waving goodbye, etc. which a fully functioning human body does so easily.

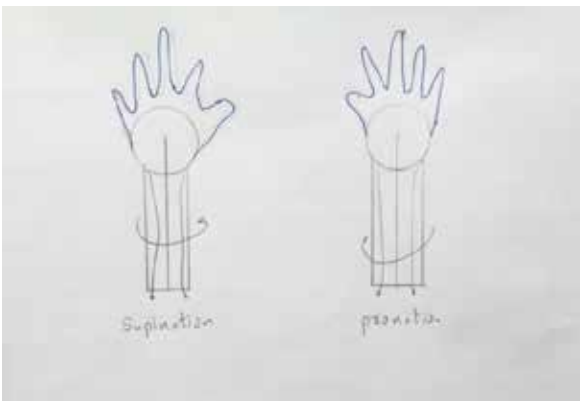


Diagram 1.8

In **Diagram 1.8**, the researcher shows the wrist unit attaining Rotation i.e. Pronation and Supination. The first movement that comes to the mind whilst thinking of the wrist is rotation, it is essential because it gives the wrist joint a wide range to attain different movements. As shown, the wrist unit again attains both the rotations just like a normally working human wrist does, thus eliminating all the handicaps one may face during skipping ropes, bowling in cricket, etc.

Conclusion

Finally in this article the researcher has explained how crucial the human wrist is, the researcher has tried to give a brief insight in the human wrist and all the movements, how muscle stimulations work and finally a proposed design for a wrist prosthesis where in all the movements can be accomplished. By using this wrist unit, the researcher feels one can come over any wrist related disability and hence the human handicap can be removed easily and efficiently and by doing this, an upper limb handicap may eventually cease to exist which is the researcher's aim.