STUDY OF PRESSURE DISTRIBUTION IN DIFFERENT LEPROSY FOOTWEAR

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IN COLLABORATION WITH

ORTHOPAEDIC DEPARTMENT
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STUDY COORDINATED BY
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WHY?

- **FOOTWEAR IS AN IMPORTANT FACTOR IN THE PREVENTION OF PLANTAR ULCERS AMONG LEPROSY PATIENTS WITH ANAESTHESIA OF PLANTAR SURFACE OF FEET.**

- **MOST OF LEPROSY CONTROL PROJECTS KNOW ABOUT PROTECTIVE ROLE OF FOOTWEAR, HOWEVER FOOTWEAR IS PROVIDED TO PATIENTS USUALLY AFTER THE APPEARANCE OF FIRST PLANTAR ULCERS.**

- **MOST OF THE PROJECTS PRODUCE A LIMITED NUMBER OF FOOTWEAR, NORMALLY IN STANDARD MODELS; OFTEN THESE ARE IDENTIFIED BY THE PATIENTS AS "LEPROSY FOOTWEAR" AND THEY MAY NOT WEAR THESE. THE COST OF THE FOOTWEAR VARIES CONSIDERABLY BETWEEN COUNTRIES AND BETWEEN PROJECTS IN SAME COUNTRIES.**

STUDY HYPOTHESIS

PLANTAR ULCERS TEND TO OCCUR MORE IN SOME SPECIFIC ANATOMICAL AREAS OF THE FOOT: FIRST TOE, HEAD OF FIRST METATARSAL BONE & HEEL. IF A FOOTWEAR IMPROVES THE DISTRIBUTION OF PRESSURE ON THE WEIGHT BEARING SURFACE OF THE FEET AT THESE SPECIFIC AREAS, IT WILL BE HELPFUL IN PREVENTING PLANTAR ULCERS.

STUDY IDEA

TO TAKE DIFFERENT KINDS OF FOOTWEAR USED IN DIFFERENT COUNTRIES BY LEPROSY PROJECTS AND TO MEASURE THE PRESSURE DISTRIBUTION ON THE PLANTAR SURFACE OF FEET WEARING THESE DIFFERENT KINDS OF FOOTWEAR.

TO COMPARE THE PRESSURE AT SOME SPECIFIC AREAS OF FEET WHILE WEARING FOOTWEAR WITH THE PRESSURES AT THE SAME SITE ON BARE FEET AND TO MEASURE THE DIFFERENCE IN PRESSURE.

STUDY METHODOLOGY

NINE KINDS OF FOOTWEAR WERE COLLECTED FROM DIFFERENT COUNTRIES. THESE DIFFERENT FOOTWEAR WERE TESTED IN 4 PERSONS (WITHOUT ANY FOOT DEFORMITY, CHOSEN ON THE BASIS OF THEIR FOOT-SIZE AS THE FOOTWEAR COLLECTED WERE OF DIFFERENT SIZES. SOME FOOTWEAR WERE TESTED IN 2 PERSONS AND SOME ONLY IN ONE PERSON.

IN EACH PERSON PLANTAR PRESSURE WAS MEASURED AT 5 DIFFERENT SITES WHERE PLANTAR ULCERS COMMONLY OCCUR, WHILE WALKING BARE-FOOT AND WHILE WALKING WITH THE TEST FOOTWEAR.

THE PRESSURE WAS MEASURED BY USING E-MED INSOLE AND PLATFORM SYSTEMS AND 2 KINDS OF READINGS WERE MADE: PEAK PRESSURE AND PRESSURE TIME INTEGRAL (PRODUCT OF PEAK PRESSURE AND PLANTAR CONTACT TIME). EACH READING CONSISTS OF 11 OR 13 SETS OF DATA CORRESPONDING TO 11/13 STEPS FOR WHICH MEASUREMENTS WERE MADE.

PLANTAR SURFACE SITES WHERE MEASUREMENTS WERE MADE:

MK-01 HEEL
MK-02 1ST META-TARSAL HEAD
MK-03 AREA UNDER 2ND TO 4TH META-TARSAL HEAD
MK-04 5TH META-TARSAL HEAD
MK-05 BIG TOE

FOOTWEAR TESTED IN THE STUDY

CODE	PROJECT-COUNTRY	CHARACTERISTICS OF FOOTWEAR
FW1	Alupe Kadem - Kenya	Commercially available Bata sandals with buckle and leather back-strap; plastic outer sole and thin leather in-sole.
FW2	Bahia - Brazil	Commercially available tennis shoe with special insole made of three layers: white tough rubber like material, yellow mouldable material and fibre covered soft MCR like rubber.
FW3	Guangdong - China	Commercially available sports shoe with velcro straps and special 4 mm thick MCR like insole.
FW4	Ghana NP	Specially made sandals with rexine straps, 10 mm thick insole of MCR with rexine cover, plastic outer sole with 8 mm heel.
FW5	Warangal - India	Leather sandals with 4 mm tyre sole and 7 mm MCR insole.
FW6	UK	Commercial closed leather shoes
FW7	Nampula - Mozambique	Sandals with rubber straps, 8 mm tyre sole and 8 mm MCR insole.
FW8	Mozambique NP	sandals with leather straps, 15 mm cork heel, 5 mm outer tyre sole, 3 mm tough rubber insole.
FW9	Poona - India	Sandal without backstrap (chappal) with 3 mm tyre heel, 5 mm hard rubber outer sole, 12 mm MCR insole.

FINDINGS

The two measurements (Peak Pressure and Pressure-Time Integral) show different results in different footwear at different sites, occasionally increasing but generally decreasing in comparison with measurements during barefoot walking, significantly in majority of footwear.

At Heel: Peak Pressure measurement is decreased at the heel with all the footwear but the reduction is maximum with FW3, FW 9 and FW4. Pressure-Time Integral is also decreased at the heel with all footwear but the reduction is maximum with FW9, FW5 and FW2.

At the head of 1st Meta-tarsal: For Peak Pressure, none of the footwear decrease the pressure significantly while FW8 and FW9 increase the pressure. For Pressure-Time Integral, only FW1 caused a significant decrease in pressure, other footwear didn't cause any significant change except for FW8 which caused a significant increase.

In the area between 2nd and 4th Meta-tarsal heads: All the footwear decreased Peak Pressure significantly except for FW 1 and FW 6 while the decrease was maximum with FW8, FW9 and FW4. FW8, FW3 and FW4 decreased Pressure-Time Integral while FW6 caused a significant increase in the measurement.

At 5th Meta-tarsal head: Peak Pressure is reduced with FW3, FW5 and FW9 while FW 1 and FW8 show an increase in pressure. Pressure-Time Integral is reduced with FW3, FW5 and FW9.

At the Big Toe: Peak Pressure is reduced with FW2, FW7 while it is increased with FW8 and FW6. Pressure-Time Integral is reduced with all the footwear except for FW5 and FW8 which cause a significant increase.

Overall Changes in Mean Peak Pressure

1. FW2, FW7 and FW 6 cause an overall and statistically significant decrease in Mean Peak Pressure at all sites on plantar surface of foot.

2. FW1, FW3, FW10 and FW 9 cause a decrease in Mean Peak Pressure which is not significant statistically.

3. FW4, FW5 and FW8 cause a statistically significant increase in overall Mean Peak Pressure.

Overall Changes in Pressure-Time Integral

1. **FW5, FW2 and FW1 cause statistically significant decrease in overall Pressure Time Integral measurement.**

2. **FW3 and FW7 cause modest decrease in overall Pressure Time Integral even if there is increase in measurement at two plantar points which is not significant statistically.**

3. **FW4, FW5, FW6, FW8 and FW 9 cause statistically significant increase in overall Pressure Time Integral.**

DISCUSSION

WHICH MEASUREMENT IS MORE SIGNIFICANT, PEAK PRESSURE OR PRESSURE TIME INTEGRAL?

Peak Pressure measures the maximum pressure reached at any time during the weight-bearing phase of walking. Pressure-Time Integral on the other hand measures the Peak pressure in relation to time, during the weight-bearing phase of walking. Both measurements are related to stress on the plantar surface of feet, though it may be difficult to prove, which of these two measurements is more significant in the causation of an ulcer.

There can be other forces like "Shearing Stress", not measured during this study which may have a significant role to play in the causation of plantar ulcers.

ROLE OF PROTECTIVE FOOTWEAR:

The fact that plantar ulcers tend to occur at specific sites on plantar surface of feet seems to point out the causative role of increased mechanical stress at these sites. For this reason, the capacity of a footwear in reducing the pressure/stress at these sites, seems important for the prevention of plantar ulcers.

However, apart from the pressure factor, a footwear also provides mechanical protection from injuries, which can also lead to occurrence of plantar ulcers.

CONCLUSIONS FROM THE STUDY:

THE STUDY TOOK IN TO CONSIDERATION SOME SPECIALLY PREPARED FOOTWEAR BY LEPROSY PROJECTS AND SOME COMMERCIALLY AVAILABLE FOOTWEAR USED FOR LEPROSY PATIENTS FROM DIFFERENT COUNTRIES. EXCEPT FOR FW2 (BAHIA – BRAZIL) NONE OF THE OTHER FOOTWEAR EXAMINED HAS GIVEN A UN-EQUIVOCAL DECREASE IN BOTH THE MEASUREMENTS AT ALL THE FIVE SITES STUDIED.

CONSIDERING THAT FOOTWEAR PROVIDE A MECHANICAL PROTECTION TO FEET, THE AUTHORS PROPOSE THAT FOR PERSONS WITH PLANTAR ANAESTHESIA AND WITHOUT ANY VISIBLE FOOT DEFORMITY, ACCEPTABILITY AND UTLISATION OF THE FOOTWEAR ARE VERY IMPORTANT. FOR SUCH PATIENTS, LOCALLY AVAILABLE COMMERCIAL FOOTWEAR MAY BE USED WITH ADEQUATE INSOLE.

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