A COMPARATIVE STUDY OF MICROORGANISMS AND RELATED SKIN INFECTIONS DURING THE COURSE OF CHEMICALLY DIFFERENT ORTHOPEDIC CASTS APPLIED FOR BONE FRACTURE TREATMENT

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ABSTRACT

The study was undertaken to compare the growth of microorganisms under the different casting and different stockinets castings used to immobilize the bones during bone fractures in India. The samples were divided into three categories, i.e. Plaster of Paris casts with cotton beddings, fiberglass casts without stockinette, but with cotton padding and fiberglass plasters with stockinette of synthetic rubber. Samples were taken immediately after the cast is removed after the onset of 21 days. Out of the total 108 patients studied, the patients having casts of plaster of Paris with cotton pads as stockinette showed higher contaminations of microorganism that included both bacteria and fungi. The patients having fiberglass plasters with cotton padding and fiberglass padding with synthetic rubber stockinette showed the less contamination of microorganism than the plaster of Paris. Among microbes were bacteria: *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Streptococcus species*, *Brucella species*, *Alcaligenes species*, *Proteus species* and Fungi: *Aspergillus niger*, *Mucor species*, *Trichoderma species*, *Dematium species* and *Rhizopus species*. The usual and cheaper version of cast with plaster of Paris and cotton underlining promotes the dermatophytic bacteria and fungi and should be avoided.
KEYWORDS: Bone fracture, orthopedic casts, skin infections, Plaster of Paris, Fiber glass cast.

INTRODUCTION
In case of bone fracture, the function of a cast is to immobilize and protect a broken or fractured bone or joint. It holds in place the broken bone, keeping it in proper alignment to prevent movement during the rehabilitation process. This support system is cast in such a way that the area of the nearby skin is covered with bandages or plasters for several days/weeks. In such situations, skin texture is usually moist and vulnerable to microbial growth.

There are several bacteria, i.e. *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus sp.* and *Micrococcus sp.* which can cause serious skin and other disorders. Similarly, some of the fungi are also found in their pathogenic form which includes *Penicillium sp.*, *Mucor sp.*, *Fusarium sp.*, *Trichoderma sp.*, *Microsporum sp.*, *Dematium sp.*, *Rhizopus sp.*, *Trichophyton sp.*, *and Yeast and* fungi can cause infection in skin nails, hairs etc. (Tannock, 1995). The yeasts (*Candida*) generally prefer warm, moist, and unventilated environments. Hence, skin areas not well-ventilated may be at risk for yeast infections, including but not limited to the skin in orthopedic casts used to set broken bones (http://www.symptomfind.com/diseases-conditions/yeast-infection). Some life threatening disease such as pneumonia, meningitis, osteomyilitis and chest pain is due to microbes and there are evidences that such microbes enter into the blood system from skin soft tissue, bone joint and wound infection (Kluytmans et al, 1997).

During bone fractures, a hard plaster is cast to support the broken bones; which acts as a covering to a large skin surface area. During the rehabilitation period of 21 days or more, skin is more prone to develop pathogenic bacteria and/or fungi in due course of time. There are many types of casting materials available based on their chemical composition such as Plaster of Paris (PoP), fiberglass, plaster, normal bandages, etc. It is obvious that these chemically different plasters provide a different environment for the microorganisms to grow on the skin surface. In India, the difference in the cost of orthopedic casts, usually three combinations are used: a) POP cast having cotton padding; which is the cheapest available option b.) fiberglass cast with cotton padding and c.) fiberglass cast with rubber stockinets, which is of higher cost. The present study focused on the development of microbial flora under all three cast conditions in the city of Jabalpur (MP). The skin micro flora developed during the time...
of rehabilitation in patients were recorded and identified. The whole laboratory exercise was to prove which casting material is suitable for the patients and avoid secondary infection in patients.

MATERIALS AND METHODS

1. Study group
The study was performed on the patients having bone fracture without any serious wound. The preferred patients were with bone fractures in the hand or leg. The patients (total number = 300) were divided into three study groups with 100 patients in each group.

Group 1: Patients who had PoP cast with cotton linings for 21 days
Group 2: Patients who had fiberglass cast with cotton underlinings for 21 days
Group 3: Patients with fiberglass cast and synthetic rubber stockinets for 21 days.

2. Sample Collection
The skin scrapings were collected from the patient who came after the rehabilitation period for the removal of the cast at the Department of Orthopedics, Netaji Subhash Chandra Bose Medical College, Jabalpur, India, under the supervision of staff of orthopedics. The samples were collected as skin scrapings just after the plaster was removed using the edge of a sterile glass slide. All collected samples were Skin scrapings were immediately placed in sterile glass vials and brought to the laboratory immediately and processed for the isolation of bacteria and fungi as soon as possible.

3. Inoculation and growth of microorganisms
For isolation of fungi and yeasts, potato dextrose agar was used. 39 g of dehydrated medium powder (MU097, HiMedia Laboratories, India) was suspended in 1L of the distilled water and autoclaved. After autoclaving, the media were carried by the laminar air flow, 5 g of streptomycin powder was added to it in order to avoid bacterial contaminations. For isolation of bacteria, 28 g of nutrient agar media (M001, Hi Media Laboratories, India) was suspended in 1L and autoclaved. Approximately 10 ml of potato dextrose agar or nutrient agar media is poured in the 100 mm Petri plats and allowed to solidify.

Skin scraping was suspended in 5% autoclaved saline (0.9% NaCl, Inven Pharma, India) and shaken well. One milliliter of this suspension was poured in sterilized Petri plates with the help of a sterilized glass pipette and spread well. The plates were placed in an incubator set at 37°C for bacterial growth or at 28°C for fungal growth.
3. Identification of bacteria
For the identification of bacteria, each distinct colony on the nutrient agar medium plate was picked up and was transferred to the fresh medium and again grown for 48 hours. Each bacterium was identified using Gram staining and different biochemical tests. The bacteria were identified using PIBWiN software (Bryant, 2004).

4. Identification of fungi
For the first hand idea, the culture characteristics such as color, texture, appearance was recorded (Hawksworth, 1979). For further identification, fungal cultures were stained with lactophenol cotton blue stain for the microscopic examination of fungal. The nature of mycelium and conidia formation (macro and micro conidia) helped to differentiate various genera (Ellis et al, 2007).

RESULTS
A total no. of 300 samples (skin scrapings) were collected from the patients who just completed the onset of the plaster applied for the treatment of bone fracture. Bacterial and fungal isolated from different types of plaster samples are summarized in table 1. Total 100 samples of POP were collected and observed that all 100 samples were contaminated with bacteria. The major types included Staphylococcus aureus, Escherichia coli, Bacillus sp., Klebsiella sp., Streptococcus sp., Brucella sp., Alcaligenes sp., Micrococcus sp. Out of 100 samples, 63 samples were found to be contaminated with fungi also that included Aspergillus fumigates, Mucor species, Trichoderma species, Dematium species and Rhizopus species.

Among 100 samples of fiberglass plasters with cotton padding, 72 samples were contaminated with bacteria that included Staphylococcus sp., Micrococcus sp., Klebsiella sp. and Proteus vulgaris. Twenty nine of such samples showed fungal contaminations which included Aspergillus sp., Mucor sp., Trichoderma sp., Rhizopus sp. and 12 samples were found to be sterilized.

Out of 100 samples with fiberglass cast and synthetic interlinings, less bacterial and fungal contaminations were observed. Only 16 such samples were found contaminated with bacteria with the predominance of Escherichia coli. Fungal contaminations were observed in only 3 samples that included only Mucor sp. The rest of the samples were found sterilized.
Table 1: Predominant bacteria and fungi isolated from the different skin scrapings during the onset of chemically different plasters.

<table>
<thead>
<tr>
<th>Type of Casts</th>
<th>Bacteria</th>
<th>Fungi</th>
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</thead>
<tbody>
<tr>
<td>POP with cotton underlining</td>
<td>Staphylococcus aureus</td>
<td>Mucor species</td>
</tr>
<tr>
<td></td>
<td>Streptococcus species</td>
<td>Aspergillus fumigates</td>
</tr>
<tr>
<td></td>
<td>Alcaligenes species</td>
<td>Rhizopus species</td>
</tr>
<tr>
<td></td>
<td>Brucella species</td>
<td>Dematium species</td>
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<td></td>
<td>Micrococcus species</td>
<td></td>
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<tr>
<td></td>
<td>Klebsiella species</td>
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<tr>
<td></td>
<td>Escherichia coli</td>
<td></td>
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<tr>
<td></td>
<td>Pseudomonas aeruginosa</td>
<td></td>
</tr>
<tr>
<td>Fiberglass with cotton underlining</td>
<td>Staphylococcus species</td>
<td>Mucor species</td>
</tr>
<tr>
<td></td>
<td>Micrococcus species</td>
<td>Rhizopus species</td>
</tr>
<tr>
<td></td>
<td>Klebsiella species</td>
<td>Trichoderma species</td>
</tr>
<tr>
<td></td>
<td>Proteus species</td>
<td>Aspergillus species</td>
</tr>
<tr>
<td>Fiberglass with Synthetic rubber stockinets</td>
<td>Escherichia coli</td>
<td>Mucor sp.</td>
</tr>
</tbody>
</table>

Fig. 1: Growth of the microorganisms under different casts during the study period. POP: Plaster of Paris, FG: fiberglass with cotton lining and FGSK: fiberglass with synthetic stockinet.
DISCUSSION

The treatment of orthopedic injuries, such as bone fractures, usually involves immobilization of a portion of the body in a cast (Patterson, 1996). Immobilization protects the injured body portion, maintains alignment of the bones and prevents further injury. Typical casting materials include plaster of Paris or fibers impregnated with Plaster of Paris as well as newer casting materials such as Fiberglass and polyurethanes which are lightweight and waterproof. In Jabalpur, 90-95% of the cases of bone fracture receive POP plaster as they are not only conventional but also inexpensive. Such plasters are cast on thick cotton padding. This padding is highly receptive of moisture and tends to develop the microorganisms (Draser et al, 1974). The skin inside the cast is always in sweating stage and this sweat provides a reasonably good medium for the bacteria and the fungi. These microbes grow enormously during the onset of plasters and this overgrowth can cause the secondary skin infection.
Yeasts and bacterial growth are the source of itching, rashes, unpleasant odor and infections. This condition leaves the skin in a continual wet or damp state (Maibach et al., 1981). In such conditions, the skin starts to breakdown and allows microorganisms to invade the underlying tissue causing the skin and underlying tissue to macerate, i.e., undergo a softening and decomposition. Maceration of the skin can lead to complete loss of the healed condition in cases of a foot cast or serious damage and loss of proportions of the palm in cases of a hand/arm cast. Maceration also leads to local necrosis of the skin and subcutaneous tissues (Tannock, 1995). The fiberglass cast, though provides some assistance and good aeration of the skin, the cotton padding still are vulnerable to the growth of the microorganisms. This was the reason why the skin secondary infections were found on such cast (http://www.rcsed.ac.uk/fellows/lvanrensburg/classification/commonfiles/open.htm). Total synthetic cast where the fiberglass plaster is cast on a synthetic rubber lining, proved to be far better than their two counterparts. Absence of cotton created a hygienic environment. Further, rubber, being waterproof, allows the patient to bath. This helps remove any microorganism growing on to the skin surface, without disturbing the orthopedic cast. Though the whole synthetic cast proved better, it will take a long while for the patients.

CONCLUSION
The present study showcases a comparison of microbial growth under the different cast conditions based on a local case study and showed that the conventional orthopedic cast with PoP and cotton underlining promotes microbial growth and harbor pathogenic bacteria. The fiberglass cast with synthetic rubber stockinette provide better protection from microorganisms and hence should be preferred.

REFERENCES


