DISCUSSION
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In India, poliomyelitis commences in childhood and infancy. Eighty percent of the total cases occur in children below five years. The most vulnerable population in India is the one between six months and three years. In U.S.A., 25 percent of cases are over the age of 15 years. The shift to age incidence is attributed to better standards to environmental sanitation. Males are more prone to clinical attack in ratio of three males to one female (Park and Park, 1983).

<table>
<thead>
<tr>
<th>Age of involvement</th>
<th>Park</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Cases &lt; 3 Yrs. of age</td>
<td>80%</td>
<td>89.6%</td>
</tr>
<tr>
<td>ii) Cases &lt; 6 Yrs. of age</td>
<td>95%</td>
<td>97.6%</td>
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In present study out of 290 patients, 224 were males as compared to 66 females with the ratio of 3.4:1 (77.2 percent were males and 22.8 percent females). Age of involvement was calculated in different age groups and maximum age incidence was found in children below one year of age. All studies inferred male preponderance over females.

Infants born of immune mothers escape infection up to the age of six months. Thereafter they become susceptible to poliomyelitis, the susceptibility being maximum in the age group six months to three years. By the age of five years, over 90 percent of the children show the presence of antibody to one or more of the three types of polio virus in their sera.
Age incidence of study group was maximum between 10 and 20 years. Youngest patient was of two years of age while eldest was of 70 years. Average age of study group was 13.2 years.

Involvement of lower limb was much more frequent as compared to upper limb. In present study 96.5 percent cases were of lower limb involvement. Of this 78.6 percent were of unilateral involvement while rest 21.4 percent were bilaterally affected.

Upper limbs were affected in 4.5 percent cases. As a whole 16 upper limbs were affected. Of these 15 were unilaterally involved while one case had bilateral affection. There was no trunk involvement in our study. I got one case of residual paralysis in which there was 7th cranial nerve involvement.

<table>
<thead>
<tr>
<th>Involvement</th>
<th>Lovett's findings</th>
<th>Findings in present study</th>
</tr>
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<tbody>
<tr>
<td>Both legs</td>
<td>127</td>
<td>60</td>
</tr>
<tr>
<td>One leg</td>
<td>85</td>
<td>220</td>
</tr>
<tr>
<td>Both legs and both arms (all extremities)</td>
<td>55</td>
<td>01</td>
</tr>
<tr>
<td>Arm and leg involvement (Upper limb with lower limb)</td>
<td>71</td>
<td>05</td>
</tr>
<tr>
<td>One arm</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Both arms</td>
<td>04</td>
<td>01</td>
</tr>
</tbody>
</table>

Lovett (1917) worked out tables - showing regional involvement of extremities in poliomyelitis. He found that
maximum number of cases were of bilateral lower limb involvement, unilateral involvement being less than half of this. But these findings were reversed in present study showing maximum involvement of lower limb unilaterally. While bilateral involvement was less than one third of unilateral involvement, the ratio being 1:3.6. Upper limb involvement was not that much frequent in our study.

In this study, most common involvement was of unilateral lower limb followed by bilateral lower limb involvement. There were only five cases in which one upper limb and one lower limb was involved, out of 290 cases.

When upper extremity was considered there was a distribution of much importance - out of 16 cases, 13 cases were of left sided involvement while two were of right side involvement and in the remaining case all the extremities were affected.

Legg (1929) noticed that lower limbs show a higher frequency of involvement than the arms, with practically no preference for right or left side. At present, there were 280 cases of lower limb affection while upper limb involved in 16 cases only.

Right lower limb was affected in 42.8 percent cases while left limb was affected in 37.7 percent cases. Thus there was no practical difference between right and left lower limb involvement.
According to Lovett (1915) partial paralysis (pareisia) was much more common than total paralysis.

<table>
<thead>
<tr>
<th></th>
<th>Total No. of affected muscles</th>
<th>Partial Paralysis (No. of muscles)</th>
<th>Total Paralysis (No. of muscles)</th>
<th>Ratio of paresis to paralysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lovett</td>
<td>1,452</td>
<td>1,036</td>
<td>416</td>
<td>2.5:1</td>
</tr>
<tr>
<td>Sharrard</td>
<td>2,464</td>
<td>1,502</td>
<td>962</td>
<td>1.56:1</td>
</tr>
<tr>
<td>Present study</td>
<td>4,435</td>
<td>3,313</td>
<td>1122</td>
<td>2.95:1</td>
</tr>
</tbody>
</table>

Above table clearly indicates that number of paretic muscles was always greater as compared to complete paralysis. Lovett studied 1,452 affected muscles and got a ratio 2.5:1 of paresis to paralysis, which was 1.56:1 in study of Sharrard. In our study this ratio was 2.95:1. This ratio of partial to total paralysis varied in individual muscles. The ratio was maximum for intrinsic muscles of foot and minimum for quadriceps. This ratio also indicates susceptibility of particular muscle to paralysis, minimum the ratio, highest the susceptibility to paralysis, while maximum ratio denotes least susceptibility.

The greater susceptibility of some muscles to complete paralysis than others is explained in the following way. The motor cell columns of some muscles are short and of others are long. In the lumbar segments, the tibialis anterior and tibialis posterior possess short columns and are surrounded by the longer columns belonging to the
quadriiceps, hamstring muscles and adductors. A small focus of poliomyelitic destruction affecting mainly the 4th lumbar segment severely damages the nuclei of the two tibialis muscles and causes them to be paralysed, while the other nuclei suffer a partial loss of their substance which, at the most, result in a mild paresis of the muscles they supply.

Thus muscles whose nuclei extend over only a short length of spinal cord are very susceptible to paralysis and muscles with long motor cell columns are more likely to remain clinically unaffected or suffer a paresis only.

"The muscles nearest the trunk are most frequently affected, distal group of muscles being least frequently affected"(Lovett, 1917). He also told that there was noticeable difference between left and right upper limbs but there was no difference between right and left lower limbs.

In our study there were 120 cases of right lower limb while 100 cases of left sided involvement. But there was marked difference between right and left upper limb involvement, left sided involvement was much commoner as compared to right.

Hips were involved in 318 limbs while second was knee, affected in 316 limbs which was followed by ankle in 303 limbs. Distal group of muscles was involved in 186 limbs. Above data clearly indicate that frequency of
paralysis is maximum nearest the trunk and it decreases as one goes distally. Out of 340 affected limbs there were 154 limbs in which distal group of muscles in lower limb was spared. This sparing of distal muscles was a general tendency in affected polio patients (Lovett 1915).

These findings can be explained on the basis of active use of right and left limbs respectively. This hypothesis was given by Lovett (1915). He told that left upper limb is less frequently used as compared to right upper limb, so that blood supply is more free around the spinal centres where the motor activity is greatest and most complicated and are less likely to get attacked on their nerve centres by paralytic polio virus. That is why right upper limb is less frequently involved.

Above explanation also holds true to explain the frequent involvement of muscles near the trunk. These muscles have to work less frequently and perform uncomplicated movements while the distal muscles perform complicated and finer movements much frequently, therefore they have better blood supply around their spinal centres and are less likely to be affected. Conversely in case of lower limbs both legs have to do equal function and in consequence there is no difference in severity of paralysis in both lower limbs.

Another feature which was observed during present study was that there was much more diffuse involvement of
limbs as compared to localized patchy involvement reported by others. Hips with knee with ankle were involved in 270 limbs, while hip alone was involved in nine limbs, knee alone in three and ankle in three limbs.

These data indicate extensive involvement in post polio patients in India. While in other European countries, where the environmental sanitation is definitely better and health services are in very good condition, distribution is patchy in nature.

In India, poliomyelitis is much prevalent and health services are inadequate. That is why polio is in its severest form here and muscle recovery is also very less. This is the reason why here we find diffuse involvement.

In present study, incidence of affection was maximum in hip flexors, quadriceps and hip abductors. Distal group of muscles was affected least frequently. Hip flexors were affected 318 times while flexor hallucis longus was affected only 165 times, i.e. hip flexors were approximately two times more (1.93 times) affected as compared to flexor hallucis longus. These findings coincide with the findings of Lovett and Sharrard and can be explained by the theory of Lovett (1917) that muscles near the trunk are much more involved as compared to distal ones.

But as regards incidence of paralysis, knee extensors (quadriceps) and tibialis anterior followed by hip adductors are much frequently paralysed while the distal group
of muscles were again at the bottom of the table. Intrinsic muscles of foot were least frequently paralysed (only in 3 limbs as compared to quadriceps which was affected in 142 limbs i.e. 17.75 times more).

These findings differ at some points with the findings of Sharrard. He noted that the largest number of paralyses were found in the distal group of muscles. He explained this stating "the severity of paralysis is proportionate to the weight to be met by the muscles at different levels. It may retard the recovery of those muscles which are working against greatest weight". But he failed to explain his own findings of very low incidence of paralysis in the intrinsic muscles of foot which by previous explanation should be the most frequently paralysed.

Skirnhoj (1949) contradicted above explanation saying—"there is no quality of the muscles such as size, function, position in the limb or phylogenetic development that can satisfactorily explain the frequent affection of some muscles and the high proportion of paralysis in others.

But we can explain the findings of present study by the previous reasoning that muscles near the trunk are much frequently affected. That is why distal muscles are least frequently affected as well as paralysed. But we can not explain the frequent paralysis of quadriceps and tibialis anterior as compared to hip flexors and extensors."
Some muscles are supplied by shorter columns of cells than others. But the root supply as a guide to the length of a muscle column may be deceptive. The tibialis anterior is supplied from the 4th and 5th lumbar segments but the supply from the 5th segment is small and the motor cell column is very short. The upper lumbar segments are more than twice as long as their numerical counterparts in the sacral segments, so a muscle supplied by all of the first and second lumbar segments has a column twice as long as a muscle supplied by the first and second sacral segments.

According to Sharrard (1955) the segmental distribution of muscles affected and muscles paralysed show that the second and third lumbar spinal segments were most frequently affected while fourth lumbar segment was most commonly involved in complete paralysis.

During our study, when segmental incidence of affection was seen, the first lumbar spinal segment was most frequently affected followed by second and third lumbar segments. The fifth lumbar segment was least frequently affected. But in case of segmental incidence of paralysis, the second and third lumbar spinal segments were most frequently paralysed followed by the first lumbar. The second sacral spinal segment was least frequently paralysed.

In present study, we got approximately same results as of Sharrard (1955). The quadriceps, tibialis anterior and hip adductors were most susceptible followed by hip
extensors and tibialis posterior. Distant group of muscles, having least susceptibility.

Sharrard (1975) regarded poliomyelitic paralysis as a haphazard affection of muscles, most frequent in the leg. In the cord lesion it appears to have a purely accidental distribution most marked in the lumbar enlargement. It is possible, however, that there are other factors than the cord lesion which determine the ultimate condition of the affected muscles.

When association among different muscles or muscle groups was seen, it gave clear interpretation that involvement was extensive or diffuse in nature, in place of patchy. It gives a false impression about the nature of poliomyelitic involvement, not being of patchy distribution. But the involvement, in this particular geographical distribution of Bundelkhand region was extensive.

At first sanitary conditions are not adequate and even worse in rural areas, which is superimposed by inadequate health services, they get. In rural areas the affected child is treated by quacks without making diagnosis. Again massage and injectibles are given to the patient without knowing its consequences, contrary to rest and no injection pricks, which aggravates the paralysis and hamper muscle recovery. As an outcome more number of muscles of affected limb are involved and with no or least recovery producing a picture of such extensive involvement.
Associated paralysis may be explained as follows —

In nuclear representation in the spinal cord, the columns for associated muscles lie side by side and extend over approximately the same length of cord. If one of the nuclei is completely destroyed by poliomyelitic affection, it is very likely that the other will be destroyed also. Hence, these muscles are associated in paralysis and conversely in freedom from paralysis (Sharrard 1955).

The pattern of paralysis can be correlated with the existence of appropriate foci of destruction in the motor cell columns of the spinal cord. If for instance, all the motor cells in lumbosacral cord are destroyed, except for those in the 3rd sacral segment, the common flail limb, in which only the intrinsic muscles of the foot are active, will result. A focus of destruction limited to the central part of the second, third and fourth lumbar segments produce paralysis of quadriceps and tibialis anterior.