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Is enteric *Staphylococcus* a causative agent of skeletal muscle abscesses in children?

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Summary

In a study of 46 children under the age of 10 years treated for pyogenic muscle abscesses, stool culture revealed *Staphylococcus aureus* in association with malnutrition, gastrointestinal infections and weaning. Naturally occurring protease-inhibitors were associated with the diets of these children along with poor standards of food hygiene. A study on 60 healthy age-matched controls showed a significant increase in the stool culture yields of *S. aureus* during weaning onto a traditional solid diet. It is probable that the bacterial overgrowth in the bowel in these states is associated with the development of muscle abscesses caused by this organism.

Résumé

Lors d'une étude de 46 enfants âgés de moins de 10 ans et soignés pour des abcès musculaires pyogènes, des cultures de selles ont revelé la présence du *Staphylococcus aureus* en association avec des infections gastrointestinales, une mauvaise nutrition et un sevrage. Des inhibiteurs de protéase se produisant naturellement ont été liés aux régimes alimentaires de ces enfants ainsi qu'à des critères d'hygiène alimentaire médiocre. Une étude de 60 individus en bonne santé et couvrant le même éventail d'âge a révélé une augmentation sensible de la teneur en *S. aureus* dans des cultures de selles pendant le sevrage, lors du passage à un régime alimentaire traditionnel à base de solides. Il est probable que la croissance bactérienne excessive dans les intestins, à ces états, est associée au développement d'abcès musculaires provoqués par cet organisme.

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Introduction

Staphylococcal skeletal muscle abscesses are endemic among children in the rain forest belt of West Africa. Many of these children suffer from chronic malnutrition and gastrointestinal infections. An increase in incidence was observed during weaning onto diets containing protease-inhibitors. An association of these states in the aetiology of pyomyositis in these children was investigated with the aid of bowel isolates from age-matched controls.

Subjects and methods

Forty-six children between the ages of 5 months and 10 years presenting to one hospital over a 9-year period with skeletal muscle abscesses were studied retrospectively. The clinical presentation in the majority of these children was with fever, malaise, anorexia and painful muscular swellings. Twenty-eight children had a single muscle abscess while 18 others had abscesses in more than one site. Thirty-nine children had polymorphonuclear leucocytosis exceeding 10,000 cells per mm^3 in their peripheral blood and 26 children had haemoglobin levels below 10 g/100 ml. Protein malnutrition of varying degrees was present in 14 children; intercurrent respiratory infections were present in nine; seven children had gastrointestinal infections and a further 15 had a recent history of gastroenteritis at the time of admission.

Dietary histories revealed that three children were on breast milk and clear fluids and 24 others were at various stages of weaning, receiving both breast milk and solid ingredients of a traditional diet. The remaining 19 were established on a solid diet. Thirty-nine children had their abscesses surgically drained and pus from 51 of these abscesses was cultured.

Sixty healthy age-matched controls were chosen during their visit to the immunization clinic of the hospital and divided into three groups of 20 children each. Group A consisted of 20 infants fed on breast milk and clear fluids only; group B consisted of 20 children between the ages of 4 months and 5 years who were on a weaning diet; and group C consisted of 20 children below the age of 10 years who were established on a traditional diet. Stool samples were collected from all 60 children in sterile containers before the administration of the scheduled vaccine.

Results

Bacteriology

Pus and blood specimens from the 46 subjects were cultured in blood agar and blood culture bottles respectively. Stool specimens were plated onto chloride-enriched tellurite media under anaerobic conditions for selective isolation of *S. aureus*. Quantitative stool cultures containing over 1×10^5 colonies/ml were considered significant. Forty out of 51 pus cultures were *S. aureus*-positive; and nine out of 12 blood cultures from septicaemic children were also positive for *S. aureus*. Stool cultures from seven children with coincident gastroenteritis all yielded *S. aureus*, along with nine of the 15 children with a recent past history of bowel infections (Table 1). Coagulase-positive *Staphylococci* accounted for 87% of all positive isolates.

The culture results on controls showed that 40 children who had had mothers' milk had a total of eight positive cultures; 40 on external food had 11 positive cultures; and 20 children with both in their diets had eight positive cultures. This suggests that external food is the factor encouraging staphylococcal bowel overgrowth during weaning and post-weaning periods.

The difference between the culture results of mothers' milk only and external food plus both external food and mothers' milk was statistically significant ($P < 0.05$) by Chi-square analysis.

Discussion

The aetiology of myositis and skeletal muscle abscesses in the tropics has been associated with a multitude of possible predisposing factors. Systemic bacterial infection, particularly from staphylococcal bacteraemia, has been suggested as a predisposing factor, with damaged or ischaemic muscle tissue forming a favoured site for seeding of the blood-borne organisms [1–3]. The association of nutritional and hookworm anaemias and the presence of the sickle cell trait was also noted [1,4]. The observation of viral particles in inflamed muscle tissue suggested a viral infection preceding bacterial invasion [5]. The association of avitaminosis

Table 1. *Staphylococcus aureus* isolates in cultures from 46 patients and 60 age-matched controls

Source of specimens	No. of cultures	*Staphylococcus aureus* isolates
Subjects		
Abscess ($n=46$)	51	40 (78%)
Stool* ($n=22$)	22	16 (73%)
Blood† ($n=12$)	12	9 (75%)
Control groups		
A ($n=20$)	20	—
B ($n=20$)	20	8 (40%)
C ($n=20$)	20	3 (15%)

*Pyomyosites subjects with gastroenteritis.
†Pyomyosites subjects with septicaemia.

and malnutrition led to the concept that dietary factors may be linked with myositis of skeletal muscle [6,7]. Lately there has been a suggestion that myositis may be produced by an intestinal organism [8]. Recent experimental evidence suggests that a ganglioside in maternal milk protects suckling rats against toxins produced by enteric organisms [9], and systemic sepsis from bowel organisms has been observed in rats during and following severe hypovolaemic states [A. J. Sori *et al.*, pers. comm.].

Children on diets low in protein have low outputs of intestinal proteases. The staple carbohydrate of the children studied consisted of roots grown locally, tubers and nuts, some of which contain well-recognized protease-inhibitors which also decrease the activity of intestinal proteases [10]. The introduction of meat to the diet of such children usually produces a phase of protein malabsorption and undigested meat fibres are readily identifiable in the bowel motions. Such a medium would encourage the growth of a variety of micro-organisms including *S. aureus*.

A phenomenon which may have some bearing on the present study occurs in the aetiology of 'pig-bel' which is a myositis of intestinal smooth muscle occurring in communities that indulge in pig-feasting ceremonies. Undigested muscle protein in the bowel following feasting encourages the growth of *Clostridium perfringens* whose toxins cause the necrosis of intestinal smooth muscle coats and peritonitis [11]. The incidence of pyomyositis in children of this region has been found to be significant [12].

A prolonged period of breast-feeding is common in rural communities in Africa and supplements an otherwise nutritionally inadequate diet of the growing child. Among the subjects studied over half received breast milk and some or all the ingredients of a traditional diet. Among controls who were on a similar weaning diet there was a 28% stool culture yield of *S. aureus*.

Staphylococcal gastroenteritis is endemic amongst children in Africa. Unhygienic methods of preparing formula feeds and inadequate sterilization of feeding utensils are responsible generally. There are indications that breast-feeding is associated with a lower incidence of diarrhoeal diseases in infants. Mothers are therefore encouraged to breast-feed their children until they are old enough to be weaned onto a solid diet. In children recovering from diarrhoeal diseases the re-establishment of 'normal' bowel flora would depend on their general health and susceptibility to re-infection and presumably on the uniformity of their diets.

Conclusion

Stool cultures of children during weaning, in malnourished states and following recovery from enteral infections suggests an overgrowth of *staphylococci* in the bowel. In children suffering from staphylococcal muscle abscesses, proof of migration of this organism from the bowel lumen into the blood stream and then to distant skeletal muscle would necessitate phage-typing of strains isolated from these sites.

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