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## RENAL FUNCTION IN RESIDENTS OF AN ENDEMIC FLUOROSIS AREA IN SOUTHERN ALGERIA

by

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SUMMARY: Kidney damage (1) in distal and proximal tubular function, (2) in glomerular filtration, occurred in 40 to 60 year olds residing in El Oued an endemic fluorosis area in Southern Algeria compared to normals from Algiers. Functional renal disturbances are proportional to the degree of fluoride accumulation which increases in relation to: a) the level of fluoride in drinking water (areas ABC), b) the fluoride level in nails and c) the radiological grade (0 I II III) of fluorosis.

KEY WORDS: Renal function; Endemic fluorosis; Algeria, endemic fluorosis in

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## Introduction

Renal function is affected by fluoride (1,2). In 1976, the biological evolution of fluorosis was correlated with a few renal parameters in adults residing in an endemic fluorosis area. Radiological changes were designated grades 0, I, II, or III (3). In 1982 (4) we recorded in adults, inside the same endemic zone, a correlation between fluoride concentration in drinking water, the degree of fluoride accumulation in nails and the radiological grade. A recent renal function exploration was performed but the results have not been published. In the following, renal disturbances investigated during these two studies are correlated with the degree of fluoride injury in areas with increasing levels of fluoride in water (A,B,C) in relation to radiological grades (0, I, II, III) compared with normals residing in Algiers.

## Material and Methods

During the first period (3) renal function was studied in groups 0, I, II, III. Radiological skeletal fluorosis was established according to Pinet et al. (5) wherein 0 = radiologically negative and I, II, III indicate increasing skeletal damage.

In a second study, renal function was correlated with the level of fluoride in drinking water in various areas inside the endemic zone namely, A where the fluoride level in drinking water is 1 - 2 ppm, B (2-3.5 ppm), C (4.5 ppm) with fluoride content in nails which appears to be a good index of $F^-$ accumulation (4) and with the radiological grade. Compared with normals from Algiers ($F^-$ in drinking water 0.2 ppm) fluoride damage to the skeleton appears to increase as the fluoride level in the water rises AI BII CIII (Table 1).

Table 1

Classification in $F^-$ Endemic Zone According to $F^-$ Level in Drinking Water and Radiological Grades

| | $F^-$ in Drinking Water | Radiol. Grade Frequencies | | Radiological Grade 0 (53) |
|---|---|---|---|---|
| Area A (29) | 1-2 mg/l | 0 | 34% | |
| | | I | 52% | Radiological Grade I (23) |
| | | II | 14% | |
| | | III | | |
| Area B (18) | 2.3.5 mg/l | 0 | 28% | |
| | | I | 29% | Radiological Grade II (19) |
| | | II | 43% | |
| | | III | | |
| Area C (22) | 4.55 mg/l | 0 | 5% | |
| | | I | 40% | Radiological Grade III (22) |
| | | II | 55% | |
| | | III | | |
| Normals: Algiers (20) | 0.20 mg/l | 0 | 95% | |

Fluoride in water and urine was measured according to the specific electrode technique (6); and fluoremia, after mineralization (7), by the same method. The classical technique was used to measure urea, creatinine and phosphorus in blood and urine: blood urea, using diacetylmonoxime; urinary urea, using hypobromite; blood and urinary phosphorus, using ammonium molybdate; blood and urinary creatinine, using alkaline picrate, after tungstate-induced deproteinization.

The following renal explorations were performed:

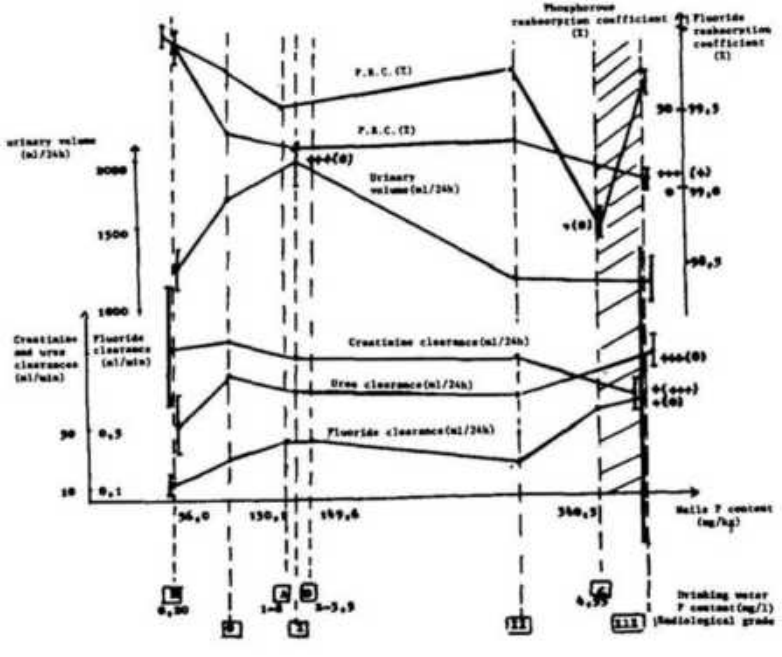
a) Proximal and distal tubular:urinary volume (ml/24h), urea and fluoride clearances (ml/min), fluoruria (mg/24h), $F^-$ reabsorbed mass(mg/24h), fluoride reabsorption coefficient (F.R.C.) (%),

b) Glomerular: creatinine clearance (ml/minute), fluoride filtered mass (mg/24h).

## Results

Tubular and, subsequently, glomerular dysfunction, correlated with fluoride in nails, with fluoride in drinking water and the radiological state (Fig. 1) were maximal, most frequently, in groups C and III.

Figure 1



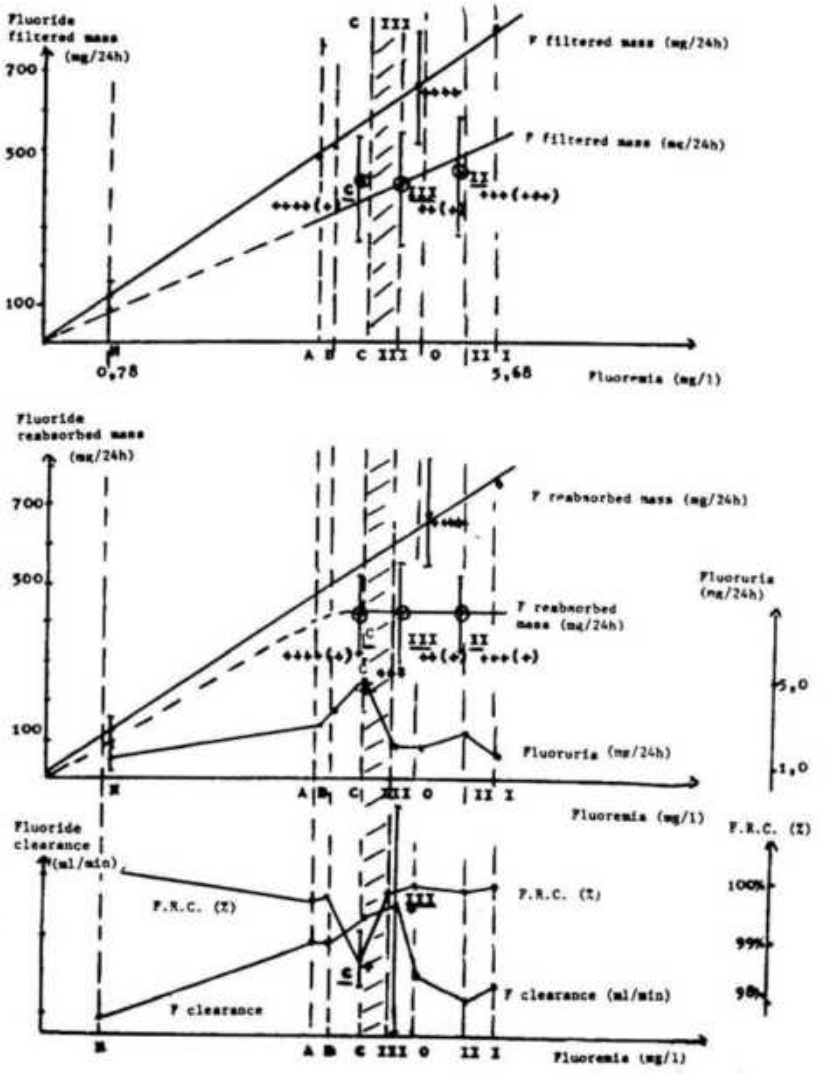

Tubular dysfunction seems to begin in grade I. Urinary volume increases, at this time, compared to N (p 0.01). Abnormalities are considerable in grade II, maximal in groups C and III.

Increases occur in urea clearance (p 0.01), fluoruria (p 0.01), fluoride clearance (slight p 0.10), F.R.C. is slightly decreased (p 0.10). These facts indicate impairment in reabsorption concerning free or Na-bound water, urea and fluoride.

Glomerular dysfunction (filtration impairment) is more evident in grade II and, principally, in C and III. At this time, in grade III, urinary volume is normalized, and creatinine clearance is decreased (difference from N=p 0.10; difference from grade 0 = p 0.01).

In Figure 2, fluoride filtered mass and fluoride reabsorbed mass are plotted against fluoremia. In our experience, fluoremia is not maximal in the highest fluoride group III and C. Both $F^-$ filtered mass and $F^-$

Figure 2



reabsorbed mass increase in all fluoridated groups, when compared with normal (p 0.01 or p 0.001). Graphic presentation of fluoride filtered mass correlated with fluoremia increase is linear, a) in groups N O A I B, the slope corresponds to the normal creatinine clearance rate, b) in groups II C III a more gradual slope corresponds to a decrease in the creatinine clearance rate. Graphic presentation of fluoride reabsorbed mass shows two curves: a) in groups N O A I B, fluoride reabsorption mass values increase with fluoremia, without any dimunition of the ascending curve, b) in groups II C III, the curve reaches a plateau, whereas fluoremia is only 4 to 6 mg/l. There could be a pathological impairment of maximal transfer in active reabsorption of fluoride, when renal fluoride damage occurs in the last three groups (Fig. 1 and 2. Table 2).

Table 2

Tubular and Glomerular Renal Aberrations

| 1) Tubular | Comparison with Normals (Algiers) | Possible Abnormalities |
|---|---|---|
| Urinary Volume Increase (ml/24h) | P < 0.01 (soon grade I) | Free water (distal) or Na bound water (proximal) impairment |
| Urea Clearance Increase (ml/min) | P < 0.01 | Urea reabsorption impairment (proximal) or collector tube diffusion |
| Phosphorus Reabsorption Coefficient Decrease (P.R.C. %) | P < 0.01 | Proximal tubular impairment (or hyperparathyroid reaction with normal renal function) |
| Fluoride Clearance Increase (ml/min) | slight p < 0.10 | |
| Fluoride Reabsorption Coefficient Decrease (F.R.C.%) | slight p < 0.10 | |
| Fluoruria Increase (mg/24h) | P < 0.001 | Fluoride reabsorption impairment |
| Fluoride Reabsorbed Mass (mg/24h) 1) continuing increase as $F^-$ filtered mass increases A B O I 2) pathological tubular maximal transfer when $F^-$ filtered mass increases C II III | P < 0.05 to P < 0.001 | |
| 2) Glomerular | | |
| Urinary Volume Returning to Normal (ml/24h) | | |
| Creatinine Clearance Decrease (ml/min) | slight p < 0.10 (difference with grade O p < 0.01) | Glomerular filtration impairment |
| Fluoride Filtered Mass Linear Increase (mg/24h) with a fluoremia increase 1) normal slope: A B O I 2) decreased slope: C II III (creatinine clearance decreased) | | |

## Discussion

In animal and man, fluoride affects renal function (1,2). Tubular dysfunction appears first. Polyuria is present (1,2,8) because of free water reabsorption by distal tubule, namely urinary loss of water (9). Polyuria is also present because of sodium-bound water reabsorption by proximal tubule, namely urinary loss of sodium and water (8). Reabsorption of aminoacids (1), glucose and phosphorus (8) is impaired. Urea clearance increases (1). Proximal damage occurs. Fluoride clearance increases (1,2) for the same reason. The appearance of glomerular dysfunction is delayed. Creatinine clearance decreases (10,11), fluoride and urea clearance first increase, then decrease (1,2). Fluorosis effect on renal tissues: proximal tubular necrosis (12), cytoplasmic vacuolation in distal tubules (11). Fluoride content is highest in soft tissue of kidneys (13). Fluoride increases gamma GT urinary elimination (14). In renal tissue, it affects cAMP intracellular level (15) and mitochondria ATPase activity (8).

Results of our investigation, concerned with 40 to 60-year olds residing in an endemic fluorosis area, are synchronized in Table 2. Renal dysfunction is first tubular, with special attention for fluoride reabsorption impairment and second glomerular, with a slight decrease of glomerular filtration.

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## FLUORIDE STANDARDS AND PREDICTING WILDLIFE EFFECTS

by

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SUMMARY: Federal and state clean air laws for the permitting of fluoride emission sources require evaluation of potential adverse ecological effects including those to wildlife and wildlife habitat. Although air quality permits and environmental assessments for fluoride emitting sources often cite compliance with various fluoride standards as demonstration of no adverse effects to wildlife, such use of these standards is inappropriate. A review of the literature regarding fluoride standards and ecological effects of fluoride reveals that adverse effects can occur to wildlife at or even below accepted fluoride standards. Alternative wildlife assessment methods including monitoring, predictive modeling, and sensitive receptor analyses are discussed.

KEY WORDS: Fluoride standards; Wildlife effects; Impact assessment

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