Growth and Skeletal Effects in Children and Adolescents After Kidney Transplantation: A 3-Year Prospective Study

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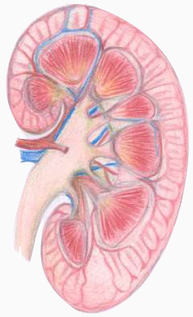
PURPOSE

Children's bone health is an important issue and there are many factors and medical conditions that are associated with an increased risk of mineral bone disorder (MBD). Children and adolescents with chronic kidney disease (CKD) are at risk of developing CKD-MBD, because of the risk of long-term consequences such as growth retardation, low peak bone mass and fragility fractures. This study was designed to follow Swedish pediatric patients prospectively for 3 years after kidney transplantation regarding growth and skeletal development.



Method

The study group comprised 13 patients (9 males), 4-15 years of age. Growth, bone mineral density (BMD) and markers of bone and mineral metabolism were investigated at start, and after 3, 12, 36 months after kidney transplantation.

Results

Median glomerular filtration rate was 63 (range 37–96) mL/min/1.73 m^2 after 3 years. The median height standard deviation score (SDS) increased from –1.7 to –1.1 after 3 years, p=0.0012, and median BMI SDS increased from –0.1 to 0.6 after 3 years, p=0.013, which implies that transplantation had a favorable outcome on growth. The fat mass percentage increased after transplantation (from median 12.9% to 27.4%), p<0.01, and total lean mass was unchanged after 3 months, but increased after 1 year and 3 years (from median 23.1 kg at baseline to 29.3 kg at 3 years), p<0.01. Total BMC increased at all time points in comparison with the initial values at study start, p<0.001. No change was observed for total BMD, calcaneal BMC and BMD over the study period. A delayed median bone age was found at start and after 3 years post-transplantation. Parathyroid hormone, phosphate and magnesium decreased at 3 months, and decreased further during the study period. The bone resorption markers tartrate-resistant acid phosphatase isoform 5b (TRACP5b) and carboxy-terminal cross-linking telopeptide of type I collagen (CTX) decreased initially after 3 months (p<0.05), and remained stable throughout the study period. The bone formation markers alkaline phosphatase, intact amino-terminal propeptide of type I procollagen (PINP) and osteocalcin decreased initially, but successively increased over the study period.

Figure 3 Markers of bone and mineral metabolism

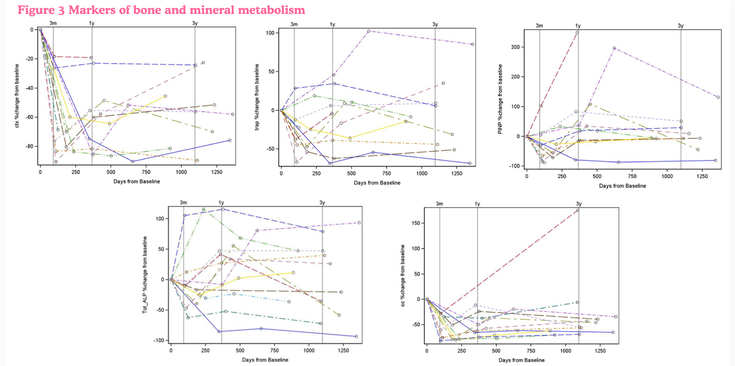


Figure 1 Auxological data

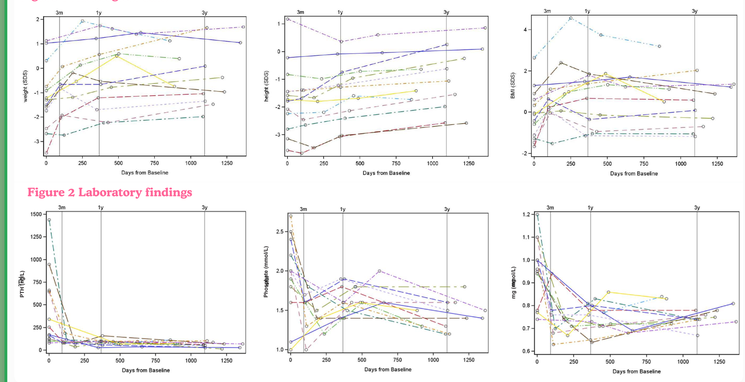


Figure 2 Laboratory findings

CONCLUSION

This study demonstrates that height SDS and BMI SDS increased, along with the increased markers of bone formation that reveals a positive bone acquisition after kidney transplantation, which was reflected by the significant increase in total body BMC.

Table 1 Clinical information at study start.

Patient no.	Gender	Age (years)	Diagnosis	GFR after 3 years	Clinical outcome	pre before Tx (ng/L)	PTH after 3 years (ng/L)	25(OH)D (µg/L)	GH therapy before Tx
1	Female	8	Dysplasia	56	Uneventful	122	53	19	Yes (3 years)
2	Male	8	Dysplasia	87	Uneventful	162	29	35	No
3	Male	10	Dysplasia	54	Second transplant Uneventful	948	69	31	No
4	Male	5	PUV	53	Early rejection	646	86	20	No
5	Male	8	PUV	63	Second transplant Uneventful	342	74	10	Yes (1.5 years)
6	Male	9	PUV	73	Uneventful	102	69	47	Yes (1.5 years)
7	Male	13	PUV	37	Early and late rejection	128	16	61	No
8	Male	15	PUV	68	Early rejection	1440	55	17	Yes (4 years)
9	Male	4	Laurence-Moon-Biedl	66	Uneventful	294	112	ND	No
10	Female	6	Interstitial nephritis	51	Uneventful	82	69	5	No
11	Female	11	ODD	96	Uneventful	660	106	29	No
12	Male	14	FSGS	63	Early recurrence and rejection	254	62	5	Yes (3 months)
13	Female	14	Neonatal hypovolemia	47	Early rejection	172	28	34	Yes (2 weeks)

25(OH)D: 25-hydroxyvitamin D; DDD, dense deposit disease; FSGS, focal segmental glomerulosclerosis; GFR, glomerular filtration rate (mL/min/1.73 m^2); GH, growth hormone; ND, not determined; PTH, parathyroid hormone; PUV, posterior urethral valves; Tx, transplantation

Table 2 Bone mass data for the investigated children

	Study entry	After 1 years	After 3 years	Delta, 0 to 1 year	Delta, 0 to 3 years
DXA					
TBBMD (g/cm^2)	0.92 (0.77 to 1.19)	0.92 (0.75 to 1.23)	0.89 (0.70 to 1.20)	–0.01 (–0.07 to 0.04)	–0.01 (–0.17 to 0.19)
TBBMC, Z-score	0.40 (–1.20 to 1.90)	–0.60 (–1.40 to 1.30)	–0.60 (–1.40 to 1.60)	–0.50 (–2.00 to 0.10) **	–0.80 (–2.30 to 0.50) *
TBBMC (g)	1034 (464 to 2511)	1222 (568 to 2717)	1401 (550 to 2693)	171 (41 to 936) ***	467 (86 to 1021) ***
DXL					
Calcaneal BMD (g/cm^2)	0.38 (0.16 to 0.50)	0.38 (0.16 to 0.47)	0.38 (0.21 to 0.55)	–0.01 (–0.05 to 0.11)	0.02 (–0.07 to 0.20)
Calcaneal BMC (g)	0.29 (0.12 to 0.38)	0.27 (0.12 to 0.36)	0.28 (0.16 to 0.41)	–0.01 (–0.05 to 0.11)	0.01 (–0.05 to 0.15)

BMD, bone mineral density; TBBMD, total body BMD; BMC, bone mineral content; TBBMC, total body bone mineral content; DXA, dual-energy X-ray absorptiometry; DXL, dual-energy X-ray absorptiometry and laser. For all measurements, n = 13. Values are given as median, with minimum and maximum values in parentheses.
* p < 0.05, ** p < 0.01, *** p < 0.001, Wilcoxon signed rank test.

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