Overview

Useful For
Diagnosing and monitoring tumor induced osteomalacia

Diagnosing X-linked hypophosphatemia or autosomal dominant hypophosphatemic rickets

Diagnosing familial tumoral calcinosis with hyperphosphatemia

Highlights
Fibroblast growth factor 23 (FGF23) is a major regulator of phosphate homeostasis.

FGF23 measurements are useful in the differential diagnosis of hypophosphatemic diseases.

Intact FGF23 is elevated in patients with tumor induced osteomalacia or X-linked hypophosphatemia.

Method Name
Chemiluminescence-Based Quantitative Sandwich Immunoassay

NY State Available
Yes

Specimen

Specimen Type
Serum

Specimen Required
Collection Container/Tube:
Preferred: Serum gel
Acceptable: Red top

Submission Container/Tube: Plastic vial
Specimen Volume: 0.5 mL
Collection Instructions: Centrifuge and aliquot serum into plastic vial.

Forms
If not ordering electronically, complete, print, and send 1 of the following forms with the specimen:
Renal Diagnostics Test Request (T830)
Oncology Test Request (T729)

Specimen Minimum Volume
0.25 mL
Reject Due To

<table>
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<tr>
<td>Gross Lipemia</td>
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Specimen Stability Information

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Clinical & Interpretive

Clinical Information

Fibroblast growth factor 23 (FGF23) is a major regulator of phosphate (phosphorus) homeostasis. FGF23 is secreted primarily by bone, followed by thymus, heart, brain and, in low levels, by several other tissues. High serum phosphate (phosphorus) concentrations stimulate FGF23 expression and secretion through a yet poorly understood mechanism. Only intact FGF23 is considered bioactive. Intact FGF23 interacts with a specific receptor on renal tubular cells, decreasing expression of type IIa sodium/phosphate cotransporters, resulting in decreased phosphate reabsorption. In addition, gene transcription of 1-alpha-hydroxylase is downregulated, reducing bioactive 1,25-dihydroxy vitamin D, thereby further decreasing phosphate reabsorption. Eventually, falling serum phosphate concentrations lead to diminished FGF23 secretion, closing the feedback loop.

Measurement of FGF23 can assist in diagnosis and management of disorders of phosphate and bone metabolism in patients with either normal or impaired kidney function. When FGF23 levels are pathologically elevated in individuals with normal kidney function, hypophosphatemia, with or without osteomalacia, ensues. This can occur in rare, usually benign, mixed connective tissue tumors that contain characteristic complex vascular structures, osteoclast-like giant cells, cartilaginous elements, and dystrophic calcifications. These neoplasms secrete FGF23 ectopically and autonomously (tumor-induced osteomalacia; TIO). In less than one-fourth of cases, a different benign or malignant soft tissue tumor type or, extremely rarely, a carcinoma may be the cause of paraneoplastic FGF23 secretion. In either scenario, complete removal of the tumor cures the TIO.

Hypophosphatemia and skeletal abnormalities are also observed in X-linked hypophosphatemia (XLH) and autosomal dominant hypophosphatemic rickets (ADHR). In XLH, variants in the PHEX (phosphate-regulating neutral endopeptidase) gene, which encodes a cell-surface-bound protein-cleavage enzyme, affect bioactive FGF23 secretion. Although the pathogenesis of XLH is not fully understood, animal studies indicate that loss of PHEX function results in enhanced secretion of FGF23.

In ADHR, FGF23 variants render the protein resistant to proteolytic cleavage, thereby increasing FGF23 levels. However, not all FGF23 variants increase renal phosphate secretions. Variants that impair FGF23 signaling, rather than increase its protease resistance, are associated with the syndrome of familial tumoral calcinosis (ectopic calcifications) with
hyperphosphatemia.

In patients with renal failure, FGF23 contributes to renal osteodystrophy. The patient’s kidneys can no longer excrete sufficient amounts of phosphate. This leads to marked increases in FGF23 secretion as a compensatory response, aggravating the 1,25-dihydroxy vitamin D deficiency of renal failure and the consequent secondary hyperparathyroidism.

In circulation, intact FGF-23 is cleaved to generate 2 biologically inactive fragments: a N-terminal fragment and a C-terminal fragment. FGF23 has a rapid clearance and short half-life, which ranges between 46 and 58 min for intact and C-terminal fragments, respectively. Different types of FGF-23 immunoassays are available: those targeting the intact form (iFGF23) and those detecting C-terminal fragments (cFGF23). Various studies have suggested that iFGF23 assays are more sensitive than cFGF23 for the detection of FGF23 concentrations in patients with TIO and patients with XLH. In addition, iFGF23 concentrations are not affected by iron deficiency, which may lead to false-positive results when using cFGF23 assays.

**Reference Values**

- **Pediatric (<18 yrs):** < or =52 pg/mL
- **Adults (> or =18 yrs):** < or = 59 pg/mL

**Interpretation**

Increased fibroblast growth factor 23 (FGF23) concentrations are present in individuals with renal phosphate-wasting diseases such as autosomal dominant hypophosphatemic rickets (ADHR), autosomal recessive hypophosphatemic rickets (ARHR), X-linked hypophosphatemia rickets (XLH) and tumor induced osteomalacia (TIO). Clinically, FGF23 measurement is useful in the differential diagnosis of these hypophosphatemic diseases since the patient presents with high FGF23 levels along with hypophosphatemia. In other causes of hypophosphatemia, such as vitamin D deficiency, FGF23 levels are low. In FGF23-producing tumors, a decrease in FGF23 concentrations following surgery is a reliable indication of complete tumor resection.

Intact FGF23 concentrations are elevated in patients with TIO or XLH. A study detected elevations of intact FGF23 in 19 of 22 TIO cases (86%).(1) In XLH, elevations of intact FGF23 were observed in 88% of patients (9 of 10 children and 13 of 15 adults).(2) While levels of intact FGF23 in XLH are usually elevated, FGF23 concentrations within the reference interval do not exclude the disease and should be interpreted in the setting of phosphate concentrations (ie, an FGF23 concentration in the upper level of the reference interval in the context of hypophosphatemia might be indicative of XLH). In ADHR, FGF23 concentrations are not consistently elevated, and the severity of renal phosphate-wasting may wax and wane; FGF23 concentrations are normal during quiescent periods when serum phosphate levels are normal, and they are elevated during active, hypophosphatemic phases of the disease.(3) FGF23 concentrations are influenced by factors such as phosphate intake and vitamin D therapy. Therefore, intact FGF23 levels are most informative in untreated patients.

**Cautions**

Fibroblast growth factor 23 (FGF23) concentrations must be interpreted in conjunction with serum phosphate (phosphorus) measurements, as FGF23 will be elevated in other conditions that cause hyperphosphatemia in vivo. These include kidney failure; severe catabolic states (eg, severe systemic illness, uncontrolled type I diabetes mellitus, and severe starvation); vitamin D toxicity; intravenous phosphate treatment and very high phosphate diets; advanced malignancy in particular with tumor lysis; crush or other significant muscle injury or destruction; fractures; and some endocrine disorders, in particular hypoparathyroidism and acromegaly. With the exception of kidney failure, FGF23
measurements will not contribute to diagnosis or patient management in these situations.

Do not interpret FGF23 concentrations as absolute evidence of the presence or the absence of tumor induced osteomalacia (TIO). Some patients with TIO may have FGF23 levels within the reference interval. It is thought that tumors in these individuals may be secreting different, and yet unidentified, phosphatonin(s). Therefore, if the clinical picture and general osteomalacia laboratory workup strongly suggest that the patient has TIO, a normal intact FGF23 level should not discourage tumor search or removal.

In rare cases, some individuals can develop antibodies to mouse or other animal antibodies (often referred to as human anti-mouse antibodies [HAMA] or heterophile antibodies), which may cause interference in some immunoassays. Caution should be used in interpretation of results, and the laboratory should be alerted if the result does not correlate with the clinical presentation.

Patients receiving burosumab therapy may have prolonged elevations of intact FGF23 in serum following monoclonal antibody administration. Measurement of intact FGF23 is not recommended on these patients. Serum phosphate, alkaline phosphatase, and 1,25(OH)2D measurements should be considered for monitoring response to therapy.

Clinical Reference

Performance

Method Description
The intact fibroblast growth factor 23 (FGF23) assay is a 2-site immunoenzymatic assay using 2 anti-human FGF23 mouse monoclonal antibodies. One antibody is coated onto microtiter wells and the other is alkaline phosphatase labeled. The signal generated is proportional to the concentration of intact FGF23 in the serum sample. The amount of intact FGF23 is determined by means of multipoint calibrator curve. Cross-reactivity of the assay with C-terminal FGF23 was evaluated in-house and determined to be no cross-reactivity with C-terminal FGF23 concentrations up to 230,680 pmol/L.(Unpublished Mayo method)

PDF Report
No

Day(s) Performed
Test Definition: IFG23
Intact Fibroblast Growth Factor 23, Serum

Report Available
2 to 8 days

Specimen Retention Time
90 days

Performing Laboratory Location
Rochester

Fees & Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact Customer Service.

Test Classification
This test was developed, and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. This test has not been cleared or approved by the US Food and Drug Administration.

CPT Code Information
83520

LOINC® Information

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