IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 6 Ver. X (June 2016), PP 60-62
www.iosrjournals.org

Renal Parenchyma Thickness: As a Tool to Assess Renal Function By Computed Tomography in Obstructed Renal Units

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Abstract
Aims & Objectives
To assess the relationship between Renal Parenchyma Thickness (RPT) by computed tomography and renal function on DTPA renogram in Chronically Obstructed Renal Units (ORUs) in order to define a minimum thickness ratio associated with adequate renal function.
To provide an efficient and pragmatic clinical tool for surgical decision making in patients with chronic ORUs
Materials & Methods
- *Thirty five consecutive patients who had undergone simultaneous nuclear renography and CT scan abdomen for unilateral obstruction between Sep 2013- Dec 2015 were included in the study*
- *The measurement was taken at an angle exactly perpendicular to the axis of the kidney*
- *Two additional measurements were obtained in each kidney: one 2 cm cranial to the midpoint and one 2 cm caudal to the midpoint*
- *The mean of the three measurements was then taken for each kidney and defined as the RPT .*

Results
- *A total of 35 patients were evaluated mean renal parenchyma thickness was 8.2 mm in ORUs and 22.6mm in NORUs. Mean patient age was 40 yrs (S.D +/-15.45) (range 7-70 years)*

The mean renal function of ORUs was 28.4% (S.D=11) and that of NORUs was 71.76% (S.D=11) Linear regression analysis comparing renogram function to RPT ratio revealed a correlation coefficient of 0.58 .A RPT ratio of 0.2 correlated with 20% renal function
Conclusions
- *RPT by CT scan appears to be a powerful predictor of renal function in ORUs*
- *RPT ratio is a useful clinical tool for surgical decision making (renal salvage versus nephrectomy) in patients with chronically ORUs.*
- *Simple method for rapid estimation of split renal function based solely on renal parenchyma thickness, regardless of the use of intravenous contrast media and without the need for complex calculations, sophisticated reconstructions.*

Keywords: *kidney; obstruction; kidney cortex; computed tomography*

I. Introduction

Computed tomography(CT) is the comprehensive renal imaging of choice .With the advances in CT imaging technology it provides not only anatomic but also quantifiable clinical information regarding renal function. advanced with the development of helical scanners, the resulting superior spatial and temporal resolution no longer limits the role of CT to assess static anatomic parameters . In recent years, Role of CT to assess renal perfusion and glomelular filtration rate (GFR) and differential creatinine clearence was demonstrated in various studies[1,2,3]

CECT is as accurate as nuclear renography for calculating total and split renal function[4].An important parameter assessed on CT is the "health" of the renal parenchyma. If RPT on CT scan suggests diminished renal function patients can be further evaluated with radio nucleotide scans for differential renal function. Thus it helps in treatment decision making by the clinician as well as patient.

In our study we tried to establish the relationship between Renal Parenchyma Thickness (RPT) by computed tomography and renal function on DTPA renogram in Chronically Obstructed Renal Units (ORUs) in order to define a minimum thickness ratio associated with adequate renal function so as to provide an efficient and pragmatic clinical tool for surgical decision making in patients with chronic ORUs .

II. Materials And Methods

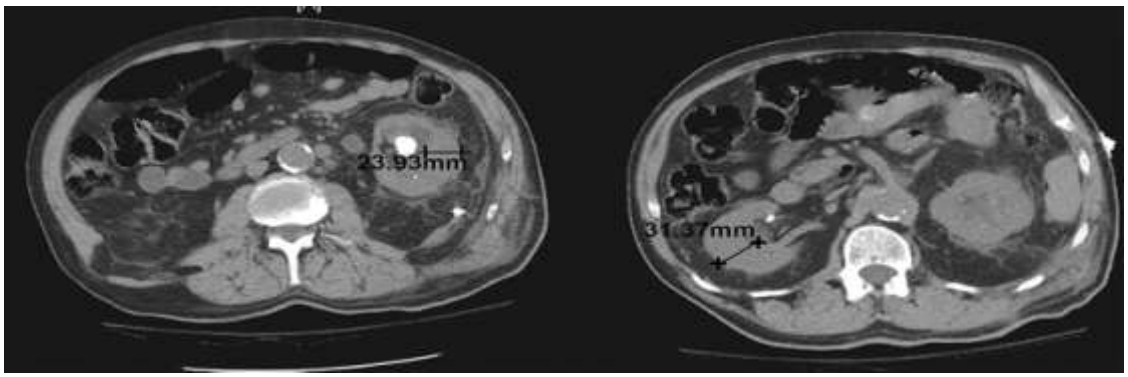
Thirty five consecutive patients who had undergone simultaneous nuclear renography and CT scan abdomen for unilateral obstruction between Sep 2013- Dec 2015 were included in the study . Patients with

bilateral hydronephrosis, solitary kidney, medical renal disease and patients whose history suggested acute obstruction were excluded CT scans were obtained with a 16 multislice unit(TOSHIBA, Japan) with slice thickness of 5mm.RPT was measured at a hilar image (exact cranio-caudal midpoint of each kidney) on CT scan of the ORU and compared to a corresponding image of the NORU .The measurement was taken at an angle exactly perpendicular to the axis of the kidney.

For all scans, the parenchyma was measured from the renal capsule to the edge of the collecting system. The parenchyma thickness at the exact cranio-caudal midpoint of each kidney was measured using calipers on a CT workstation.

Two additional measurements were obtained in each kidney: one 2 cm cranial to the midpoint and one 2 cm caudal to the midpoint .The mean of the three measurements was then taken for each kidney and defined as the RPT .

Regression analysis was performed using WESSA statistical software (Wessa, P. (2013), Free Statistics Software, Office for Research Development and Education, version 1.1.23-r7, URL http://www.wessa.net/) Correlation between RPT ratio and function was determined



Measurement of renal parenchyma thickness for obstructed renal unit (A) and non-obstructed renal unit (B)

III. Results

A total of 45 patients were analysed .Mean patient age was 40 yrs (S.D +/-15.45) (range 7-70 years) Obstruction was secondary to ureteropelvic junction obstruction (n = 14), calculus disease (n = 12)), stricture (n = 3), ureterocele (n = 1), and non-specified hydronephrosis (n = 4). malignancy (n = 1).20 patients were evaluated with noncontrast CT scan and 15 patients with contrast CT scan. Mean parenchyma thickness was 8.2mm(S.D=3.6) and 22.6 mm(S.D=15) in ORUs and NORUs, respectively.

The mean renal function of ORUs was 28.4% and the mean renal function of NORUs was 71.6%. Linear regression analysis comparing renogram function to RPT ratio revealed a correlation coefficient of 0.587 ($p<0.00002$). The linear regression equation was computed as Renal Function = 0.46 x RPT ratio + 0.11 . A RPT ratio of 0.2 correlated with 20% renal function.

0-15	**2**	**5.7**
16-30	**9**	**25.7**
31-45	**12**	**34.2**
46-60	**10**	**28.5**
61-75	**2**	**5.7**
TOTAL	**N=35**	**100**

S.NO	ETIOLOGY OF ORUs	No of Pts	%
1	PUJO	14	40
2	CALCULUS	12	34.2
3	NON SPF HDN	3	8.5
4	URET STRICTURE	4	11.4
5	URETEROCOCELE	1	2.8
6	MALIGNANCY	1	2.8
7	TOTAL	35	100

CT	NO OF PT
Contrast	16
Non contrast	19

MEAN RPT	mm
ORUs	8.2
NORUs	22.6

Mean SRF	%
ORUs	28.4
NORUs	71.6

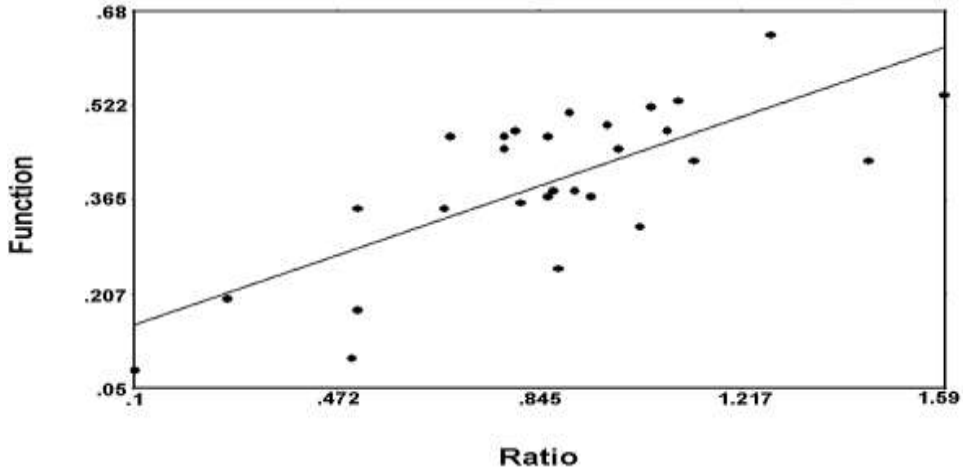


Figure 2 – Linear regression showing renal parenchyma thickness ratio vs. renogram function.

IV. Discussion

Computed tomography has became a first line and the most effective renal imaging modality for diagnosing the etiology of obstruction[5.] CT also provides a clear depiction of the renal anatomy and may provide additional valuable and quantifiable clinical information regarding renal function. An important parameter assessed on CT is the "health" of the renal parenchyma. Often in the outpatient setting RPT on CT scan may suggest diminished renal function. When this is observed, patients often undergo radionucleotide scans for a more formal evaluation of differential renal function. This information then helps the clinician and the patient make decisions about the appropriate course of treatment.The major limitation of our study is that the nuclear renogram is used as the gold-standard test for function. We chose the nuclear renogram because it is the most commonly used test for function of ORUs at most institutions Mean RPT of ORUs and mean SRF in our study were low compared with Kaplon et al this may be due to late presentation and longstanding HDN resulting thinned out parenchyma resulting in poor renal function .

V. Conclusion

RPT by CT scan appears to be a powerful predictor of renal function in ORUs.RPT ratio is a useful clinical tool for surgical decision making (renal salvage versus nephrectomy) in patients with chronically ORUs. It is aStraightforward method for rapid estimation of split renal function based solely on renal parenchyma thickness, regardless of the use of intravenous contrast media and without the need for complex calculations, sophisticated reconstructions.It can be done in a retrospective manner also because of the simple measurements technique, without involving complicated mathematical models for analysis, it is intuitive to predict that this method could be applicable to other imaging techniques, such as ultrasound and non-enhanced MRI .

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