Presegmental Arterial Pattern of Human Kidneys in Local Population

Objective: To investigate the variations in the presegmental arterial pattern of human kidneys obtained from cadavers of the local adult population.

Materials and Methods: This study was conducted at Anatomy Department of University of Health Sciences, Lahore, for a period of one year (October 2006-October 2007). Forty four adult human kidneys were obtained after autopsy; they were randomly divided in two groups A and B of right and left kidneys respectively. Simple blunt dissection and corrosion cast techniques were used to study the presegmental arteries. Statistical analysis was carried out by using SPSS version 16.0 and STATA version 8.0.

Results: Presegmental arteries were present in 100% of specimens of groups A and B. Variations were seen in the site of origin (extrahilar, hilar and intrarenal) of presegmental arteries of both groups.

Conclusion: The presegmental branches of renal artery in local population showed variations different from those reported in the earlier work carried out in other countries.

Key Words: Presegmental Arterial Pattern; Human Kidneys

Introduction

Recent advances and refinements in renal surgery as well as radiological interventional procedures have revived interest in renal arterial anatomy. Renal arteries arise from abdominal aorta and supply the kidneys through a number of its subdivisions. Near the renal hilum, each renal artery divides into anterior and posterior divisions (presegmental arteries), which further divide into segmental arteries (apical, upper, middle, inferior and posterior) supplying the renal arterial segments.

In conservative surgical procedures, a serious consequence of renal arterial lesion is the development of hypertension. The lesion of any branch of renal artery, regardless of its diameter, origin or destination will lead to ischemia of the related renal parenchyma, subsequently leading to renal hypertension. Selective renal arterial occlusion or ligation, particularly of the presegmental and lower polar segmental arteries may allow laparoscopic partial nephrectomy to be performed with minimal ischemic risk to the remnant renal tissue. Ligation of a segmental artery will not produce ischemia or interference with the blood supply of the neighboring segments.

Clamping segmental artery produces a highly selective interruption of renal blood flow to its segment. Presegmental renal arteries are also amenable to clamping. Occlusion of a presegmental artery offers less selective renal blood flow interruption because two or more segments of the kidney will be affected. Additionally, if access to a segmental artery is challenging, presegmental arterial ligation can still spare most of the kidney from an ischemic challenge. Clamping a presegmental artery may be advantageous for larger tumors or tumors that overlap a number of renal segments. For these tumors, presegmental artery can be selectively clamped before partial resection of the organ. In partial nephrectomy, the branches of the renal arteries are defined so that the surgeon can safely excise the morbid renal substance without compromising the vascular supply of the remaining part of the kidney.

The extrarenal arterial anatomy consists of presegmental and segmental branches of renal artery. The Anatomical Society of Great Britain and Ireland made the first systematic attempt to study the frequency of occurrence of renal vascular variations. The work of Brödel, a German anatomist, was most influential in stimulating the development of renal surgery in America. He took forty human cadaveric kidneys, used the corrosion cast technique, and gave the concept that the kidney could be divided into an anterior and a posterior division, each division being supplied by separate end arteries. Graves was the first to classify the renal parenchymal segments and their respective segmental artery. He studied the plastic casts and arteriograms of the intrarenal branches in humans and observed that there was constant segmental arrangement of these
vessels which was without collateral arterial circulation
between them.9,10 In one of the studies performed by
Chatterjee and Dutta on neoprene casts of human
kidneys, it was observed that the renal artery divided
into five branches, four from the anterior division and
one from the posterior division; their observations were
consistent with those of Graves.13 Weld et al., defined
the renal artery as the artery travelling from aorta to the
renal hilum; the presegmental artery was defined as a
branch of the renal artery that divided into two or more
branches which were named as segmental arteries,
these then entered the renal parenchyma.8 The first
divisions of renal artery were defined by Shoja et al., as
the primary branches and the subsequent divisions as
secondary or tertiary branches.14

Ethnical and geographical variations in the renal
arterial system have been reported earlier.1,11 A study
was performed by Lloyd on the racial differences in the
course of renal artery in Whites and American Negroes;
the results showed that a larger proportion of Whites
presented variations in the renal arterial supply than
those in Negroes.11 It had been reported by Özkan and
co-workers that the renal arterial variations are more
common in Africans and Caucasians than those in
Hindus.15 A study of the arrangement of the branches of
renal arteries in African, European and Indian population
by Fine and Keen has revealed a large variety of
patterns.16

In view of the previous reports on the variations
of renal vascular pattern and paucity of work in this field
on local population of Pakistan, the present study was
designed to investigate vascular distribution using right
and left cadaveric kidneys.

Materials and Methods

Forty four unclaimed adult human cadaveric
kidneys were obtained from forty four cadavers from the
Forensic Medicine Department of King Edward Medical
University, Lahore. The kidneys were removed in
compliance with the ethical committee of University of
Health Sciences, Lahore. The human cadaver was put
in a supine position on the autopsy table. A median
incision was given to open the front of abdomen; it was
made from the manubrium sterni to the pubic
symphysis. and then extended at the upper end towards
the acromiclavicular joints, following the line of
clavicles.17 The abdomen was opened; liver, stomach,
intestines and spleen were lifted along with the
peritoneum and the kidneys were identified and taken
out from the cadaver. The specimens were transported
in plastic jars containing 10% formalin solution11,18 to the
Anatomy Department of University of Health Sciences,
Lahore. The kidneys were randomly divided into two
groups, A and B, having right and left kidneys
respectively; twenty two specimens were present in
each group (n=22). The kidneys were irrigated with
normal saline for flushing out of blood and formalin from
the organ.18,19 The presegmental branches of renal
arteries were studied by using simple blunt dissection
and corrosion cast technique. After performing blunt
dissection, the renal artery and its branches were
painted with red oil paint (Figure I). Batson’s No 17
corrosion kit (Polysciences) was used to make the renal
arterial corrosion cast.20 For maceration purpose, the
kidney was placed in 20% solution of potassium
hydroxide in a glass jar at room temperature; the
amount of potassium hydroxide solution used was two
to three times the volume of the renal mass.17,19,21-23

After about ten days, the macerated tissues were
removed; the specimen was washed with tap water and
air-dried. The exclusion criteria consisted of: presence
of renal abnormalities on gross inspection, evidence of
renal trauma or renal surgery, and presence of
abdominal growths.6,21,24-27

The statistical analysis was carried out using
computer software Statistical Package for Social
Sciences (SPSS) version 16.0 and STATA version 8.0.
The significance of the data between the groups was
calculated by Pearson Chi-square test and Fisher exact
test; the association was regarded statistically significant
if the ‘p’ value was <0.05.

Results

Presegmental arteries (PSA) were present in all
the specimens (100%) of groups A and B. Total number
of PSA was 174; 90 in group A and 84 in group B.
Although variations were observed in the number of Presegmental arteries in groups A and B, no statistically significant association was found between the two groups. Group A showed total number of 90 PSA out of which 53 (58.9%) were anterior while 37 (41.1%) were posterior. Group B showed total number of 84 PSA out of which 48 (57.1%) were anterior while 36 (42.9%) were posterior (Figure II). No statistically significant association was found between the two groups in the number of anterior and posterior PSA. The site of origin of most of the anterior PSA in both groups showed extrahilar origin (Figure I) with the following variations: In group A, total number of anterior PSA was 53, out of which 40 (75.5%) were extrahilar, 11 (20.8%) were hilar, whereas 2 (3.8%) were intrarenal. In group B, total number of anterior PSA was 48, out of which 34 (70.8%) were extrahilar, 9 (18.8%) were hilar, while 5 (10.4%) were intrarenal.

The site of origin of posterior PSA in both the groups showed the following variations: In group A, total number of posterior PSA was 37, out of which 28 (75.7%) were extrahilar, 8 (21.6%) were hilar, while 1 (2.7%) was intrarenal in origin. In group B, total number of posterior PSA was 36, out of which 19 (52.8%) were extrahilar, 9 (25%) were hilar and 8 (22.2%) were intrarenal in origin. Statistically significant association was found between the extrahilar and intrarenal origins of posterior PSA of groups A and B (p-values: 0.04 and 0.01 respectively); however no statistically significant association was found between the two groups in the hilar origin of posterior PSA.

When the sites of origin of total number of anterior and posterior PSA was compared between the two groups, statistically significant association was found in the intrarenal origin of PSA (p-value: 0.005); no statistically significant association was present in the hilar and extrahilar origin of total number of PSA of both the groups.

No accessory renal artery was observed in any specimen, either of group A or of group B.

**Discussion**

In our study, the presegmental arteries were present in all the specimens (100% of cases) of groups A and B; this finding is in accord with those from the previous reports. Our findings indicate that no specimen of group had a single presegmental artery, whereas one of the specimens of group B showed a single presegmental artery Figure II). In a previous study performed by Sampaio et al., forty nine polyester resin corrosion endocasts of renal vasculature were made and it was observed that in all cases with a single renal artery, the main renal artery bifurcates into anterior and posterior branches. However, in a study performed by Weld et al., at Washington University School of Medicine on seventy three human cadaveric kidneys, contrary to our observations, 50% of the specimens showed the presence of presegmental arteries while they were absent in rest of the specimens.

In the current study, variations were observed in the number (one to six) and sites of origin (extrahilar, hilar or intrarenal) of presegmental arteries; 75% of anterior and posterior presegmental arteries of group A showed extrahilar origin while 70.8% and 52.8% of anterior and posterior presegmental arteries respectively of group B were extrahilar in origin. These findings were comparable with those of the observations made by Longia et al., and Ajmani in which 71% and 68% of specimens showed extrahilar origin of presegmental arteries respectively. 21% of specimens of group A showed hilar origin of anterior and posterior presegmental arteries; 18.8% of specimens of group B showed hilar origin of anterior presegmental arteries whereas 25% of specimens of group B showed hilar origin of posterior presegmental arteries. Studies by Longia et al., and Ajmani showed 11% and 14% of specimens with hilar origin of anterior and posterior presegmental arteries respectively. In the present study, the intrarenal origins of presegmental arteries...
were observed in 3.8% and 2.7% of specimens in group A, whereas 10.4% and 22.2% of specimens of group B showed intrarenal origin of presegmental arteries. Statistically significant association was present in the extrahilar and intrarenal origins of posterior presegmental arteries. These findings were not comparable with the observations made by Ajmani, who observed 18% and 16% of specimens having intrarenal origin of presegmental arteries in Nigerian population.

Conclusion

The presegmental branches of renal artery from local population showed variations from those reported in the earlier work carried out in other countries. It would provide a reliable scientific referral data, which will be used by the anatomists, surgeons, radiologists and endoscopists.

References