DISCUSSION

One of the most vital and disabling outcomes associated with intracranial aneurysms is bleeding; thus, early surgical or endovascular treatment is recommended. Coil embolization is an established therapeutic procedure for both ruptured and unruptured intracranial aneurysms, and in many centers, this procedure is recommended as the first treatment option. All the series in the literature showed low morbidity and mortality rates of endovascular therapies (Bekelis et al., 2015).

Since the early era of detachable coil therapy, assessments of aneurysm geometry and its effect on treatment decisions and treatment outcomes have been in use (Gonzalez et al., 2008). The most common and well-studied geometric determinants of treatment decision and outcome have been dome-to-neck ratio or the maximum aneurysm dome width to neck diameter, and neck width (Kiyosue et al., 2002). Zubillaga et al originally defined a “wide neck” as an absolute neck diameter of 4.0 mm (Zubillaga et al). Debrun et al, defined “wide-neck” aneurysms as those with dome-to-neck ratios of <2.0 (Debrun et al., 1998). These early definitions were created on the basis of success with endovascular coil therapy when the technique was in its infancy. Cloft et al, later noted that the technical advance of complex coil shapes allowed successful endovascular therapy of aneurysms with a dome-to-neck ratio of >1.5 (Cloft et al., 2000). These definitions predicted widespread use of major technical advances that allow successful coil therapy of wide-neck aneurysms, such as balloon remodeling and stent assistance (Pierot et al., 2008).
A more practical modern approach to the definition of “wide-neck” or “difficult” aneurysm would be a definition that predicts the need to use adjunctive measures, such as balloons or stents, to treat the aneurysm safely. Furthermore, in addition to dome to neck ratio and neck width, other geometric factors may play a role in treatment decisions and outcomes. Aspect ratio, defined as aneurysm height-to-neck width, may play a role as a predictor of treatment outcomes and decisions. So with growing experience, advanced biplane imaging with rapid subtraction fluoroscopy and refinements of technique in the use of coiling, most brain aneurysms can be obliterated at a low complication rate (Brinjikji et al., 2013).

This study was designed to obtain accurate correlation between the size of aneurysm necks with also associated Aspect Ratio and with the degree of aneurysm occlusion as seen on follow-up angiograms and with clinical outcome after endovascular intervention.

In this study, all aneurysms were divided according to neck size into small neck aneurysms group <4mm and the other group with wide neck aneurysm >4mm, and according to AR into group with AR> 2, group with AR 1.5 – 2 , group with 1 – 1.5 and a group with AR < 1.

For significance of the neck area and also its relation to dome height, extremely precise measurement is applied. The measurement accuracy can be limited by any factor that may alter vessel caliber. Examples of such factors are vasospasm caused by subarachnoid hemorrhage, compression caused by mass effect (Brown and Broderick, 2014).

Different angiographic projections can therefore show varying diameters. So that neck size and dome height should be carefully taken into consideration when planning an endovascular approach to these
lesions. An erroneous estimation of the neck size and dome height can lead to a wrong prediction of the results of treatment. This reinforces the necessity of obtaining views of the aneurysm in multiple projections to guarantee that the largest neck diameter is measured (Miley et al., 2008).

We noticed that aneurysms in certain locations were usually better analyzed in a specific projection. This observation had already been described by Lin and Kricheff; The antero-posterior projection is the most suitable to measure the neck of basilar artery bifurcation aneurysms. It is difficult to identify the actual neck extent in the lateral view, because of superimposition of the posterior cerebral arteries (Lin and Kricheff, 1987). However, if the dome of the aneurysm points ventrally or dorsally, a pure antero-posterior view can be misleading, because the neck will still be hidden by the sac. In these cases, a Waters or a Townes projection, respectively, will be more adequate. A sub mento-vertex view may be needed in certain ventral growing basilar artery bifurcation aneurysms. Furthermore, when the axis of the aneurysm is not in the sagittal plane, an oblique projection (Townes oblique, Waters oblique) also may be required (Van Rooij et al., 2008).

Aneurysms of the internal carotid artery-ophthalmic artery junction originate dorsally or medially and are distinguished by a dorsal medial projection. Therefore the neck of these aneurysms is best assessed in lateral and lateral oblique projections (John et al., 2008).

Most posterior communicating artery aneurysms are best seen in lateral and lateral oblique views, because their sacs commonly project posteriorly or postero-laterally (John et al., 2008).

In this study, the small necked group with modified Raymond classification are ; class I was achieved in 22 (68.75%) aneurysms, class
II in 8 (25%) aneurysms, class IIIa in one (3.1%) aneurysm, class IIIb in one (3.1%) aneurysm. The wide necked group provides different results, class I was achieved in 4 (40%) aneurysms, class II in 2 (20%) patients, class IIIa in 3 (30%) aneurysms and class IIIb in one (10%) aneurysm (Fig 37).

![Diagram](image)

*Fig 37: Diagram for distribution of occlusion degrees in small and wide necked aneurysms.*

According to AR with modified Raymond classification; a group with AR > 2 had shown class I in 15 (78.9%) aneurysms, class II in 2 (10.5%) aneurysms, class IIIa in 2 (10.5%) aneurysms, no class IIIb was achieved.

A group with AR 1.5 – 2 had shown class I in 9 (52.9%) aneurysms, class II in 6 (35.3%) aneurysms, class IIIa in 1 (5.9%) aneurysms, class IIIb in 1 (5.9%) was achieved.

A group with AR 1–1.5 had shown class I in 2 (33.3%) aneurysms, class II in 2 (33.3%) aneurysms, class IIIa in 1 (16.7%) aneurysms, class IIIb in 1 (16.7%) was achieved. No patients in the study with AR < 1 (Fig 38).
In this study, endovascular coiling were accomplished by single microcatheter in 36 aneurysms, double microcatheter in 4 aneurysms, 2 balloon assisted, and no stent or flow diverters were used. single microcatheter technique was used in 30 small neck aneurysms and 6 wide neck aneurysms, according to AR; this technique was used in 19 aneurysms with AR >2, 15 aneurysms with AR 1.5-2, and 2 aneurysms with AR 1-1.5. double microcatheter technique were used in 2 small necked aneurysms and 2 wide necked aneurysms, according to AR; this technique was used in 2 aneurysms with AR 1.5-2, and 2 aneurysms with AR 1-1.5. balloon assisted technique were used in 2 wide necked aneurysms, according to AR; this technique was used in 2 aneurysms with AR 1-1.5.

The analysis of these results clearly indicates that the degree of aneurysm occlusion and the endovascular technique used is affected by the aneurysm neck size and its relation to dome height. This finding can be explained by taking into consideration the behavior of the occlusive material inside the lesion. In endovascular therapy a small neck holds the occlusive agent inside the aneurysm. Using the Guglielmi detachable coil technique, the smaller the neck the higher the probability that the mesh of...
coils bridges across the neck area. This allows aneurysm occlusion without the danger of herniation into the parent vessel and with little risk of coil migration.

In wide-necked aneurysms, bridging of the neck area by the coil mesh is difficult because of the hazard of coil deposit in the parent vessel. Thus, loose coil packing of the neck region may be inevitable. Subsequently, the coils can be pushed by the arterial pressure and become compacted toward the aneurysm sac, resulting in re-exposure of portions of the aneurysm to the circulation. So theses aneurysms were planned for coiling assisted techniques as double microcatheter, balloon catheter, Neuroform stent and flow diverters (Miri et al., 2015).

Brinjikji et al study, demonstrated that a low aspect ratio plays a more dominant role than either dome to neck ratio or neck diameter in predicting the need for adjunctive techniques in the coiling of intracranial aneurysms. Furthermore, aspect ratio is a significant independent predictor of the need for these adjunctive techniques. also demonstrated that the coiling of intracranial aneurysms without adjunctive techniques such as stent placement and balloon remodeling is clinically favored for aneurysms with an aspect ratio >1.6, a dome to neck ratio > 1.6, and a neck size < 4mm. Coiling with a adjunctive techniques is favored for aneurysms with dome to neck ratios >1.6 ,aspect ratios >1.6, and neck size >4mm. analysis of these results goes with our study (Brinjikji et al., 2009).

Standhardt et al study, was achieved in 202 patients and had shown a significant link between neck size and occlusion rate. The occlusion rate was substantially higher in small neck aneurysms, in narrow neck aneurysms 77.1% complete, 18.1% neck remnant, 4.8% incomplete and
in wide neck 35.8% complete, 51.6% neck remnant, 12.6% incomplete, this results coincident with our study, with little difference in percentage related to little patients in our study (Standhardt et al., 2008).

Zubillaga et al study, evaluated the relationship between the degree of occlusion after intra-aneurysmal embolization using GDC and the neck size in 79 cases of intracranial aneurysms with complete occlusion was achieved in 85% of the aneurysms included in the small necked group. The remaining 15% of the aneurysms in this group showed residual aneurysm neck filling at the follow-up angiogram. The wide necked group provides significantly different results. Only 15.7% of the cases showed complete occlusion. In a much higher proportion (84.3%), the occlusion was subtotal. The analysis of these results goes with our results in a group of small neck but with marked difference in wide neck group due to more advance in intervention related to imaging and assisted techniques as double microcatheter, balloon assisted, stent and overflow diverters (Zubillaga et al., 1994).

Irie et al study, was achieved in 22 patients with 22 aneurysms and had shown, complete occlusion was achieved in 70% of small aneurysms. The remaining 30% showed residual aneurysm with neck filling on follow up angiogram. In the wide neck group, only 25% of the cases showed complete occlusion. Analysis of results coincident with our results, but with some difference in wide neck group due to more advance in intervention techniques and materials (Irie et al., 1997).

In contrast to results of this study, Miri et al reported that complete occlusion was achieved in 91.7% of small aneurysms. The remaining 8.3% showed subtotal occlusion. In the wide neck group, complete occlusion was achieved in 85% of small aneurysms. The remaining 15%
showed subtotal occlusion. Analysis of results there was no significant relationship between aneurysm neck size with total or subtotal occlusions, these results are relatively similar in small necked aneurysms, but marked differences in wide necked aneurysms due to usage of Neuroform stent with more safety for coiling without herniation to parent artery (Miri et al., 2015).

In this study, six procedures (15%) were found to be complicated. The most common complications were aneurysm perforation (5%), thromboembolic events (5%), and device induced vasospasm (5%).

In Standhardt et al study, thirty-nine procedures (19.3%) were found to be complicated. The most common complications were thromboembolic events (10.9%), coil dislocation (4.0%), and problems in connection with the vascular access sheath (1.5%), device induced vasospasm (1.9%), and distal arterial perforation (1%). This study were done on 202 patients (Standhardt et al., 2008).

In Willinsky et al study, Aneurysm perforation 23 (6.1%), Parent vessel occlusion 15 (4.0%), thromboembolic events 11 (2.9%), Mass effect 1 (0.3%), Arterial dissection 2 (0.6%), Parent vessel rupture 1 (0.3%). This study were done on 377 patients (Willinsky et al., 2009).

In Miri et al study, Eleven patients (12.5%) experienced complication during the procedure including 2 (2.3%) distal perforation, 4 (4.5%) thromboembolic events, 2 (2.3%) mild to moderate vasospasms, and 3 (3.4%) aneurysm perforation. This study were done on 88 patients (Miri et al., 2015).

In this study, no procedure-related mortality was recorded. One (2.5%) patient with related mortality to global vasospasm. In Standhardt
et al, the overall procedure-related mortality was 0.5% (Standhardt et al., 2008). In Miri et al, There was no mortality during the procedure (Miri et al., 2015).

In this study, un ruptured aneurysms in 8 patients had shown good outcome (GOS 5). In ruptured aneurysms, Glasgow Outcome Scale (GOS) were mainly affected by clinical presentation at admission according to Hunt and Hiss grades. In ruptured aneurysms in 32 patients, 8 patients with H&H grade 1, had shown (GOS 5) at hospital discharge. Eleven patients were presented with H&H grade 2, had shown (GOS 5) at hospital discharge in 9 patients and other 2 patients had (GOS 4). Nine patients were presented with H&H grade 3, had shown (GOS 5) in 3 patients, 3 patients had (GOS 4) and 2 patients had (GOS 3) and one patient had (GOS 2). Four patients were presented with H&H grade 4, had shown moderate disability (GOS 4) in 1 patients, 2 patients had (GOS 3) and one patient were dead (GOS 1). So, good outcome (GOS 5) was achieved in 28 (70%) patients, six patients (15%) had moderate disability (GOS 4), 4(10%) patients with severe disability (GOS 3), one (2.5%) patient were vegetative state (GOS 2) and one (2.5%) patient were dead (GOS 1).

Willinsky et al study, had shown Outcome discharge of 377 patients. 131 patients with Hunt and Hiss grade 1, had shown GOS 5 in 120 patients, GOS 4 in 5 patients, GOS 3 in 1 patient, GOS 2 in 1 patient and GOS 1 in 4 patients. Seventy four patients with H&H grade II, had shown GOS 5 in 65 patients, GOS 4 in 4 patients, GOS 3 in 0 patient, GOS 2 in 1 patient and GOS 1 in 4 patients. Ninety four patients with H&H grade III, had shown GOS 5 in 62 patients, GOS 4 in 14 patients, GOS 3 in 10 patient, GOS 2 in 0 patient and GOS 1 in 8 patients. Seventy patients with H&H grade IV, had shown GOS 5 in 30 patients,
GOS 4 in 11 patients, GOS 3 in 13 patient, GOS 2 in 3 patient and GOS 1 in 13 patients. Eight patients with H&H grade V, had shown GOS 5 in 1 patients, GOS 4 in 2 patients, GOS 3 in 0 patient, GOS 2 in 1 patient and GOS 1 in 4 patients. So, good outcome (GOS 5) was achieved in 278 patients (73.8%). Thirty six patients (9.5%) had moderate disability (GOS 4), 24 (6.4%) patients with (GOS 3), 6 (1.6%) patients with (GOS 2) and 33 (8.7%) patients with (GOS 1) or a poor clinical outcome, and 33 patients (8.8%) died. These results coincident with our study except there were high mortality and sever disability in Willinsky et al study, as in our study no cases with H&H grade 5 were included, and patients with H&H grade 4 were done after improvement of clinical condition (Willinsky et al., 2009).

In this study, among 34 patients with 36 aneurysms who underwent follow up angiography after 6 months, 29 aneurysms (80.6%) had no change, five (13.9%) had recanalization and two (5.6%) had further occlusion. 5 patients were missed and 1 patient were dead.

In D’Agostino et al study, 76 aneurysms with a 6-month angiographic follow up, four (5.3%) revealed further occlusion, 54 (71.1%) were unchanged, and 18 (23.7%) showed recanalization (D'Agostino et al., 2009). In Miri et al study, Among patients who underwent control angiography, 34 aneurysms (89.4%) had no change, two (5.3%) had new growth and two (5.3%) had widening of the neck after 6 months follow-up (Miri et al., 2015).

The technique of endovascular occlusion with Guglielmi detachable coils was originally designed to offer a less traumatic therapy for intracranial aneurysms. The results of this study clearly confirm that complete occlusion of small-necked aneurysms and aneurysms with AR
> 1.5 can be achieved with simple coiling. The results obtained in the wide-necked group and aneurysms with AR < 1.5 are less satisfactory. As noted above. Thus, coiling with adjunctive techniques as balloon or Neuroform stent and flow diverters, is favored for better results.