SYSTEMATIC REVIEW

True brachial artery aneurysm: A systematic review

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Abstract

Objective: To identify and critically appraise literature on true brachial artery aneurysm, exploring its demographic characteristics, aetiologies, clinical manifestations and different methods of repair along with complication rates to determine future treatment strategies.

Method: The systematic review was conducted at Liaquat National Hospital, Karachi, from September 30, 2021, to November 30, 2022, in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Literature was searched on MEDLINE, EMBASE and Cochrane databases for relevant studies in English language or with English translation published till May 31, 2022. The key words used for the search were "brachial artery aneurysm". Data was noted on a proforma and was subjected to descriptive analysis.

Results: Of 113 articles, 6 (5.3%) were retrospective studies, 7 (6.1%) were case series and 100 (88.4%) were case reports. The total number of patients involved was 157 with mean age 43.1±23.4 years (range: 2 months to 84 years). The gender was mentioned for 152(96.8%) patients; 111(73%) males and 41(27%) females. The mean diameter of true brachial artery aneurysm was 36.2 ±17.5mm and 106(67.5%) patients presented with localised swelling, 65(41.4%) with pain, 41(26.1%) with distal ischaemic symptoms, and 28(17.8%) with median nerve compression. True brachial artery aneurysms were more common in renal failure patients having a history of arteriovenous fistula creation in the affected limb and were on immunosuppressant drugs due to renal transplant 81(51.5%). Less common causes included primary/idiopathic 27(17.1%), trauma 13(8.2%), connective tissue disorders 8(5%) and vasculitis 7(4.5%). The treatment of choice was aneurysmectomy in 142(90.4%) cases, with revascularisation of limb primarily with reversed great saphenous vein graft 79(50.3 %), followed by end-to-end anastomosis of brachial artery 17(10.8%) and synthetic grafting 17(10.8%). Endovascular intervention was performed in 6(3.8%) cases to exclude true brachial artery aneurysm, and to re-establish adequate blood flow to the associated limb.

Conclusion: True brachial artery aneurysm, although a rarity, may lead to significant neurological and vascular problems if ignored. Arteriovenous fistula and immunosuppression are identified as two significant risk factors in the development of true brachial artery aneurysm. Therefore, an effective long-term follow up in renal failure patients is recommended to prevent its complications. Open surgical repair has been the most preferred mode of treatment, but further significant studies are needed to explore and compare different modes of surgical intervention, like open versus endovascular, to plan future treatment strategies.

Key Words: Brachial artery, Aneurysm, Systematic review, Arteriovenous fistula, Immunosuppression.

DOI: https://doi.org/10.47391/JPMA.9042

Introduction

True brachial artery aneurysms (TBAAs) are rare peripheral vascular aneurysms (0.17%) that usually present with a swelling in the upper extremity and a history that suggests local injury or inflammation.[1,2] The normal brachial artery diameter is 3.5mm to 4.3mm for females and 4.1mm to 4.8mm for males.[3,4] A "true aneurysm", compared to its counterpart, the "false or pseudo aneurysm", is defined as at least a 50% increase in the diameter of an artery compared to its normal diameter, and involving all 3 layers of the vessel wall.[4] Although the natural course of this condition is unknown, once detected, therapy is essential to avoid complications, like rupture, thrombosis or distal embolisation.[5]

Regarding treatment of brachial artery aneurysms, they can be managed in the initial stages by surveillance alone, especially if they are asymptomatic and small in size, but the main mode of treatment is open surgical repair due to easy access to aneurysm and less morbidity associated with the operative treatment.[5,6] Recently, with the evolving trend of endovascular treatment, some reports

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Submission complete: 30-01-2023 **Review began**: 13-03-2023
Acceptance: 04-11-2023 **Review end:** 30-08-2023

have also described the repair of brachial artery aneurysm by endografts, coil embolisation and even by a hybrid technique, with good success rate, but these modes of treatment are still not in common practice.[7-9]

Data on brachial artery aneurysm, its demographics, risk factors and treatment is scarce due to low prevalence of the condition. Only some case reports and a few retrospective observational studies have been reported on brachial artery aneurysm treatment, but no comparative cohort study or and randomised control trial (RCT) or systematic review has been identified. The current systematic review was planned to fill the gap by identifying and critically appraising literature on TBAA, exploring its demographic characteristics, aetiologies, clinical manifestations and different methods of repair along with complication rates to determine future treatment strategies.

Materials and Methods

The systematic review was conducted at Liaquat National Hospital, Karachi, from September 30, 2021, to November 30, 2022, after registration with the PROSPERO (Prospective Register of Systematic Reviews) (CRD42023469243), and was done in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[10, 11]

Literature was searched on MEDLINE, EMBASE, Cochrane Library and Cochrane Central Register of Controlled Trials (CENTRAL) databases through PubMed, Ovid and TRIP medical database search platforms. The key term used for the search was "brachial artery aneurysm". Relevant literature in English language or with English translation, including studies, case series, case reports, editorials and pertinent review bibliographies from major medical journals, conference proceedings for indexed abstracts, and grey research, published till May 31, 2022, were included. Approval from an ethics review committee is not required in systematic review, and, therefore, was not taken.

The relevance of all the search results was assessed. For the material centred on TBAAs, publications were included based on an abstract screening. Because of the small number of publications currently available, there were no restrictions on the kind of publication, quality, research technique, or risk of bias.

The initial screening filtered out papers that has nothing to do with TBAAs. Material related to pseudo or false aneurysms was excluded after full-text screening, and so was the case with articles that were not in English and their English translation was also not available in the institutional library. A secondary screening excluded articles for which full-text access was not available.

The Cochrane Handbook for Systematic Reviews of Interventions did not advocate meta-analysis because of the overall clinical diversity of the studies found in the current review.[12] The experimental designs, treatment protocols, and methods of outcome assessment in each of the study examined were all distinct, therefore performance of meta-analysis was inapplicable. Due to these reasons, only a Systematic review and descriptive analysis of the existing data was performed.

Results

Of 113 articles, 6(5.3%) were retrospective studies, 7(6.1%) were case series and 100 (88.4%) were case reports[1-3, 5-9, 13-117]. The total number of patients involved was 157 with mean age 43.1 ± 23.4 years (range: 2 months to 84 years). The gender was mentioned for 152(96.8%) patients; 111(73%) males and 41(27%) females.

The side of the aneurysm development was mentioned in 129(82.16 %) cases; 79 (61.24%) left upper limb, 44(34.10%) right upper limb and 6(4.65%) bilateral.

Mean TBAA size was 36.25±17.53 mm (range: 8-105mm).

The most common symptom was upper extremity localised swelling 106(67.5%) among whom 60(56.6%) were pulsatile, and 46(43.39%) were non-pulsatile. The second most common symptom was pain in 65(41.40%) cases. Distal ischaemia of limb and hand 41(26.1%) and median nerve compression symptoms 28(17.8%) were less commonly found (Table 1).

More than half of TBAA patients had chronic renal failure (CRF) 81(51.5%) with history of arteriovenous fistula (AVF) creation and renal transplantation (RT) ($p<0.05$).

In 27(17.1%) patients, no significant cause or risk factors were determined and they were labelled as primary or

Table-1: Symptoms associated with true brachial artery aneurysm (TBAA).

S No.	Symptoms		Number of Patients (%)
1	Localized Swelling		106 (67.51%)
		Pulsatile	60 (38.21%)
		Non-Pulsatile	46 (29.29%)
2	Local Pain		65 (41.40 %)
3	Distal limb and hand ischaemia (colour change, cold, gangrenous finger tips)		41 (26.11%)
4	Median Nerve compression (distal limb motor weakness and paresthesia)		28 (17.83%)
5	Localised skin changes like erosion of over lying skin		2 (1.27%)
6	Asymptomatic (Benign course)		9 (5.73%)
7	Not available (NA)		3 (1.91%)

Table-2: Causes and risk factors of true brachial artery aneurysm (TBAA).

S No.	Causes/ Risk factors	Number of Patients (%)
1	CRF patients having AVF in affected limb and RT history	81 (51.5%)
2	Primary / Idiopathic aneurysm	27 (17.1%)
3	Post Trauma (including recurrent trauma by use of Crutches)	13 (8.2%)
4	Connective tissue disease	8 (5.0 %)
5	Vasculitis	7 (4.5%)
6	Atherosclerotic disease	5 (3.1%)
7	Infective or Mycotic	4 (2.6%)
8	Degenerative / Myxomatous changes	4 (2.6%)
9	Aneurysmal disease (involvement of other vessels)	2 (1.3%)
10	Arteriovenous Malformations	2 (1.3%)
11	Blood vessel tumour	2 (1.3%)
12	Metabolic disorder	2 (1.3%)
13	Aortic Dissection	1 (0.6%)
14	No information available	2 (1.3%)

CRF: Chronic renal failure, AVF: Arteriovenous fistula, RT: Renal transplant.

idiopathic brachial aneurysm. However, other notable causes were trauma 13(8.2%), connective tissue disease 8(5%), vasculitis 7(4.5%), atherosclerotic disease 5(3.1%) and infective or mycotic 4(2.6%) (Table 2).

The treatment primarily used was aneurysmectomy, which is resection of brachial aneurysm, 142(90.4%), followed by re-establishment of distal limb perfusion by

Table-3: Treatment details of true brachial artery aneurysm (TBAA).

S No.	Treatment		Number of Patients (%)
1	Aneurysmectomy and		142 (90.4%)
	a. Grafting	a	122 (77.7%)
	Reversed Saphenous vein graft		79 (50.3%)
	Other venous and arterial grafts		26 (16.56%)
	Synthetic grafts		17 (10.82%)
	b. End to end anastomosis	b	17 (10.82%)
2	Endovascular procedures		6 (3.8%)
3	Others		14 (8.91%)
	Ligation of brachial artery / Aneurysm		11(7%)
	Lateral Aneurysmorraphy		2 (1.27%)
	Partial Aneurysmectomy		1 (0.63%)

inter-positional vascular grafts 122(77.7%). In grafts the most preferred one was reversed saphenous vein graft (RSVG) 79(50.3%). Other venous grafts were also used, including cephalic 8(5%), basilic 7(4.4%) and internal iliac artery 1(0.6%), femoral artery 1(0.6%). Use of Synthetic grafts was the last option to re-vascularise the distal limb in 17(10.82%) cases. In 17(10.82%) cases where sac of aneurysm was small and distance between the cut edges of native vessel was <2cm, primary end-to-end vascular repair was attempted to anastomose the remaining segments of native artery to restore its continuity and

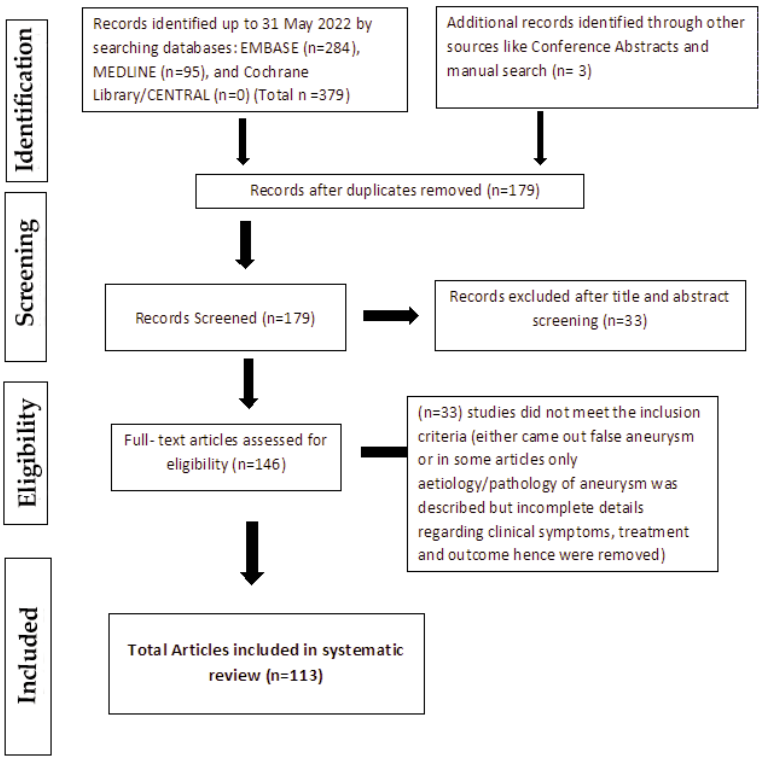

Figure: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart.

Table-4: Complications related to true brachial artery aneurysm (TBAA) treatment

S No.	Complication	Number of Patients (%)
1	Recurrence of aneurysm in venous graft	5 (3.1%)
2	Recurrence of aneurysm in native artery	4 (2.6%)
3	Persistent distal Neuropathy	2 (1.27%)
4	Local Haematoma need drainage	2 (1.27%)
5	Distal ischaemia need amputation	1 (0.6%)
6	Anastomotic stenosis needed secondary procedure	1 (0.6%)
7	Thrombosis of graft needed secondary procedure	1 (0.6%)
8	Death due to uncontrolled bleeding from artery proximal to ligation of aneurysm	1 (0.6%)
9	Information not available (NA)	4 (2.6%)

distal vascularisation.

Endovascular procedures had been employed in 6(3.8%) cases; 3(50%) by stent grafts, embolisation of aneurysmal sac, angioplasty and catheter thrombolysis were employed in 1(16.7%) case each to relieve ischaemic symptoms.

Some modified surgical techniques in unsuitable cases were also noted, like surgical ligation of brachial artery, lateral aneurysmoraphy and partial aneurysmectomy (Table 3).

There were only 17(10.8%) cases of post-operative complications among whom 5(3.1%) developed recurrence of aneurysm in the venous graft, and 4(8.9%) in native brachial artery. Besides, 2(1.2%) patients complained of persistent neuropathy in the form of weakness of hand grip and paraesthesia even after 6-12 months. Ischaemic symptoms reversed almost in every patient except in 1(0.6%) patient who developed gangrene and amputation was done. Further, 2(1.27%) cases developed significant haematoma at the operative site that required surgical drainage. Also, 1(0.6%) mortality was noted in a patient having primary diagnosis of neurofibromatosis, due to uncontrolled bleeding from artery proximal to ligation of aneurysm on the 4th post-operative day.

Mean follow-up duration was 15.77±19.21 months (range: 3 days-72 months). In available long-term follow-up, it was found that only 1(0.6%) patient had developed anastomotic stenosis and needed angioplasty, while 1(0.6%) had secondary procedure for graft thrombosis (Table 4).

Discussion

To the best of our knowledge, the current systematic review is among the first on brachial artery aneurysm and its treatment. TBAAs are rarely encountered in clinical practice with its frequency being as low as 0.17 % in all peripheral arterial aneurysms.[1] Aetiology of TBAAs include genetic pathologies, such as connective tissue disorders, vasculitis, atherosclerotic disease and trauma.[118] It has also been observed that TBAA are not only limited to genetic pathologies, but may also arise as a complication to a systemic pathology that may affect the haemodynamics of the arterial system in a secondary manner.[13-24,119] Findings noted in the current review also confirmed of the above theory. It was found that 51.5% patients with TBAA had a history of CRF with AVF creation in the affected limb and received 1-2 RTs.

The most prominent and accepted view that supports the above relation is that the development of an AVF alters the arterial wall dynamics due to increased resistance of the vessel wall secondary to persistent increased flow that eventually weakens the arterial walls and causes aneurysm formation.[13-15] Another proposed theory states that the increased release of reactive oxygen species (ROS) results in an increase in negative ions that stimulates an up-regulation of metalloproteases, resulting in the degradation of the internal vessel wall.[16,17] Moreover majority of CRF patients receive renal transplant/s and take steroid and immunosuppressive drug therapy to prevent rejection. Steroids can also pose a threat to the integrity of the muscular walls of vessels and increase the risk of aneurysm disease.[17] However, development of aneurysm after AVF creation and steroids is a slow process and takes years to progress (11.3 ± 5 years) and the risk of development of aneurysm persists even after ligation of fistula and cessation of steroids.[18]

Another finding that supports the association of AVF with brachial aneurysm is that the left-sided TBAA (50.3%) was almost twice as common (1.79: 1) as the right-sided (28.0%). The left upper arm is a preferable site for AVF creation.

Regarding risk factors, it was found that handicapped patients who had history of long-term use of crutches for their mobility had more chance of developing TBAA compared to other cohorts. It was observed that the upper end of a crutch put pressure in axilla which gradually damaged the brachial artery wall by pressing it against the humerus bone, causing aneurysm formation.[19-24] These findings shed light on the risk of aneurysm development associated with prolonged use of such walking aids and warrant caution to be taken by physicians and physiotherapists.[19]

Remaining aetiologies / risk factors that were found included primary/idiopathic aneurysm, connective tissue

Supplementary Table: Summary of all the studies included in the systematic review related to true brachial artery aneurysm (TBAA) (for online publication only).

S. No	Author, year	Age	Sex	Side	Size (largest diameter in mm)	Symptoms	Treatment	Post treatment complications	Cause/ co-morbidity/ risk factors	History of kidney transplant	Follow up duration
1	Zahdi O et al, 2022(ref # 13)	67 yrs	M	L	53 mm	Painful throbbing mass for last 7 months also causing Paraesthesia	Aneurysmectomy +Primary repair of Brachial artery by end to end anastomosis	None	Chronic Renal failure (CRF) with Arterio Venous fistula (AVF) ligated 5 yrs before	Yes	18 months
2	Gonzalez-Urquijo M. et al,2022 (ref#9)	65 yrs	F	L	23 mm	Pallor and pain in left forearm, accompanied by a pulsatile mass	Embolization of Aneurysmal sac + revascularization by reversed saphenous vein graft (RSVG)	none	Idiopathic	No	3 months
3	Jahanzeb K et al,2022 (ref#27)	6 months	M	L	30 mm	Pulsatile mass only	Lateral Aneurysmorraphy	None	Metabolic disorder	No	1 month
4	Barac Sorin et al, 2022 – 1 (ref#14)	59 yrs	NA	L	76 mm	Pulsatile mass only	Aneurysmectomy +repair with RSVG	none	Chronic Renal failure (CRF) with AVF	yes	10 days
5	Barac Sorin et al, 2022 - 2(ref#14)	42 yrs	NA	L	64 mm	Pulsatile mass with skin erosion and loss of grip strength.	Aneurysmectomy +repair with collagen impregnated woven Nylon graft (Vascutek /Terumo)	None	Alport Syndrome, CRF with AVF	yes	3 months, Developed Constrictive pericarditis after 2 months and Died after 3 months
6	Juan Bautista Sanchez et al,2022 (ref # 28)	67 yrs	F	L	25 mm	Pulsatile mass with stabbing pain in left forearm	Aneurysmectomy +repair with RSVG	none	Atherosclerotic changes detected on histopathology in anaeurysmal wall.	no	6 months

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7	Jordan Kaplan et al, 2021 (ref#29)	3 yrs	M	R	NA	Recurrent painless, pulsatile swellings/ aneurysm in arm after several repairs	Aneurysmectomy +repair with RSVG +reinforcement of arterial suture line with Gore-Tex wrap to prevent recurrence of suture line aneurysm	No recurrence of aneurysm up to 18 months	Suspected Collagen diseases	no	18 months
8	Baran Simsek et al. 2021 (ref#19)	48 yrs	F	Bilateral	L=40 mm, R=30 mm	Severe left forearm pain with distal embolization, Right brachial aneurysm asymptomatic	Left Aneurysmectomy +repair with 4mm Propten Heparin bound graft by Gore+ radial & Ulnar Thromboembelectomy	no	Post Traumatic due to use of Crutches	no	12 months
9	Hamdulay khaleel et al, 2021 (ref#30)	69 yrs	M	L	45 mm	upper extremity pain, swelling and median nerve neuropathy	Aneurysmectomy +repair with PTFE interposition graft	NA	CRF with AVF, Atrial Fibrillation (AF)	Yes	NA
10	Montoya Ching R. et al, 2021 (ref#20)	84 yrs	F	R	43.7mm31.6 mm	2 adjacent aneurysm in Rt arm causing :Pain, loss of pulses in forearm and necrosis of phalanges with Cyanosis and coldness	Aneurysmectomy + repair with RSVG.	Ischemia and Forearm amputation.	Prolonged use of crutches	No	NA
11	Yilmaz F et al,2021 (ref#7)	39 yrs	M	R	20 mm	pain, coldness, and cyanosis in the distal phalanx of the right fifth digit	Implantation of a FLUENCY stent (6 X 80 mm) + 1 month anticoagulant & antiplatelet course.	none	Previous history of Brachial artery injury repair after car accident	No	12 months
12	A L Naik et al, 2021 (ref# 31)	2 yrs	M	R	45 mm	Swelling in upper arm	Aneurysmectomy +repair with RSVG	none	Behcet's disease	No	6 months
13	Kaushik et al,2021 (ref#32)	49 yrs	M	R	NA	Arm pain and tingling	Aneurysmectomy +repair with interposition graft + Palmar arch angioplasty	none	CRF with AVF	Yes	3 months

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14	Schilling E.M et al, 2020 (ref#33)	NA	M	R	105 mm	large, erythematous, oval tumour on his right upper arm	Aneurysmectomy +repair with Basilic vein.	None	CRF with AVF, AAA and bilateral Popliteal aneurysms	Yes	1 2 months
15	Osipov et al, 2020 (ref# 34)	2 months	F	L	23 mm	upper extremity swelling, impaired upper extremity and hand functions with neurological disturbances	Aneurysmectomy + Repair with end-to-end anastomosis of artery	None	Idiopathic	No	10 months
16	Franchin M. et al, 2020 (ref# 35)	68 yrs	M	L	20 mm	Pulsatile swelling in left arm +forearm pain	Aneurysmectomy + repair by using 8-mm heparin-bonded expanded polytetrafluorethylene graft (ePTFE)	none	CRF secondary to Polycystic Kidney Disease with AVF, Plasmablastic lymphoma	Yes	Death after 5 months due to sepsis/MOF
17	Tadayon et al, 2020 (ref# 36)	66 yrs	F	R	25 mm	upper extremity swelling, paresthesia, coldness, and pain	Aneurysmectomy +repair with RSVG	none	Idiopathic	No	6 months
18	Taghi et al, 2020 (ref#37)	70 yrs	F	R	26 mm	upper extremity pulsatile swelling and paresthesia	Aneurysmectomy + Repair with end-to-end anastomosis of artery	none	Idiopathic	No	NA
19	Salerno et al, 2020 (ref# 38)	45 yrs	M	L	35 mm	upper extremity pulsatile swelling	Aneurysmectomy +repair with RSVG	none	CFR with AVF	Yes	6 months
20	Youssef Shaban et al,2020 (ref#2)	83 yrs	M	L	18.5 mm	Pulsatile Swelling, Pain, Erythema and decreased left hand grip strength	Aneurysmectomy +repair with RSVG +Radial and ulnar embolectomy.	none	Idiopathic	No	6 months
21	Curtis Woodford et al, 2020 (ref#39)	18 yrs	F	L	35 mm	Bilobed swelling in left Antecubital fossa causing Pain and paresthesia in Median Nerve distribution.	Aneurysmectomy +repair with Reverse femoral vein graft (unavailability of any other suitable venous graft)	none	Past history of AVM of interosseus artery treated with embolization 7 yrs before development of aneurysm	no	10 months

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22	Simson Rosie et al, 2019 (ref#40)	71 years	M	R	30 mm	Pulsatile, non-painful swelling in the ipsilateral antecubital fossa.	Extra-anatomic bypass from the mid arm brachial artery to the mid forearm radial artery was performed using an ipsilateral reversed cephalic vein	None	Infective endocarditis	No	3 months
23	Senarslan et al, 2019 – 1 (ref#5)	27 yrs	M	L	Three consecutive aneurysms with max diameter 44 mm	Pulsatile mass + upper extremity pain and numbness + weak distal pulses	Aneurysmectomy +repair with RSVG	none	Degenerative disease	No	24 months
24	Senarslan et al, 2019- 2 (ref#5)	81 yrs	F	L	50 mm	pain, swelling, cyanosis, and gangrenous lesions at the tips of the fingers of left hand	Aneurysmectomy +repair with RSVG	none	Atherosclerotic disease + Atrial Fibrillation	No	12 months
25	Senarslan et al, 2019 – 3 (ref#5)	78 yrs	M	L	30 mm	numbness, cyanosis in the hand and pain on the left forearm	Aneurysmectomy +repair with biological vascular graft (Omniflow II, LeMaitre)	none	Atherosclerotic disease	No	6 months
26	Toyota et al, 2019 (ref#15)	60 yrs	M	L	35 mm	upper extremity pulsatile swelling	Aneurysmectomy + Repair with end-to-end anastomosis of artery	none	CRF with AVF	Yes	12 months
27	Christiana Anastasiadou et al, 2019 (ref#41)	49 yrs	M	L	37 mm	upper extremity painful , pulsatile swelling	Aneurysmectomy + Repair with reversed cephalic vein interposition graft	none	CRF with AVF, Atherosclerotic changes in aneurysmal wall	Yes	24 months
28	Allinjawi et al, 2019 – 1 (ref#42)	38 yrs	M	L	NA	sudden onset left arm pain and swelling	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	12 months
29	Allinjawi et al, 2019 – 2 (ref#42)	34 yrs	M	L	NA	extensive skin scarring and partial erosion	Aneurysmectomy + Ligation of Brachial artery.	none	CRF with AVF	Yes	6 months
30	Coelho et al, 2019 (ref#43)	14 yrs	F	L	15 mm	painful pulsatile left arm mass and occasional hand paresthesia	Aneurysm exclusion by ligation and transposition of distal RadioUlnar artery in Genuine Brachial artery by lateral anastomosis	none	Kawasaki Disease	No	2 months

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31	R. Agarwal et al, 2019 (ref#44)	74 yrs	M	R	60 mm	Pulsatile swelling, change in color, pain and paresthesia in the right hand, chronic ischaemia in limb	Aneurysmectomy + Repair with end-to-end anastomosis of artery	none	Trauma	No	NA
32	Degenaar et al, 2019 (ref #45)	48 yrs	F	L	2 large (24 and 22mm) , 1 small aneurysm (10 mm)	Progressive and painful swelling of the left upper arm	Aneurysmectomy +repair with RSVG	Persistant deficit in strength and sensation of left hand	Type 1 Neurofibromatosis	No	1 month
33	Gorkem Yigit 2019 (ref#8)	31 yrs	F	R	16 mm	Pulsatile mass, pain and numbness in arm, Slight motor and sensory loss in distal phalynx of index finger with absent pulses.	Endovascular repair with 2 covered stent	None	Behcet's disease	no	NA.
34	Rodrigues et al, 2019 (ref#46)	54 yrs	F	L	41 mm	upper extremity pain, pulsatile swelling and edema	Aneurysmectomy +repair with PTFE interposition graft	None	CRF with AVF	Yes	NA
35	Prendes et al, 2017-1 (ref#47)	44 yrs	M	NA	60 mm	Asymptomatic swelling	Aneurysmectomy +repair with RSVG	45 mm aneurysmal dilation of vein graft was found after 2 yrs repaired with PTFE graft	CRF with AVF	Yes	72 months
36	Prendes et al, 2017-2(ref#47)	55 yrs	M	NA	45 mm	Asymptomatic swelling	Aneurysmectomy +repair with inverted ipsilateral basilic vein interposition graft	None	Malignant Nephroangiosclerosis with AVF, Right Popliteal aneurysm	Yes	6 months
37	Soares et al, 2017 (ref#48)	66 yrs	M	L	44 mm	Pulsatile mass with upper extremity pain, redness and heat	Aneurysmectomy +repair with RSVG	none	CRF with AVF	yes	7 days
38	Pradhananga et al, 2017 (ref#25)	59 yrs	M	L	NA	Non pulsatile mass with upper extremity pain, coldness,	Aneurysmectomy +repair with RSVG	None	Idiopathic	No	NA

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						paresthesia, and blackish discoloration					
39	Lopes da Costa et al, 2017 (ref#21)	68 yrs	F	L	30 mm	Paleness and ischaemia of left upper limb + concurrent Venous aneurysm	Aneurysmectomy +repair with RSVG + distal embolectomy with balloon catheter	none	Trauma caused by prolonged crutch use	No	NA
40	Fendri et al, 2017 – 1 , (ref#49) (Retrospective observational study)	47 yrs	M	R	45 mm	pain in upper limb	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	12 months
41	Fendri et al, 2017 - 2(ref#49)	37 yrs	M	L	30 mm	pain in upper limb	Aneurysmectomy +repair with de-valvulated SVG	none	CRF with AVF	Yes	12 months
42	Fendri et al, 2017 - 3(ref#49)	40 yrs	M	L	18 mm	pain in upper limb	Aneurysmectomy +repair with femoral artery transposition	none	CRF with AVF	Yes	12 months
43	Fendri et al, 2017 - 4(ref#49)	76 yrs	M	R	30 mm	pain in upper limb	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	12 months
44	Sergio Teixeria et al, 2017 (ref#18) (retrospective observational study of 10 cases of Brachial artery aneurysm)	52 yrs + 7.84 (37-63)	9M and 1 F	NA	37.5 mm + 14.54 (17.5-64mm)	a)Localized pain with pulsating mass in 6 pts. (60%)	Aneurysmectomy in all pts +repair with	a) No complication in 8 patients. b) postoperative haematoma in 1 pt need drainage c) Anastomotic stenosis in 1 pt need angioplasty at 50th month	CRF with AVF	In 9 pts. (90%)	69 mo (range: 1–177)
45	Mafalda Correia et al, 2017 (ref#50)	43 yrs	M	N/A	45 mm	Localized pain with occasional Paraesthesia and compression symptoms	Partial Aneurysmectomy +repair with PTFE graft	Recurrence of Aneurysm at 2 yrs again treated with Partial	CRF with AVF	Yes	24 months

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								aneurysmectomy and repair with PTFE graft			
46	Chiarandini et al, 2016 (ref#51)	66 yrs	M	L	50 mm	pulsatile mass , pain and parasthesia in left hand	Aneurysmectomy +repair with ePTFE graft	none	CRF with AVF	Yes	3 months
47	Jones J.L.et al, 2016 (ref # 52)	29 Yrs	M	R	12 mm	right arm pain and a cool and cynosed right hand with loss of distal pulses but NO paresthesia and sensory motor loss.	Aneurysmectomy +repair with RSVG + Embolectomy +heparin therapy for ischaemic symptoms	haematoma formation need durgical evacuation, ulnar artery was narrowed and occluded at the wrist	Fibromuscular dysplasia	No	1 .5 months
48	Ben Mrad et al, 2016 (ref#53)	40 yrs	M	L	37 mm	upper extremity pain, swelling and oedema	Aneurysmectomy +repair with RSVG	none	Idiopathic	No	12 months
49	Davis K.M. et al , 2016-1 (ref#54)	4 yrs	M	R	18 mm	Mass over the brachial artery	Aneurysmectomy +repair with interposition graft	none	Kawasaki disease	No	132 months
50	Davis K.M. et al , 2016-2 (ref#54)	6 yrs	M	R	16mm	Mass over the brachial artery	Aneurysmectomy +repair with RSVG	none	Kawasaki disease	No	72 months
51	Davis K.M. et al , 2016-3 (ref#54)	10 yrs	F	L	16mm	Mass over the brachial artery	Aneurysmectomy +repair with RSVG	none	NA	no	30 months
52	Nishimura et al, 2016 (ref#55)	65 yrs	M	L	20 mm	upper extremity rest pain and ulceration of the left second and third fingers	Aneurysmectomy +repair with RSVG	None with complete resolution of symptoms	CRF with AVF, Atrial flutter, Type 'B' Aortic dissection	No	15 days
53	Gardiner et al, 2016 (ref#56)	66 yrs	M	L	60 mm	upper extremity pain and swelling, thrombosis in radial artery	Aneurysmectomy +repair with two cadaveric superficial femoral artery homografts.	none	CRF with AVF	Yes	42 months
54	Ghazanfar et al, 2016 (ref#57)	2 yrs	M	R	30 mm	upper extremity painless and pulsatile swelling	Aneurysmectomy +repair with RSVG	none	Idiopathic	No	6 months

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55	Ferrara et al, 2016 (ref#58)	61 yrs	M	L	NA	upper extremity pain, swelling and paresthesia, compression of Median Nerve	Aneurysmectomy +repair with interposition reversed basilic vein graft	none	CRF with AVF	Yes	1 month
56	Gangopadhay et al, 2016 (ref#59)	7 months	M	L	20 mm	Pulsatile mass with good distal pulses, Diminished spontaneous	Aneurysmectomy +repair with RSVG	None, Median Nerve function	Idiopathic	No	1 month
57	Y. Yuan et al, 2016.(ref#60)	38 yrs	M	R	30 mm	Painful pulsatile mass in arm	Aneurysmectomy +repair with RSVG	no	Idiopathic	No	5 days
58	Kordzadeh et al, 2015-1 (ref#26)	40 yrs	M	L	38 mm	upper extremity pain, coldness, paresthesia, and discolouration of hand with no distal pulses	Aneurysmectomy +repair with PTFE graft	none	CRF with AVF	Yes	18 months
59	Kordzadeh et al, 2015-2 (ref#26)	54 yrs	M	L	30 mm	upper extremity pain, coldness, and bluish discolouration of finger tips with absent radial pulse	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	18 months
60	Cleveland et al, 2015 (ref#61)	48 yrs	M	L	22 mm	Cold Left hand with numbness, pain and decreased power due to median N neuropathy, Distal pulses are palpable	Aneurysmectomy +repair with cephalic vein interposition graft	None , complete resolution of Median nerve neuro-pathy	CRF with AVF	Yes	3 months
61	Jung Nam Kwon et al, 2015 (ref#62)	51 yrs	F	L	20 mm	pulsatile mass in the left antecubital fossa	Aneurysmectomy +repair with RSVG	none	Intravascular papillary endothelial hyperplasia (epithelial Haemangioma)	No	24 months
62	Heydari et al, 2015 (ref#63)	52 yrs	M	R	22 mm	sudden onset and progressive pain with coldness of right upper extremity and absent distal pulses	Aneurysmectomy +repair with RSVG +Embolectomy and warfarin therapy	none	Idiopathic	No	5 days
63	Grkovski et al, 2015 (ref# 64)	51 yrs	F	R	NA	NA	Endo vascular treatment with stent graft	none	Trauma-Frequent shoulder luxation	No	NA

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64	M. Marconi et al, 2015 (ref#65)	61 yrs	NA	L	90 mm	Giant upper limb swelling with no compressive or ischaemic symptoms	Aneurysmectomy +repair with PTFE graft	None	CRF with AVF	yes	60 months
65	Nakanishi et al, 2014(ref#66)	38 yrs	F	R	12 mm	severe pain and subcutaneous bleeding in the right upper arm	Brachial artery ligation proximal and distal to aneurysm	No distal ischemia after ligation but development of aneurysm of collateral brachial artery after 5 months treated with embolization	Ehler Danlos Syndrome (Vascular type)	No	11 months
66	De Santis et al, 2014 (ref#67)	47 yrs	M	L	NA	upper extremity pain swelling, and finger hypothermia	Aneurysmorraphy of anterior wall of aneurysm	none	CRF with AVF	yes	6 months
67	Bahia, 2014-1 (ref#3)	60 yrs	M	L	25 mm	upper extremity swelling and ischaemic pain in left arm	Aneurysmectomy +repair with RSVG + Thrombectomy	None with complete resolution of symptoms	CRF with AVF	Yes	NA
68	Bahia, 2014-2 (ref#3)	63 yrs	M	L	30 mm	upper extremity pain, pallor and paresthesia with cold finger tips	Aneurysmectomy +repair with RSVG	None with complete resolution of symptoms	CRF with AVF	Yes	NA
69	Khalid et al, 2014- 1 (ref#16)	44 yrs	F	L	24 mm	upper extremity pain and pulsatile mass	Aneurysmectomy +repair with RSVG	persistent arteriomegaly proximal to the repair	CRF with AVF	Yes	6 months

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70	Khalid et al, 2014- 2 (ref#16)	50 yrs	F	L	17 mm	Paresthesia of left hand and discoloration	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	12 months
71	Khalid et al, 2014- 3 (ref#16)	75 yrs	M	L	50 mm	upper extremity pain and pulsatile swelling	ligation of feeding vessel of aneurysm	none	CRF with AVF	Yes	12 months
72	Martins P. et al, 2014. (ref#68)(Retrospective observational study of 6 patients)	54 yrs (average age)	5 M (83%) & 1 F(17%)	NA	Average diameter was 32.5 mm	Painless pulsatile mass was most common presentation	Aneurysmectomy in all patients + repair with a) Interpositional RSVG -4 pts b) Prosthetic graft 1 pt. c) End-to-end anastomosis in 1 pt	a) 2 patient developed aneurysmal degeneration of graft and /or proximal brachial artey at 60 months b) thrombosis of 1 prosthetic graft at 2 months All above need 2nd procedure but no fatalities or limb loss	All are CRF with AVF	All were kidney transplant recipients	60 months
73	Furukawa et al, 2013 (ref#22)	83 yrs	M	L	25 mm	Symptoms of Acute limb ischaemia: cold, pale upper limb, weak grip and paresthesia	Aneurysmectomy +repair with RSVG +catheter Thromboembolectomy	None, with resolution of symptoms	Trauma-caused by prolonged crutch use	No	NA
74	Guler et al, 2013 (ref#69)	37 yrs	M	R	20 mm	palpable mass in upper limb with hand ischaemia and loss of distal pulses	Aneurysmectomy +repair with RSVG	None	Degenerative changes secondary to Hyperhomomocyteinaemia	No	3 days

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75	Ramon Garza et al, 2013 (ref#70)	47 yrs	M	R	23 mm	Pain ,discolouration and Paresthesia of the distal fingertips but no sensory and motor loss.	Aneurysmectomy +repair with RSVG	none	Myxomatous degeneration secondary to Polycystic Kidney disease, CRF with AVF	Yes	NA
76	Ramakrishna et al, 2013 (ref#71)	35 yrs	M	R	20 mm	Pulsatile mass in arm with pain and bluish discolouration of the right-hand finger tips with tingling and numbness	Aneurysmectomy +repair with Reversed venous graft	None with resolution of symptoms	Traumatic	No	NA
77	Dinoto et al, 2012 (ref#17)	64 yrs	M	R	80 mm	upper extremity swelling with pain and paresthesia in hand	Aneurysmectomy +repair with interposition PTFE graft	None	CRF with AVF	Yes	6 months
78	S.S. Ning Wong et al, 2012 (ref#72)	37 yrs	M	L	44 mm	upper extremity pulsatile swelling	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	3 months
79	Greenberg et al, 2012 (ref#73)	18 months	F	L	12 mm	upper extremity swelling	Aneurysmectomy +repair with RSVG	None	Idiopathic	No	NA
80	A Fakhree M Bet al, 2012 (ref#74)	67 yrs	M	R	20 mm	upper extremity pain, paresthesia, pallor and impaired function of hand with no distal pulses	Aneurysmectomy + repair with RSVG + proximal and distal embolectomy	none	Idiopathic	No	1 month
81	Marzelle et al, 2012-1 (ref#75)	37 yrs	M	NA	80 mm	upper extremity pain and swelling	Aneurysmectomy + Repair with basilic vein interposition graft	Aneurysmal degeneration of venous graft(40 mm) treated with PTFE bypass	CRF with AVF	Yes	21 months
82	Marzelle et al, 2012-2 (ref#75)	42 yrs	M	NA	35 mm	ischaemic symptoms	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	38 months
83	Marzelle et al, 2012-3 (ref#75)	41 yrs	M	NA	35 mm	upper extremity pain	Aneurysmectomy +repair with interposition PTFE graft	none	CRF with AVF	Yes	48 months

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84	Marzelle et al, 2012-4 (ref#75)	42 yrs	F	NA	39 mm	upper extremity pain and swelling +median nerve neuropathy	Aneurysmectomy +repair with RSVG	Aneurysmal degenerated of venous graft (50mm) treated with PTFE bypass	CRF with AVF	Yes	4 months
85	Sohawon et al, 2012 (ref#76)	33 yrs	F	L	25 mm	upper extremity pain and paresthesia	Aneurysmectomy +repair with RSVG	none	CRF with AVF	NO	NA
86	M.T. Clarke et al, 2012 (ref#77)	71 yrs	M	L	50 mm	Left hand ischaemia with rest pain and coldness	Aneurysmectomy +repair with reversed Basilic vein.	none	CRF with AVF	yes	2 months
87	B. Padhye et al, 2012 (ref#78)	9 weeks	F	Bilateral	NA	Marked peripheral ischaemia with focal necrotic tips of fingers and toes	Bilateral Aneurysmectomy +repair with venous graft	none	Kawasaki disease	No	4 months
88	Raber et al, 2011 (ref#79)	29 yrs	M	R	40 mm	Pain and Pulsating mass above Right elbow	Aneurysmectomy +repair with Cephalic vein graft	none	Idiopathic	No	6 months
89	Alagaratnam et al, 2011 (ref#80)	64 yrs	F	L	34 mm	upper extremity swelling and paresthesia in fingers secondry to median Nerve compression	Aneurysmectomy +repair with RSVG	none	Idiopathic	No	4 months
90	Seongmin Ko et al, 2011 (ref#81)	32 yrs	F	R	50 mm	upper extremity pain and progressive swelling	Aneurysmectomy +repair with RSVG	Recurrence of aneurysm after 1 month- repaired again with RSVG	Idiopathic	No	40 days
91	Ardakani et al, 2011 (ref#23)	64 yrs	M	R	25 mm	Coldness, pain, decreased movement in hand, painful non healing ulcers at tip of fingers	Aneurysmectomy +repair with RSVG	none	Trauma- caused by prolonged crutch use	No	NA
92	Li Dalin et al, 2011 (ref#82)	76 yrs	M	L	50 mm	Asymptomatic pulsatile mass in the left axilla arising	Aneurysmectomy + Axillary artery repair and ligation	none	Idiopathic	No	NA

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						from deep brachial artery	of profunda brachial artery+ heparin therapy				
93	Carlo Basile et al 2011 (ref#83)	55 yrs	M	L	24 mm	Pulsatile swelling	Aneurysmectomy +repair with RSVG	None	CRF with AVF	Yes	NA
94	Tor F. , 2010 (ref#84)	65 yrs	M	L	NA	asymptomatic antecubital fossa pulsatile mass	Aneurysmectomy +repair with RSVG to create brachial to ulnar artery bypass	none	NA	NA	NA
95	Chemla et al, 2010-1 (ref#85) (Retrospective observational study of 13 patients)	26 yrs	M	R	35 mm	upper extremity cramps, coldness and weakness	Aneurysmectomy + basilic vein interposition graft	none	CRF with AVF	Yes	16 months
96	Chemla et al, 2010-2 (ref#85)	51 yrs	M	R	60 mm	Dusky right hand with pale and numb finger tips	Aneurysmectomy + cephalic vein interposition graft	none	CRF with AVF	Yes	16 months
97	Chemla et al, 2010-3(ref#85)	51 yrs	M	L	40 mm	upper extremity pain and swelling	Aneurysmectomy + end-to-end anastomosis	none	CRF with AVF	Yes	16 months
98	Chemla et al, 2010-4(ref#85)	77 yrs	M	R	30 mm	Weak power grip	Aneurysmectomy + repair with RSVG	none	CRF with AVF	Yes	16 months
99	Chemla et al, 2010-5(ref#85)	41 yrs	M	L	45 mm	upper extremity pain	Aneurysmectomy + repair with RSVG	none	CRF with AVF	Yes	16 months
100	Chemla et al, 2010-6(ref#85)	60 yrs	M	L	40 mm	upper extremity pain and swelling	Aneurysmectomy + end-to-end anastomosis	none	CRF with AVF	Yes	16 months
101	Chemla et al, 2010-7(ref#85)	42 yrs	M	L	40 mm	none	Aneurysmectomy +end-to-end anastomosis	none	CRF with AVF	No	16 months
102	Chemla et al, 2010-8(ref#85)	41 yrs	M	R	30 mm	upper extremity gradual swelling	Aneurysmectomy + end-to-end anastomosis	none	CRF with AVF	No	16 months
103	Chemla et al, 2010-9(ref#85)	46 yrs	M	L	60 mm	upper extremity tenderness and swelling	Aneurysmectomy + end-to-end anastomosis	none	CRF with AVF	Yes	16 months
104	Chemla et al, 2010-10(ref#85)	73 yrs	M	L	50 mm	upper extremity pain and swelling	Aneurysmectomy + repair with RSVG	none	CRF with AVF	No	16 months
105	Chemla et al, 2010-11(ref#85)	50 yrs	F	L	80 mm	upper extremity pain, swelling and impaired function	Aneurysmectomy +end-to-end anastomosis	none	CRF with AVF	Yes	16 months
106	Chemla et al, 2010-12(ref#85)	47 yrs	M	L	50 mm	None	Aneurysmectomy + repair with RSVG	none	CRF with AVF	Yes	16 months

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107	Chemla et al, 2010-13(ref#85)	60 yrs	M	L	30 mm	none	Aneurysmectomy + end-to-end anastomosis	none	CRF with AVF	Yes	16 months
108	Omer Tetik et al, 2010 (ref#6)	50 yrs	F	R	25 mm	upper extremity pain and pulsatile swelling	Aneurysmectomy +repair with RSVG	none	Idiopathic	No	NA
109	Hudorović et al, 2010 (ref#86)	77 yrs	F	L	40 mm	upper extremity swelling	Aneurysmectomy +repair with RSVG	none	Idiopathic	No	12 months
110	Stephen O Neil et al, 2010 (ref# 87)	55 yrs	M	R	50 mm	Pulsatile swelling in arm	Aneurysmectomy +repair with RSVG	None	Past history of Trauma	No	12 months
111	Makoto Emori et al, 2010 (ref#88)	53 yrs	F	L	NA	Severe pain & Rapidly progressive swelling above elbow due to rupture	Aneurysmectomy +repair with RSVG	none	Neurofibromatosis type 1	No	24 months
112	Murphy et al, 2009 (ref#89)	61 yrs	M	L	47 mm	upper extremity pain and swelling	Aneurysmectomy +repair with cephalic vein graft	none	CRF with AVF	Yes	12 months
113	Simosa H et al, 2009 (ref#90)	68 yrs	M	L	30 mm	Pain within digits, numbness, tingling, cyanosed, cold upon touch	Aneurysmectomy + repair of Brachial artery by end-to-end anastomosis + Catheter directed Thrombolysis	None with reversal of symptoms	CRF with AVF	Yes	12 months
114	Takanori Konishi et al, 2009 (ref# 24)	57 yrs	M	Bilateral	R- 20 mm,	a) Rt forearm Ischaemia b)Left symptomatic Aneurysm	Aneurysmectomy +repair with RSVG +forearm embolectomy	None	Trauma due to prolong Crutches use	No	NA
115	Muzaffer Bahcivan et al, 2009 (ref#91)	9 months	M	L	35 mm	Painless Swelling in arm	Aneurysmectomy + repair of Brachial artery by end-to-end anastomosis	None	Idiopathic	no	NA
116	WK Jeong et al, 2008 (ref#92)	35 yrs	F	R	NA	Acute onset of pain and swelling in right arm due to rupture	Aneurysmectomy and ligation of Artery	Death suspected from bleeding from the site, possibly proximal to brachial artery ligation on 4th day	Neurofibromatosis	No	NA

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117	Sultana et al, 2007 (ref#93)	57 yrs	M	L	37 mm	upper extremity swelling and subjective coldness	Aneurysmectomy +repair with RSVG	None	CRF with AVF	Yes	NA
118	Acikgoz SK. et al, 2007 (ref#94)	35 yrs	M	R	40 mm	Pulsatile swelling within the antecubital fossa	Aneurysmectomy +repair with RSVG	None	Infective endocarditis – Mycotic Aneurysm	No	NA
119	Godwin et al, 2006 (ref#95)	10 months	F	Bilateral, multiple	a)Rt- 30 mm, b)Lt upper 50mm, c) Lt lower 15mm	Pulsatile mass in upper arm bilaterally	a) Right side: observation only b)Left side: Aneurysmectomy and artery ligation	none	Menkes disease (defeciency of Copper metabolisim enzyme)	No	8 months
120	Ghazi et al, 2006 (ref#96)	27 yrs	F	R	20 mm	asymptomatic swelling of upper limb	Aneurysmectomy + end-to-end anastomosis	none	Atherosclerosis	No	2 months
121	Battaglia et al, 2006 (ref#97)	58 yrs	M	L	50 mm	upper extremity pain and swelling with median nerve compression	Aneurysmectomy +PTFE bypass graft	none	CRF with AVF	Yes	3 months
122	Ventura, 2006 (ref # 98)	63 yrs	M	NA	50 mm	upper extremity pain	Aneurysmectomy +PTFE graft	NA	CRF with AVF	Yes	NA
123	English et al, 2004 (ref#99)	14 yrs	M	L	NA	Palpable brachial artery aneurysm	Aneurysmectomy +repair with RSVG	NA	Vascuilitis having Multiple arterial aneurysms involving left vertebral,brachial,radial,renal and iliac arteries	No	60 months
124	Schunn et al, 2002, (ref# 1)	52 yrs	F	L	70 mm	upper extremity pain, swelling and exercise-induced Ischaemia	Aneurysmectomy +repair with interposition graft of reversed median vein of the forearm	none	History of AVF and transient renal failure	No	24 months
125	Janowski et al, 2002 (ref#100)	40 yrs	M	R	40 mm	pulsatile mass in upper arm	Aneurysmectomy +repair with RSVG	none	CRF with AVF	Yes	NA
126	R. Katoch et al, 2001 (ref #101)	29 yrs	M	L	20 mm	pulsatile mass in upper arm	Aneurysmectomy +repair with RSVG	none	Mycotic Aneurysm secondary to fistula in ano	No	36 months

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127	AG Sayin, 2001 (ref#102)	11 yrs	M	R	NA	pulsatile mass in upper arm	Aneurysmectomy + Ligation of Brachial artery	NA	Ehlers Danlos syndrome Type IV	No	NA
128	Nguyen et al, 2001 (ref#103)	51 yrs	M	L	50 MM	Swelling with local dull ache and tingling in all fingers , absent flow in radial artery	Ligation of Aneurysm + bypass between axillary artery and distal arteries by RSVG	None	CRF with AVF	yes	NA
129	Cakalagaoglu et al, 1999 (ref#104)	39 yrs	F	L	NA	Tender and pulsatile mass in upper limb	Aneurysmectomy +repair with RSVG + 12 Months antibiotic course	None, no recurrence of aneurysm	Mycotic secondry to Brucella mediated Prosthetic wall endocarditis	No	48 Months
130	Richard J. Gray et al, 1998-1 (ref#105) (Retrospective study of 12 pts)	NA	NA	NA	53 mm	Thrombosis of Aneurysm and distal ischemia	Aneurysmectomy +repair with RSVG	None	Idiopathic	No	31 months
131	Richard J. Gray et al, 1998-2 (ref#105)	10 yrs	NA	NA	38 mm	Symptomatic mass	Aneurysmectomy +repair with internal iliac artery	None	Repetitive Trauma	no	31 months
132	Bartels et al, 1995 (ref#106)	24 yrs	F	L	25 mm	heaviness and reduced muscular exercise tolerance of left upper limb	Aneurysmectomy +repair with PTFE graft	None	F.P.Weber Syndrome (arteriovenous malformations)	No	NA
133	Fann et al, 1994 (ref#107)	3 yrs	M	left, right	Left = 20 mm, Right= 11 mm	a) pain, discoloration, numbness of left upper limb b) Pulsatile swelling only	Bilateral Aneurysmectomy +repair with interposition grafting	none	Idiopathic	No	36 months
134	Hale et al, 1994 (ref #108)	29 yrs	M	L	70 mm	upper extremity swelling	Aneurysmectomy +repair with RSVG	Minimal parasthesia in fingers	Alport syndrome,CRF with AVF, left axillary aneurysm	Yes	NA
135	Shipolini et al, 1993 (ref#109)	63 yrs	F	R	40 mm	painful upper limb , paraesthesia and weakness in the fingers related to exercise due to median N. compression	Aneurysmectomy +repair with RSVG	Recurrence of aneurysm in native rt brachial artery at 14 months treated with ligation	Fibromuscular Dysplasia	No	14 months

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								and by pass with venous graft			
136	B.Yoffe et al. 1993 (ref# 110)	4.5 yrs	M	R	10 mm	Painful pulsating swelling in Rt. Arm	Aneurysmectomy +repair with interposition Venous graft	None	Myxomatous Degeneration of Brachial artery	No	8 months
137	TR Jones et al, 1988 (ref#111)	29 months	M	L	8 mm	Pulsatile painless mass in upper limb	Aneurysmectomy + end-to-end anastomosis	none	Idiopathic	No	36 months
138	JT Lie et al, 1988 (ref #112)	4 months	M	R	8 mm	nontender swelling in the right antecubital fossa	surgical resection	none	Idiopathic	No	60 months
139	Parvin et al, 1987 (ref#113)	5 yrs	F	R	30 mm	pulsatile mass in upper limb	ligation	none	Idiopathic	No	6 months
140	Holleman et al, 1983 (ref#114)	8 yrs	M	NA	NA	NA	resection	none	Idiopathic	No	1 year
141	Suchenwirth et al, 1976 (ref#115)	14 yrs	M	NA	NA	paresis of ulnar and median nerves	resection	none	Trauma	No	3 years
142	Burnett et al, 1973 (ref# 116)	17 yrs	F	Bilateral	NA	NA	surgical resection	none	Ehlers-Danlos syndrome	No	9 years
143	Collin et al, 1971 (ref#117)	21 months	M	L	2 aneurysms each 25 mm in diameter	pulsatile masses (2) in upper limb	Ligation of brachial artery proximal to aneurysms	none	Idiopathic	No	9 months

disease, vasculitis, atherosclerotic disease, infective/mycotic, myxomatous change, arteriovenous malformations, blood vessel tumour, aortic dissection and metabolic disorder, which are already known causes of aneurysm.[118]

Symptoms observed were mostly upper extremity swelling and pain. These classical findings were usually followed by ischaemic and median nerve compression symptoms. The presence of swelling usually manifested as a palpable mass, but was subjected to the size of aneurysm, as a small-size aneurysm may not present with a palpable mass on examination and could be completely asymptomatic. Similarly, palpable brachial aneurysm was not always pulsatile as generally understood.

Diagnostics and investigations included a physical examination of any palpable swelling, and application of the Allen test to assess arterial blood supply. The results can be confirmed by a Duplex scan. The radiological modalities available for further detailed imaging are computed tomography (CT) scan and magnetic resonance imaging (MRI).[3] However, in regard to imaging, some studies have debated whether or not it is necessary as majority of the aneurysms are easily detectable on physical examination.[15,18] This statement, however, should be subjective to the case of the patient as not all the aneurysms can present with a palpable mass.[25] Management strategies are subject to the severity of the pathological process and morphological change that the aneurysm has caused. Common factors to take into consideration include the severity of symptoms, size of aneurysm, load of thrombus in aneurysmal sac, distal ischaemia of limb and any compression of the nerves of the upper limb.[26]

Treatment options include mainly open surgical intervention due to the superficial location of brachial

artery aneurysm and rarely endovascular aneurysmal repair or embolisation.[6-9] Aneurysmectomy was the primary procedure chosen by most of the vascular surgeons 142(90.4%). After aneurysmal sac resection vascular continuity was maintained by either using grafts or by direct end-to-end anastomosis.

Alternative pathway of endovascular repair, which is gaining popularity very rapidly among vascular surgeons now-a-days, has shown little role in the management of TBAA, as reflected in earlier studies.[7,8]

After successful treatment of TBAA, complications were noted only in 17 (10.82%) patients, among whom the most common was recurrence of aneurysmal degeneration (95.7%). However, 1 patient died due to uncontrolled bleeding.

The good outcome in TBAA patients was due to effective management and timely surgical intervention that helped the patients in recovering from ischaemic and neurological symptoms within a relatively short hospital stay. Due to the same reasons long-term follow-up (>1 year) was not available or mentioned in most cases, which is a limitation of the current systematic review.

Among other limitations is the fact that the review was initially registered with PROSPERO as the initial plan was to compare surgical and endovascular treatments, but later it was found that there were only 8 case reports on endovascular treatment which made comparison impossible. Also, no trial or comparative study was found to conduct meta-analysis. As such, the current study was only a systematic review.

Conclusion

Due to rare presentation of TBAAs, the available literature is limited. Arteriovenous fistula (AVF) in CRF patients and immunosuppression therapy in renal transplant patients were found to be significant risk factors for TBAA development. Patient with above risk factors need long-term follow-up (10-15 years) even after the ligation of fistula and cessation of immunosuppressive therapy. Surgical aneurysmectomy and revascularisation by venous grafting was the major mode of treatment due to relatively superficial location of aneurysm and having good outcome. Further studies are needed to explore the risk factors and generate comparative data for the selection of the best mode of treatment.

Acknowledgement: The research was undertaken in partial fulfilment of the requirements for ChM (Masters) in Vascular and Endovascular Surgery from the University of Edinburgh (UoE). The whole research, including data-gathering, was conducted at the Liaquat National Hospital (LNH), Karachi, under the supervision and online guidance received from Professors Kamal Muhammad Yousuf and Anwar-ul-Huda of the UoE. The valuable guidance and facilitation provided by the individuals and the institutions are gratefully acknowledged.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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Author's Contributions
SMHA, SM, RG and NJ: Study conception.
SMHA, SM, KA and AE: Data collection.
SMHA, SM, RG and NJ: Writing.
All authors are involved in critical review, revision, final approval and accountability for all aspects of the work.