

## FUNCTIONAL OUTCOME ASSESSMENT OF EDEN HYBINETTE PROCEDURE FOR RECURRENT SHOULDER DISLOCATION: A PROSPECTIVE STUDY EVALUATING MODIFIED ROWE AND WOSI SCORES AT 37 MONTHS

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### Abstract

**Background:** Eden Hybinette procedure is used to surgically treat recurrent shoulder dislocation with glenoid bone deficits especially in failed previous bankart repair or Latarjet. The purpose of this study is to establish the functional outcome through objective modified ROWE score and WOSI score at a mean of 37 months. **Materials and Methods:** Twelve patients with mean age of 39.92 years  $\pm$  2.97 years, in a prospective cohort study from R.G. Kar Medical College and Hospital was subjected to an open procedure through deltopectoral approach after quantification of bone defect by En face 3D CT scan. The mean age of patients undergoing revision surgery was 40.5 years with three patients having a failed Latarjet procedure and seven patients having a failed arthroscopic Bankart repair. **Result:** The mean post operative ROWE score improved to 81.25 $\pm$ 15.54 (P-value<0.001) with stability (r=0.80) and mobility (r=0.83) having strong positive correlation. The mean post operative WOSI score was 21.67 $\pm$ 3.031 with lifestyle (r=0.82) and sports activities (r=0.85) having positive correlation with achievement of a better score. One patient developed glenohumeral arthritis at 4.5 years and two patients had a redislocation as complication. **Conclusion:** Eden Hybinette procedure has the merits of incorporating a large size bone graft to match the contour of the glenoid defect ensuring rigid fixation and conversion of an Off track Hill Sach's lesion into an On-track lesion, with active and active assisted rehabilitation being pivotal in heralding good to excellent outcomes. Glenohumeral arthritis should be ruled out and intra-operative precautions to be taken to prevent overstuffing the glenohumeral joint with overhanging graft.

## INTRODUCTION

For centuries, various bone augmentation methods have been utilized to address recurrent anterior shoulder instability. Several crucial factors contribute to the ultimate success of these procedures, including age, athletic activity levels, predisposition to contact sports pre and post-surgery, joint hyperlaxity, and the extent of bony defects in the glenoid and humeral head. These factors significantly impact outcomes following a soft tissue arthroscopic Bankart repair.<sup>[1,2]</sup> Recurrent shoulder dislocations can result in varying consequences, from a soft tissue Bankart lesion affecting the anterior glenoid labrum to glenoid bone defects, sometimes accompanied by a

Hill-Sachs lesion. Identifying risk factors through En-face 3D CT scans and MRI scans is crucial for assessing glenoid bone loss, Hill-Sachs lesion depth, and whether the lesion is "off-track" or not, essential for treatment planning.

Procedures aimed at restoring glenoid deficiency include the Eden-Hybinette procedure, Latarjet procedure, J-bone graft procedure, and distal tibial allograft reconstruction. The Latarjet procedure is commonly used as a salvage option after failed Bankart repair and may even be considered as a primary intervention for patients with a high instability severity index score. Significant bone loss is typically defined as exceeding 25% of the inferior glenoid,<sup>[3]</sup> or having a supero-inferior length greater

than half of the maximal anteroposterior diameter of the glenoid. Specific radiographic features, such as the loss of the sclerotic glenoid line on AP radiographs, highlighted by Burkhart SS, DeBeer JF, Jankauskas et al., can signal anterior glenoid rim defects.<sup>[4]</sup> These features can prompt essential cross-sectional imaging to determine critical glenoid bone loss extent.

The long-term follow-up of the Latarjet procedure indicates a recurrent instability rate of 5-6%, necessitating a shift towards more consolidated procedures to minimize failure rates.<sup>[5]</sup>

The Eden-Hybinette procedure, originating over a century ago, demonstrates notably positive outcomes, particularly in cases where Latarjet surgery has failed or when the glenoid bone defect exceeds the capacity of a coracoid graft. Additionally, it proves beneficial in situations where abnormal coracoid morphology or an irreparable glenoid fracture prohibits the use of the Latarjet procedure. Its effectiveness lies in its ability to flawlessly restore bone defects by precisely matching the inner table of the iliac crest bone block with that of the glenoid defect.

Initially focused on bone augmentation with capsulorrhaphy, the procedure has evolved significantly since its inception in 1917, transitioning into an all-arthroscopic technique. This evolution presents distinct advantages over alternative bone block procedures, preserving the coracoid process and minimizing damage to the subscapularis muscle. The procedure's development has revolved around various surgical approaches, graft selection, positioning, and fixation techniques.

Studies have highlighted the benefits of employing suture button fixation in revision surgeries following a failed Bristow-Latarjet procedure. An arthroscopic "double-inlay" Eden-Hybinette procedure with modified suture button fixation has demonstrated a "quadruple" reinforcement effect, boasting excellent biomechanical strength.<sup>[6]</sup>

In cases where a deltopectoral approach is necessary, excessive scarring from a previous unsuccessful Latarjet procedure might hinder the identification of the deltopectoral interval. This scarring could obscure the coracoid and conjoined tendon, typically reliable landmarks for dissection. To overcome this challenge, the subscapularis muscle is either split in line with its fibers at its superoinferior midpoint or a tenotomy is performed to improve exposure.

## MATERIALS AND METHODS

Twelve patients were operated for recurrent shoulder dislocation in our institute and mid-term results were prospectively followed up as per guided protocol and functional assessment done using the ROWE and Western Ontario Shoulder Instability(WOSI) scoring systems respectively at 6-, 12- and 24-months post operatively. CT scans were done at 3 months to assess the incorporation of the graft. No patients were

lost to follow up. The minimum and maximum duration of follow up period to assess the clinical and functional outcome is 12 months and 54 months respectively with a mean follow up period of 37 months. All patients underwent En face 3D CT reconstruction of the shoulder to determine the amount of glenoid bone loss and Hill Sach's interval to evaluate whether the lesion is engaging or not. Patients with a previous failed arthroscopic Bankart repair surgery and/or failed Latarjet procedure were chosen for glenoid bone augmentation technique. [Table 1]

Three patients (25%) presented with a failed Latarjet procedure. Seven patients(58.3%) presented with failed Arthroscopic Bankart repair for recurrent shoulder dislocation. 10 patients were males(83.33%). [Table 2] In seven patients(58.3%), the dominant side was affected. There was a mean number of 6 dislocations before the initial surgical procedure among patients who had not undergone any index procedure. In 7 patients(66.67%), the initial dislocation was caused by a traumatic event, while in 4 patients, it was a unidirectional recurrent anterior stability. Two patients(16.67%) had not undergone any index stabilization procedures out of which one female patient was suffering from Grand mal Seizures. In her case, the initial dislocation was precipitated by a seizure attack. Patients having multidirectional instability and rotator cuff tear were excluded from the study.[Table 1] Follow-up protocol involved clinical assessment by means of the apprehension, Jobe's relocation tests and Load-and-shift tests to exclude any laxity. Passive and active Range-of-motion was assessed based on flexion, abduction, internal and external rotation at both 0° and 90° of abduction.

The mean age of patients undergoing revision surgery is 40.5 years. Out of three patients with failed Latarjet procedure, the mean age at revision surgery is 41.67 years. The mean time period between the index procedure and the revision surgery was 6.4 years. In 7 cases, redislocation after initial surgery was caused by a traumatic event. Intraoperatively, during revision surgery, the bony fragments were graded on the basis of thickness while the glenoid rim was considered eroded or non-eroded. In cases of bankart lesion, distinction was made between fraying of labrum, absence of labrum or scapular detachment of the capsule from scapular neck.

Open procedure using autogenous structural tricortical iliac crest bone graft was employed for incorporation in the defect in supine position under General Anaesthesia combined with interscalene block. After surgical preparation and draping, deltopectoral approach was used to expose the affected shoulder. The skin incision was taken from the tip of the coracoid surface landmark towards the anterior axillary fold. Instead of using the coracoid and conjoined tendons as reliable landmarks, the axillary nerve is used as a trail to identify the deltopectoral interval. The cephalic vein was identified, dissected out from the surrounding tissue

bed and retracted laterally along with the deltoid. Next important part of the surgical step was the way to deal with the subscapularis. In majority of patients who had not undergone a previous Latarjet procedure, the subscapularis muscle was split along the length of its fibres at its superoinferior midpoint to expose the capsule and the glenohumeral joint. In the other three patients who had undergone a previous Latarjet procedure, the subscapularis was elevated subperiosteally with a small margin of tendon close to the bicipital groove for it to be repaired at closure, in anticipation of the conjoint tendon being scarred into Subscapularis. Anterior Capsulotomy was then done with the longitudinal arm till the glenoid neck and the margins tagged with Polyglamide sutures to repair at the end. Fukuda retractor [Image2] placed to displace humeral head posteriorly whereas a Cobra retractor placed over the anterior glenoid to yield an adequate amount of exposure to scrutinize the glenoid surface and/or osteotomise any prominent bony chunk [Image3]. Herein, all suture anchors and the remnants of coracoid graft respectively for a failed arthroscopic Bankart and Latarjet procedure were removed and glenoid surface is prepared by abrading to produce a bleeding bony surface. A 25mm long and 15mm deep graft [Image4] was harvested using osteotomes off the iliac crest, ensuring concavity of the inner table to align with the glenoid articular surface and thereafter graft contoured appropriately to reciprocate the bony defect in the glenoid.

A 2.5mm drill bit was employed to drill two holes [Image5] in the harvested graft to make home for the recipient screw. Ensuring the drill holes being centered on the graft and collinear with the anticipated position of screw fixation over the glenoid, the latter was placed provisionally on the glenoid articular surface, congruent with or slightly medial to the articular surface along with a drill guide and transfixed with two 1.5-mm Kirschner wires. The drill guide was then removed, leaving both wires in place. A 2.5- mm cannulated drill bit was used to penetrate the near cortex of the native glenoid through the predrilled holes in the graft. Two 3.5mm cortical screws were inserted after removal of the Kirschner wires [Image6].

The post operative protocol was directed on the method of management of Subscapularis. Since in majority of patients, it was split, the patient was kept in a sling for 4 weeks. Pendulum exercises were begun at 1 week along with active shoulder shrugging exercises. From 2 weeks onwards, formal physical therapy was commenced with passive range of motion exercises followed by graduated active assisted exercises under supervision of trained personnel. Active range of motion exercises with assisted stretching was executed at 1 month when patient was able to do active forward flexion of the shoulder above 90-100 degrees. Strengthening exercises were begun after 2 months. For the patients in whom Subscapularis was raised subperiosteally, the rehabilitation protocol was a little modest and

although pendulum exercises were begun from 1<sup>st</sup> week onwards, the formal supervised physical therapy was commenced from the 4th week onwards. For one of our patients who was suffering from epilepsy, she was counseled and encouraged to bear strict adherence to the management of epilepsy in accordance with the treatment protocol of respective Neurologist.

#### Statistical Analysis

Statistical analysis was done using the Prism software (GraphPad, San Diego, CA) and SPSS software. Data tools used were the Mann-Whitney test for nonparametric data, unpaired t tests for parametric data, and Pearson correlation coefficient as and wherever was found relevant. The level of significance was set at  $P < .05$ .



**Image 1: Surface landmarks for the Deltopectoral approach**



**Image2: The Fukuda retractor and cobra retractors**



**Image 3: The strategic placement of Fukuda retractor and the adequate exposure**



**Image 4: a through c: Illustrating the dimensions of the autologous tricortical iliac crest graft harvest**



**Image 5: Predrilled holes in the graft harvest to mate with the drill holes on the glenoid**

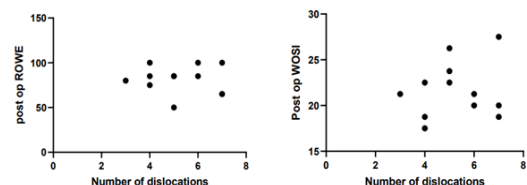


**Image6: a through c: Depicting the fixation of the autograft with 3.5mm cortical screws and the final position of the graft**

## RESULTS

All patients were subjected to an En-face 3D CT analysis of the affected shoulder to evaluate the Hill Sach's interval and categorise the Hill Sach's lesion

into On-Track and/or Off-Track lesion. Seven patients were registered to have a failed arthroscopic Bankart repair while three patients were catered a previous Latarjet procedure for the recurrent shoulder dislocation. Four patients (33.33%) were found to have a unidirectional recurrent instability. One female patient was a known epileptic who, however did not have any episode of Grand mal seizure in her respective postoperative follow up period. The mean duration of surgery was 90 minutes with an average length of hospital stay being 4 days with no immediate post-operative complications. The results were compartmentalized into clinical outcome vis-à-vis stability, functional objectification by the ROWE and WOSI scores respectively and radiological outcome assessment. Analysis of atraumatic failures of index procedures were also executed based on intraoperative evaluation. The mean length of time elapsed between the index surgery and the revision surgery in failed arthroscopic bankart repairs and Latarjet procedure was 6.4 years. The mean length of follow up has been 37 months for this study, with minimum and maximum being 12 and 54 months respectively. Ten men (83.33%) and two women (16.67%) were included in the study and the mean age of patients is 39.92 years  $\pm$  2.97 years. The dominant side was affected in nine (75%) of patients. Ten patients(83.33%) met with failure of the index procedure, out of which, three patients were having unidirectional instability and the rest were victims of a traumatic event. Seven patients had undergone arthroscopic bankart repair while three of them underwent Latarjet procedure as an index surgery, respectively. None of the patients had a capsular shift and/or bony procedure such as Eden Hybinette performed earlier. The mean number of dislocations in patients presenting with failed previous index surgeries is 5.6, while the mean number of dislocations in patients without any index surgery is 3.5. There was no significant relationship between the age of patients and the number of dislocations( $r=-0.11$ ;P-value=0.74). There is neither any statistical significance between the number of dislocations and the post operative total ROWE score( $r=-0.08$ ; Pvalue=0.80), nor between the former and the total mean post operative WOSI scores( $r=0.16$ ; P-value=0.6) [Figure 1].

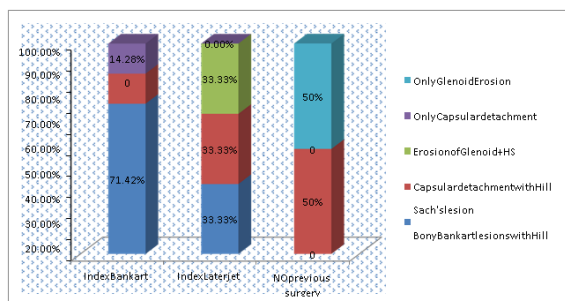


**Figure 1: Scatter plots depicting the relationship between the number of dislocations and the Post operative scores**

In five(71.42%) and one(33.33%) of patients who had undergone an index arthroscopicbankart repair and open Latarjet procedure respectively, were found

to have a Bony Bankart lesion more than 2mm thick, whereas the anterior glenoid rim was found to be eroded without a discernible fragment in two of the patients, one of whom had a previous open Latarjet procedure and the other who had not been subjected to any previous surgery. In ten(83.33%) of our patients, an Engaging Hill Sach's lesion was evident. ANALYSIS OF REVISION CASES:

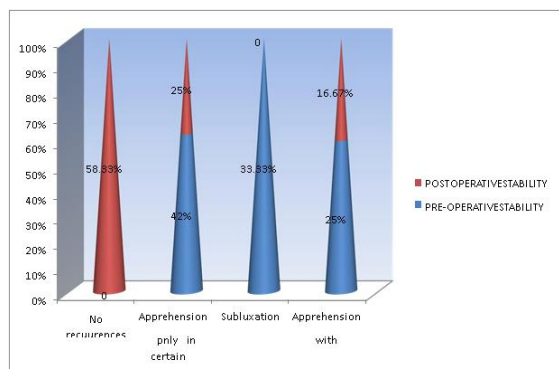
During analysis of atraumatic failures intra-operatively, out of the twelve patients with recurrent shoulder dislocations, ten of them were found to have an off track Hill Sach's lesion(83.33%). Six patients(50%) were found to have a bony bankart lesion with reduced convexity at the anteroinferior margin and significant diminution of transverse diameter, along with an off-track Hill Sach's lesion. One of the patients was having an eroded glenoid rim more than 2mm thick. Four patients were having typical Bankart lesion with an extensive capsular detachment [Figure 2].



**Figure 2: Correlation of Pathological aspect with previous surgeries**

### Stability Assessment

Stability was ensured by a negative apprehension sign and good functional range of motion. Four patients were having unidirectional ligamentous instability and presented with a subluxed joint pre-operatively. Three of these patients improved significantly following the surgery rendering a normal mobility in the affected shoulder. Two patients, both being candidates of failed arthroscopic bankart repair and a positive apprehension sign met with redislocation following the Eden Hybinette procedure. Nevertheless, our patient with an epileptic disorder improved in terms of the stability score to having apprehension only in certain positions of the affected shoulder. 58.33 % of patients were found to have highest grade of stability following surgery, whereas, 16.67% of patients succumbed to instability resulting in redislocation following surgery, as opposed to a larger percentage (25%) having the worst stability score prior to surgery. 25% of patients were having apprehension only in certain positions following the surgery as opposed to 42% of the subject group having the same before surgery. None of the patients were having subluxation following the Eden Hybinette procedure. Moreover, there was a strong positive correlation between the post operative stability score and the total ROWE scores( $r=0.83$ ).



**Figure 3: Depicting the percentage of patients with their respective stability grades prior to and after conducting surgery**

### FUNCTIONAL OUTCOME:

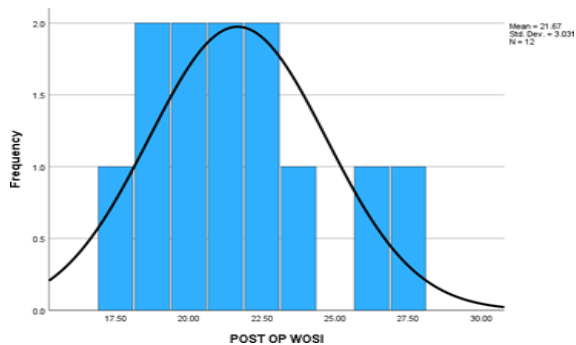
According to the Rowe scoring method, the mean pre-operative Functional, pain, stability mobility scores are 11.25, 5.83, 7.92 and 2.5 respectively. The mean total pre-operative ROWE SCORE stands at  $29.2 \pm 15.1$ . The Post operative mean ROWE SCORE is  $81.25 \pm 15.54$ , ranging from 50 to 100. The mean pain score improved from 5.83 pre-operatively to 9.16 (by 57.1%). Two of our patients were having a mild degree of pain especially with overhead activities and retrospectively, both patients were found to have an eroded glenoid rim at surgery. There was no statistical significance between the age and Postoperative ROWE Score ( $r=-0.48$ ; P-value=0.11). Eight patients (66.67%) were having a normal range of motion while four patients showed diminution of forward elevation, external and internal rotation respectively by less than  $25^\circ$ .

Results as per the modified ROWE score are depicted herein in the form of Mean  $\pm$  Standard deviation and the data statistically compared by paired t-test between the pre-operative and postoperative groups [Table 1]. It was seen that Functional status of patients improved by an intimidating 277% (P-value < 0.001) while the total ROWE score soared by a staggering 195.4% (P value < 0.001). The mobility scores were found to have a positive correlation with the stability justifying the observation of a better range of motion of shoulder with delivering of a more stable joint ( $r=0.62$ ). Moreover, when assessed by the total ROWE indexing score, stability ( $r=0.80$ ) and mobility ( $r=0.83$ ) were the parameters found to have a positive influence on achievement of a better score. [Table 2]

The mean pre-operative total WOSI score was found to be 75.52 ranging from 71.25 to 78.75 which ameliorated to a mean of  $21.67 \pm 3.031$  in the post operative period ranging from 17.5 to 27.5. [Figure 4]

Results of individual parameters of the WOSI score are depicted herein in the form of Mean  $\pm$  Standard deviation and the data was found to be statistically significant when compared between the preoperative and post-operative measures by means of paired ttest [Table 3]. The physical activities improved by a

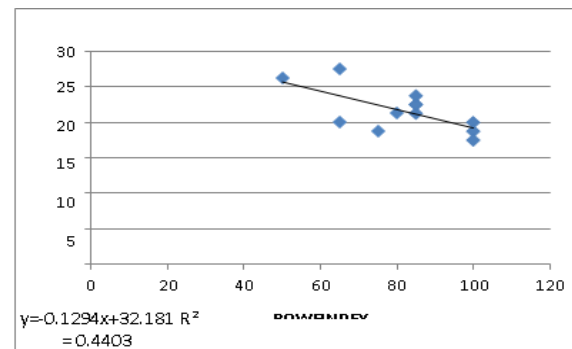
handsome 240.4%. Sports activities and Lifestyle were found to be positively correlated( $r=0.68$ ) following the procedure depicting the influence of the former on the latter [Table 4].Both lifestyle( $r=0.82$ ) and sports activities( $r=0.85$ ) individually played a pivotal role in augmenting the eventual post operative outcome. [Table 4] Meanwhile, the total ROWE score post operatively was found to be inversely correlated to the Mean post operative WOSI scores( $r=-0.66$ ) [Figure 5].



**Figure 5: Representing the Gaussian distribution curve of the Post-operative WOSI scores in twelve patients**

**Radiological outcome assessment:**Autogenous graft incorporation was confirmed radiologically in the subsequent follow up periodic evaluation and

elucidated acceptable bone uptake in 3 months time. There were no patients with pre-existing arthritis. One of our patients aged 42 years at presentation with a failed Latarjet procedure developed glenohumeral arthritis at 4.5 years with mild degree of pain post the Eden Hybinette procedure. He was categorized into Samilson mild grade of glenohumeral arthritis. There is no significance between the number of dislocations and the development of arthritis. The mean age of patients with arthritis is 42 years while the patients without arthritis were having a mean age of 39.72 years. There is no statistical significance between the two age groups (P-Value=0.87)



**Figure 6: Correlation between the types of indexes in the Eden-Hybinette procedure ( $r^2 = 0.44$ )**

**Table 1: Signifying the Inclusion and Exclusion Criteria**

Inclusioncriteria	Exclusioncriteria
All patients with a failed Arthroscopic Bankart repair Patients with previous failed Latarjet procedure Patients having Off-track(engaging)Hill Sach's lesion Patients with epileptic seizures	Patients with Rotator Cuff Tear Patients with Multidirectional Instability and/or Beighton's Score >5/9

**Table 2: Depicting the correlation of demographic distribution according to Etiology**

Category	NUMBER and GENDER OFPATIENTS with Percentage		INCITINGFACTORFORRE-DISLOCATION	
	Failed Arthroscopic Bankart Repair	Seven(58.3%)-All Males		Traumatic
Failed Latarjet procedure	Three(25%)	Female-1	Unidirectional Recurrent Instability	3
		Male-2	Traumatic	2
No prior Index procedure	Two(16.67%)	Female-1	Unidirectional Recurrent Instability	1
		Male-1	NA	

**Table 3: Depicting significant improvement in pain, function, stability and mobility after EDEN HYBINETTE procedure**

	Roweindex		%changeimprovement/	95%ConfidenceIntervalofthe Difference	P-value
	Pre-Operative	Post-Operative			
Function	11.25±12.45	42.50±7.83	277.7%	-37.17-(-)25.32	<0.001
Pain	5.83±3.58	9.16±1.94	57.1%	-5.40-(-)1.26	<0.01
Stability	9.58±6.20	21.25±11.89	168.6%	18.21-(-)5.12	<0.01
Mobility	2.50±3.37	8.33±2.46	233.2%	8.11-(-)3.55	<0.001
Total Score	27.50±17.12	81.25±15.53	195.4%	60.26-(-)47.23	<0.001

**Table 4: Significant correlation of stability and mobility scores when compared to total ROWE score**

	Pearson's correlations				
	Function	Pain	Stability	Mobility	Total
Function	1	.000	-.110	.354	.476
Pain		1	-.049	.158	.113
Stability			1	.621*	.802**
Mobility				1	.832**
Total					1

**Table 5: Amelioration in physical activities, sports, lifestyle and emotional component following EDEN HYBINETTE procedure**

		Wosiindex		%changeimprovement	95%ConfidenceIntervaloftheDifference	P-value
		Pre-Operative	PostOperative			
Physical		77.99±5.41	22.91±4.50	240.4%	51.16– 58.83	<0.001
Sports		77.90±4.52	26.25±5.69	66.3%	47.10– 56.22	<0.001
LifeStyle		72.50±3.37	21.25±11.89	70.6%	49.88– 57.61	<0.001
Emotion		73.75±3.76	18.75±4.82	74.5%	51.97– 58.02	<0.001
TotalScore	Mean	75.52±1.95	21.66±3.03	71.3%	52.24– 55.45	<0.001

**Table 6: Depicting how sports and lifestyle were significantly correlated in the post operative patients**

	Pearson'sCorrelations				
	Physical	Sports	Lifestyle	Emotion	Meanwosi
PHYSICAL	1	.200	-.111	-.445	.236
SPORTS		1	.684**	-.021	.856**
LIFESTYLE			1	.186	.824**
EMOTION				1	.311
MEANWOSI					1

	Pearson'sCorrelations				
	Age	No. of dislocations	PostOperativeStabilityScore (ROWE)	PostoperativeTotal score (ROWE)	Postoperative Totalscore (WOSI)
Age	1	-.107	-.332	-.480	.358
No.ofdislocations		1	-.272	-.081	.166
Postoperative stabilityscore(ROWE)			1	.832**	-.355
Postoperative Totalscore(ROWE)				1	-.664*
Postoperative Totalscore(WOSI)					1

\*. Correlation is significant at the 0.05 level (1-tailed). \*\*. Correlation is significant at the 0.01 level (1-tailed).

## DISCUSSION

Patients incurring high energy traumatic shoulder joint dislocation followed by multiple low energy or spontaneous events represent a harbinger of a classical glenohumeral bone deficiency<sup>7</sup>. On the corollary, recurrent shoulder instability may lead to erosion or impaction to result in bone loss. Stephen S. Burkhart et al,<sup>[7]</sup> in his case series on 194 consecutive arthroscopic Bankart repairs performed by suture anchor technique found that significant bone deficiencies were evident in 66.67% of patients with recurrent shoulder instability, either in the form of inverted pear glenoid or Engaging Hill Sach's lesion and It was concluded that arthroscopic Bankart repairs sufficed best in cases presenting without significant bone deficiencies. According to literature review, bony bankart lesions were found in 20% of first time dislocations and in 90% of recurrent dislocations,<sup>[8]</sup> whereas, Hill Sach's lesions were found in upto 100% of patients with recurrent dislocations in contrary to 67% of the first time dislocations.<sup>[9-11]</sup> In our study comprising of twelve recurrent dislocations, 83.33% of patients were having an Hill Sach's lesion in contrast to bony bankart lesion being evident in 50% of the patients.

All of the patients having a bony bankart lesion were also having an engaging Hill Sach's lesion.

An intact capsule is paramount for rendering stability of the shoulder joint. Rowe et al,<sup>[12]</sup> and Bigliani et al,<sup>[13]</sup> illustrated that the capsule is invariably overstretched in shoulder instability, thereby addressing of capsular redundancy is an inevitable way to obtain good functional outcome. In cases of capsular laxity Neer and Foster,<sup>[14]</sup> and other authors have recommended a capsular shift combined with closure of the rotator interval to reduce capsular volume. Eugene M. Wolf et al,<sup>[15]</sup> emphasised the importance of a modestly overlooked HAGL lesion in patients with recurrent instability, whereby capsular laxity also plays a pivotal role in its manifestation. In evaluation of 64 patients, 9.3% were found to have HAGL lesions against generalised capsular laxity in 17.2% of patients. Latarjet procedure in itself bears the predicament of failure of graft union with jeopardy of the availability of a source of autologous graft such as the coracoid. The triple blocking benefits of Latarjet procedure was elucidated by Patte and Debeyre,<sup>[16]</sup> emphasising on the sling effect of the conjoint tendon on the inferior subscapularis and the inferior capsule, rendering increment of the anteroposterior glenoid diameter and the effect of repairing the capsule to the stump of

the conjoint tendon. The Eden Hybinette procedure was originally described in 1932 using a L-shaped iliac crest bone block placed between the anterior glenoid and its overlying periosteum, leaving a short segment of the graft overhanging the anterior part of glenoid, without screw fixation. Later it was modified by De Palma who emphasised the use of screw to consolidate the fixation.<sup>[17]</sup>

Rouxel et al,<sup>[18]</sup> in a multicenter study on 76 shoulders with recurrent instability demonstrated that, 17 patients underwent revision surgery in the form of Eden Hybinette following failed Latarjet procedure with no recurrences thereafter, however with a 46% rate of apprehension on clinical testing. The incidence of arthritis was 50% in the total study population, out of which 14% were moderate to severe. The percentage of patients developing arthritis in the failed Latarjet group was not given separately though. In our study, there were no recurrences in patients who had undergone a Eden Hybinette procedure following a failed Latarjet procedure and the overall incidence of apprehension on clinical examination was found to be 16.67% patients, who had previously undergone an arthroscopic Bankart repair. One patient (8.33%) developed mild glenohumeral arthritis, who had previously undergone a Latarjet procedure. Walch et al,<sup>[19]</sup> in his review of 23 cases, which were predominantly Trillat procedures apart from Latarjet, Oudart, and Bankart procedures. Principally the Trillat procedure as done, but modified Eden-Hybinette and Latarjet procedures were also done in respectively five and two patients. Excellent to good results were observed in 57% patients with a 26% recurrence rate, all of whom had undergone the Trillat procedure. In our study, excellent to good outcomes following the Eden Hybinette procedure were found in 75% of patients. In the article by Tauber et al,<sup>[20]</sup> 41 patients of recurrent anterior instability of the shoulder comprised failed arthroscopic Bankart repair in 25 cases (60.97%), open Bankart repair in 14.63% of patients, Eden-Hybinette procedure in 9.75% of patients, rotational osteotomy in 2 cases, capsular T-shift operation in 1 case, Bristow-Latarjet in 2.44% of patients, and a J-bone graft procedure in one case. 56% of patients were found to have a defect in the anterior glenoid bony rim while 17% were found to have a typical Bankart lesion. 51.22% of patients were subjected to a revision surgery using a bone graft augmentation technique. None of the patients had a redislocation and the post operative Rowe scores were excellent and good in respectively in 81% and 19% cases. In our study, the post operative Rowe scores are found to be excellent in 25% of patients and good in 50% of patients.

Recurrent anterior shoulder instability is closely associated with generalised tonic clonic seizures with resultant bipolar lesions owing to the violent muscle contractions of the conjoint tendon muscle unit. Arcerio et al,<sup>[21]</sup> reflected how bipolar lesions had a deplorable effect on the shoulder stability. In our

study, six patients (50%) were having bipolar lesions due to recurrent shoulder dislocation, among which two patients were having unidirectional instability pre-operatively. One patient with Grand mal seizures was having an erosion of glenoid rim along with a Hill-Sachs lesion. Buhler and Gerber,<sup>[22]</sup> in an assessment of outcome of 34 unstable shoulders in 26 epileptic patients established the imperative of a skeletal reconstruction to obtain skeletal stability. Thangarajah and Lambert,<sup>[23]</sup> evaluated shoulder instabilities in epileptics and reported a recurrence rate of 71% after soft tissue repair alone and 28% after bone augmentation. In our study, we had one patient with epilepsy who underwent Eden Hybinette procedure who had a good outcome post-operatively and did not succumb to a redislocation in the 36 months of her follow-up. Latarjet procedure has a high recurrence rate when performed in epileptics, one of the main reasons being the small size of the coracoid bone graft,<sup>[24]</sup> hence the most rational treatment in epileptics is adequate control of epilepsy and Eden Hybinette procedure. Literature reviews have also demonstrated that Eden Hybinette yields good outcome when addressed for a failed Latarjet surgery in non-epileptic patients.<sup>[25-27]</sup>

In the article by Tauber et al,<sup>[20]</sup> 78% were males and the dominant shoulder was affected in 59% of cases. 85% patients were found to have an inciting traumatic event to precipitate the first dislocation with some form of sport activities being the culprit in 65.7% of those patients. 15% patients had unidirectional instability and specific trauma was not accounted for it. In one patient in the series, the initial dislocation was due to a Grand mal seizure. In our study, 50% of patients were having an initial traumatic episode to incur a dislocation, while 33.33% of patients were having unidirectional instability and one patient had an epileptic attack to precipitate the first dislocation. 83.33% of subjects were males and the dominant shoulder was affected in 75% of patients. The mean age of patients in the study group was 39.92 years. In four of our patients (33.33%), there was a loss of internal rotation and forward elevation by less than 25°, signifying the resemblance to established literature whereby, 45% patients could reach the thoracic spine and 8% could reach the lumbar spine by internal rotation, respectively<sup>[20]</sup>. In the article by Lunn et al,<sup>[27]</sup> the mean age at index Latarjet surgery was 24.6 years and 30 years at the time of Eden Hybinette procedure. The dominant side was affected in 77% of patients which closely resembles our observation. The mean time to redislocation was 26.5 months overall with the atraumatic group having a shorter duration of 15.8 months to redislocation as opposed to 36 months for the traumatic group. In our study the average duration till redislocation in the traumatic group was 29.71 months whereas, in the atraumatic group it was 13.75 months excluding the patient with Grand mal seizures.

On analysis of the causes of failure in previous Latarjet procedure, graft malposition was found in



one patient, one patient had graft lysis while there was ligamentous laxity in one patient. These risk factors corroborate with the ones shown by Lunn et al.<sup>[27]</sup> The mean number of dislocations in our study was 5.25 overall, with 5.6 being in the patients who had undergone a previous surgery and 3.5 in the group devoid of any primary surgery. This was comparable to the values depicted in the study by Tauber et al,<sup>[20]</sup> with an average number of 12 dislocations prior to the initial surgery. The lower mean age in our study to undergo an Eden Hybinette procedure was justified owing to the presence of a bipolar lesions comprising bony bankart lesions in 50% of patients and erosion of glenoid rim in 16.67% of patients with engaging Hill Sach's lesion in 83.33% of patients.

The modified ROWE score and WOSI scores were obtained for all patients and excellent to good functional outcome was evident according to the former in 75% of cases. As per the WOSI scores, there was 71.3% overall improvement in the mean WOSI scores following the Eden Hybinette procedure. Both the objective scoring criteria were inversely correlated and the total modified ROWE scores were influenced a great deal by the total stability scores post surgery. Lunn et al,<sup>[27]</sup> demonstrated objective good to excellent outcomes as per the modified ROWE scoring in 82% of patients with 12% rate of redislocation and 6% rate of recurrent dislocation. Tauber et al<sup>[20]</sup> established a mean score of 95.5 points with 81% excellent results and 19% good results bearing resemblance to the mean score of 81.<sup>[25]</sup> in our study. The rate of apprehension on clinical examination in the series of Lunn et al,<sup>[27]</sup> was 41%, whereas, in our study 16.67% patients were having positive apprehension with instability as opposed to 25% experiencing subjective apprehension only on putting the arm in certain vulnerable positions.

According to some literature reviews, hyperlaxity rates vary from 46% to 59%,<sup>[28,29]</sup> in patients presenting after failure of primary surgery and Boileau et al,<sup>[30]</sup> noted 9% incidence of ligamentous laxity in patients undergoing primary stabilisation. In our series, overall 33.33% patients were having ligamentous laxity, however with Beighton's core < 5/9. Out of these, one of the patients had a previous Latarjet procedure and two patients had a previous arthroscopic Bankart repair. Only one of the patients (8.33%) who was undergoing a primary Eden Hybinette procedure was found to have ligamentous laxity apart from the revision scenario.

Buscayret et al,<sup>[31]</sup> established that the rate of arthritis prior to surgery was 9.2% and 19.7% after a mean of 6.5 years with a longer duration of follow up, intra-articular hardware placement or overhanging bone block and older age at initial dislocation being significant risk factors. Latarjet procedure is cursed with high incidences of post operative arthritis at long term follow up varying from 49% in one study<sup>[32]</sup> to even 62% in another study.<sup>[33]</sup> Hindmarsh et al,<sup>[34]</sup> documented an incidence of moderate or severe

arthritis at 8 years follow-up in 58% patients for the original EdenHybinette technique, which compelled for a modification by Rahme et al,<sup>[35]</sup> with placement of the graft flush with the glenoid, alleviating the incidence of arthritis to 30% in 29 year follow up. In our study, after employing the modified Eden Hybinette technique immaculately, there was only 8.33% of arthritis at a mean of 54 months. For the patients who had a redislocation, a revision surgery was contemplated and capsular plication with closure of rotator interval was planned in addition to a bony augmentation with rigid fixation. For the patient with glenohumeral arthritis, the onset could not be reversed neither could the progression be halted, nevertheless its course could be made slower by encouraging good functional range of motion rehabilitation programme as restricted range of motion was not held responsible for the progression of severity of the same.<sup>[20]</sup>

## CONCLUSION

Eden Hybinette procedure manifests a manifold advantage over any other bony augmentation technique to surpass the fear of failure owing to the usage of a large sized graft devoid of muscle attachments, which precludes its vulnerability to redislocation in epileptic patients moreover. Eden Hybinette is of paramount importance in conversion of an Off-track Hill Sach's lesion to an On-track lesion. The merits of using a larger size graft cannot be overemphasised considering the room for placement of larger screws for rigid fixation and better contouring to fill the void with less apprehension of breakage and/or lysis. However it does not restore congruity of the joint and care should be taken to not place the graft overhanging the edge of the glenoid. Active and active assisted formal physical rehabilitation is crucial to facilitate return to pre-injury level sports and lifestyle and the presence of pre-operative subtle glenohumeral arthritis should be ruled out by clinical examination and necessary investigations.

### Limitation:

The limitations of this study are that, it reflects mid term results of a bony augmentation technique in prospective analysis and the sample size is small considering the duration of study, since it is hardly employed as a primary surgical intervention for recurrent shoulder dislocations. Larger sample sizes and greater duration of follow up is warranted to manifest any complications and its clinical relevance with respect to quality of life and activities. Also, comparison to soft tissue Bankart repair in tandem with other procedures such as remplissage is incomplete in patients with larger bone defects without a large population cohort.

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