

**SPINAL ACCESSORY DYSFUNCTION FOLLOWING NECK
DISSECTION
WITH HARMONIC SCALPEL V/S ELECTROCAUTERY – A SINGLE
CENTRE EXPERIENCE.**

Abstract:

Aims: This study is an effort towards comparing the efficacy of the Harmonic Scalpel and Electrosurgical technique with regard to nerve injury especially spinal accessory nerve and its morbidity postoperatively after neck dissection.

Sample: Ninety patients of oral carcinoma who required neck dissection were included in the study.

Study design: This is a prospective study.

Place and Duration of Study: Bhagwan Mahaveer Cancer Hospital & Research Centre, Jaipur, Rajasthan, India for a period of 17 months from November 2016 to March 2018.

Methodology: Patients' post-operative recovery was studied prospectively by using parameters pertaining to shoulder function and shoulder pain.

Result: There were significant differences in the pain and abduction deformity at various time periods after surgery. However differences in the quality of life did not show significant difference at the end of 3 months.

Conclusion: Though the technique of neck dissection (harmonic v/s electrocautery) has significant impact on shoulder dysfunction, despite that in postoperative period shoulder function measured by way of shoulder pain and shoulder abduction recover almost fully during follow-up period without causing significant morbidity and with minimal effect on quality of life. There are few recommendations we would like to suggest that if incorporated, they might significantly affect the outcome and better results.

Introduction

With time several instruments made their impact on surgery like monopolar cautery, bipolar cautery, radiofrequency ablator, hemo clips etc with aim to reduce the blood loss and intra operative time during head neck surgery.¹ Harmonic scalpel (HS) using ultrasonic energy

38 became popular in head and neck surgeries since its introduction in 1990.^{2,3} Harmonic scalpel
39 does reduce the blood loss and intra operative time for neck dissection. However there is very
40 limited data comparing the harmonic scalpel with other conventional electrosurgical techniques
41 with regard to nerve injury especially SAN (spinal accessory nerve) and its morbidity
42 postoperatively after neck dissection. In this hospital based comparative study, we compared the
43 efficacy of the HS and electrosurgical technique, with regard to SAN injury after selective neck
44 dissection for oral cavity cancer. We assessed the shoulder function and shoulder pain
45 immediately following neck dissection and in the subsequent follow up visits.

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48 **Material and methods**

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50 This study was an interventional prospective study. Ninety patients of oral carcinoma
51 who required neck dissection between november 2016 and march 2018 were included for the
52 study. Inclusion criteria were: age 18 years with informed written consent and selective neck
53 dissection (1 to 4) as part of treatment plan. Patients who had received prior radiotherapy,
54 undergone prior surgery, did not give informed consent, had restriction of shoulder movements
55 and KPS<90 were excluded from the city. The patients are randomly and equally divided into
56 control and experimental groups. Forty five cases were performed with harmonic scalpel and
57 other 45 cases were done using electrocautery. Both HS and EC were set for a contact time of 1
58 to 4 sec. Before surgery all the patients were clinically examined, biopsy was done for primary
59 lesion and CT scan was done to assess the nodal status and as well as disease extent. In all the
60 neck dissection a transverse cervical incision was given and the skin flaps in both the groups
61 were raised using mono polar electro cautery. 16FR suction drains were placed after neck
62 dissection. Patients were given NSAIDs for first 48 h, there after pain management drugs were
63 given only if symptomatic.

64 Pain was measured by visual analogue scale (continuous scale usually 10 cm in length, anchored
65 by 2 verbal descriptors, 0 for normal and 5 for moderate pain and 10 for extreme pain) was
66 assessed at day 1, day 2, day 7 and 1st month and 3rd month. The spinal accessory nerve
67 function and shoulder pain was evaluated at day 1, 1st week, 1st month and 3rd month to asses
68 for recovery of shoulder function in both groups. Shoulder movements were assessed by means
69 of degree of abduction and graded as grade I/0–90; grade II/90–135; grade III/135–180 degree.
70 Quality of life was measured by using simple questionnaire (can perform routine self care
71 activity only, can perform household chores, can do strenuous weight bearing e.g. lifting a sac of
72 10 kg on shoulder)

73 Data was entered in excel sheet to prepare a master chart & was subjected for statistical
74 analysis. Continuous variables were summarized as mean and SD and were analyzed by using
75 unpaired and paired t-test. Nominal/categorical variables were summarized as proportions (%)
76 and was analysed by using chi square test/fisher exact test. Ordinal variables e.g. VAS score
77 were summarized as median and range & were analyzed by using Mann Whiteny U Test and

78 Wilcoxon Signal Rank Test. P value of <0.05 was taken as significant. Med calc 16.4 version
79 was used for all calculations.

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Figure 1- Harmonic Focus Hand Piece.



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Figure 2 – Harmonic Cord



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88 **Results**

90 The age distribution was comparable in both the arms. ($P = 0.955$) Most common age
 91 group was of 51-60 yrs, with share of 33.33% and 35.56% in control and study group
 92 respectively. The distribution of sex ratio was comparable in both the arms. ($P=0.812$) Male sex
 93 was most commonly affected in both the arms: 32 (71.11%) in control arm and 34 (75.56%) in
 94 study arm.

95 The performance status of participating patients were similar in both arms. Karnofsky
 96 performance status was used to assess the patients. Squamous cell carcinoma was the only
 97 histology in both the arms. T stage was again comparable in both the arms ($P=0.499$). The
 98 distribution was as followed:

99 T1 disease - 13(28.89%) in control group and 7 (15.56%) in study group.

100 T2 disease - 17(37.78%) in control group and 16 (35.56%) in study group.

101 T3 disease - 11(24.44%) in control group and 16 (5.56%) in study group.

102 T4a disease - 4 (8.89%) in control group and 6 (13.33%) in study group.

103 The N status was comparable for N1, N2 disease except N0 ($P=0.003$), as follows:

104 N0 disease - 18(40%) in control arm and only 4(8.89%) in study arm.

105 N1 disease - 20(44.44%) in control arm and 29(64.44%) in study arm.

106 N2 disease - 7(15.56%) in control arm and 12(26.67%) in study arm.

107 No N 3 lesion was there in both the arms.

108 The subsite distribution was similar in both the arms. ($P=0.418$) tongue and
 109 gingivobuccal (GB) sulcus being the most common. In control group tongue 17 (37.78%)
 110 followed by GB sulcus 15(33.33%) being most common. Among study arm GB sulcus
 111 20(44.44%) followed by tongue 14(31.11%) was the most common. Utility incision was the only
 112 incision used in both the groups.

114 **Table 1 – Distribution of NSAID given for patients in both the arms beyond 48 hours**

Oral NSAID	Control Group		Study Group		Total	
	No.	%	No.	%	No.	%
No	26	57.78	21	46.67	47	52.22
Yes	19	42.22	24	53.33	43	47.78
Total	45	100.00	45	100.00	90	100.00

115 Fisher Exact Test; $P = 0.399$

116 Though the numbers of patients in harmonic group were more who needed analgesia beyond 48
 117 hours but it was not statistically significant.

119 **Table 2- Affection at 3 month quality of life**

QOL score	Control Group		Study Group		Total	
	No.	%	No.	%	No.	%
1	27	60.00	31	68.89	58	64.44
2	13	28.89	14	31.11	27	30.00
3	5	11.11	0	0.00	5	5.56
Total	45	100.00	45	100.00	90	100.00

120 Chi-square = 5.313 with 2 degrees of freedom; P = 0.070

121 There was no difference in quality of life post- 3 month in both the arms. (P=0.70)

122 Twenty seven patients (60%) in control arm and 31 patients (68.89%) in test arm could lift
 123 weights (Grade 1). Thirteen patients (28.99%) in control arm and 41 patients (31.11%) in test
 124 arm could perform house hold chores without any difficulty. Five patients (11.11%) in control
 125 arm and none patient in test arm had grade 3 that is difficulty in combing hair.

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128 **Table 3 - Comparison of Pain by VAS in both arms**

Pain by VAS	Group	N	Mean	SD	Median	'p' Value*
Day 1	Study	45	2.13	1.08	2	0.007
	Control	45	3.29	1.71	2	
Day 2	Study	45	1.33	1.13	2	0.052
	Control	45	1.96	1.38	2	
Day 7	Study	45	0.13	0.50	0	0.001
	Control	45	0.91	1.00	0	
1 Month	Study	45	0.00	0.00	0	0.045
	Control	45	0.49	0.87	0	
3 Month	Study	45	0.00	0.00	0	0.069
	Control	45	0.44	0.84	0	

129 * Mann-Whitney Rank Sum Test

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132 **Table 4 - Comparison of Abduction deformity in both arms**

Abduction deformity	Group	N	Mean	SD	Median	'p' Value*
Day 1	Study	45	2.62	0.49	3	0.365
	Control	45	2.51	0.51	3	
Day 7	Study	45	2.87	0.34	3	0.102
	Control	45	2.67	0.48	3	
1 Month	Study	45	3.00	0.00	3	0.102
	Control	45	2.80	0.40	3	
3 Month	Study	45	3.00	0.00	3	0.045

	Control	45	2.76	0.43	3	
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133 * Mann-Whitney Rank Sum Test

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135 At day 1 the abduction deformity was comparable in both the arms.P=0.365

136 At day 7 the abduction deformity was comparable in both the arms.P=0.102

137 At one month the abduction deformity was comparable in both the arms.P=0.102

138 At 3rd month the abduction deformity was more in control arm as compare to test arm.P=0.045

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140 **Table 5 - Affection QOL at 3rd month in both the arms**

Group	N	Mean	SD	Median	'p' Value*
Study	45	1.31	0.47	1	0.314
Control	45	1.51	0.69	1	

141 * Mann-Whitney Rank Sum Test

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143 There was no difference in quality of life at end of 3 months in both the arm.

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145 **Discussion**

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147 **Age and sex distribution**

148 In a study by Arulalan et al⁴ on 40 patients in 2016, Comparison of spinal accessory
 149 dysfunction following neck dissection with harmonic scalpel and electrocautery – A randomized
 150 study, the mean age was 48 years in electrocautery arm and 45.5 yrs in harmonic arm. Which is
 151 comparable to our study (50 and 52 yrs respectively).

152 The male to female ratio was 3.44:1, which is not different from our study (2.7:1). Showing the
 153 same trend in Indian population.

154 In a study by Sheno R et al⁵ on 295 patients in 2010, mean age of patients of oral cancer
 155 was found to be 49.73 years, comparable to our study.

156 Similarly the male to female ratio was 4.1:1, showing a trend towards male
 157 predominance.

158 To compare with western world as per US National Cancer Institute SEER program, the
 159 mean age of diagnosis of oral cancer is 65 years.⁶

160 That is at least a decade earlier then western world, so we would like to state here that,
 161 ease at which tobacco and its related products are available at very affordable prices at the
 162 grocery stores and *paan* or betel quid kiosks is leading to people adopting this pernicious habit in
 163 our country that to at very early age.

164 The Karnofsky Performance Scale (KPS) score is a widespread metric to stratify patient
 165 prognosis, morbidity and determine appropriate management in Head and Neck surgery. Low
 166 preoperative KPS values have been associated with delayed recovery of Spinal Accessory nerve.
 167 So in our study we had chosen the patient with KPS 90 to rule out any factor which can affect the
 168 outcome of study in terms of patient's functional condition. Both the arms in our study had a

169 KPS of 90, so ruling out any kind of functional differences in the selected population under
170 study.

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173 **Histology**

174 The most common histology was squamous cell carcinoma in our study, which is similar
175 to the study done by Arulalan et al⁴ on 40 patients in 2016, Comparison of spinal accessory
176 dysfunction following neck dissection with harmonic scalpel and electrocautery – A randomized
177 study. Study done in year 2012 by Ramachandra NB³¹”The Hierarchy of oral cancer in India”
178 and in 2010 a study by Sheno R et al⁵ the most common histopathology was squamous cell
179 carcinoma. The other reported histology are salivary gland tumors, lymphomas and mucosal
180 melanomas.

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182 **Stage distribution**

183 In our study group 20 patients (22.2%) had pathological stage I disease while 36.67%,
184 30% and 11.11% of the patients had stage II, III and IVA disease, respectively. In a study by
185 Jatin P. et al⁷ on, “The Patterns of Cervical Lymph Node Metastases From Squamous Carcinoma
186 of the Oral Cavity”, out of total 512 patients, 19%, 29%, 36% and 16 % of the patients had stage
187 I, II, III and IV disease, respectively.

188 In a study by Liao CT, et al⁸ “Tongue and buccal mucosa carcinoma: is there a difference in
189 outcome?”, patients with tongue and buccal mucosa had stage I, II, III and IV disease in 23.7%,
190 28.3%,20.2% 17.9% and 12%, 25.6%, 22.9% , 39.6% of the patients, respectively.

191 The study done by Arulalan et al⁴ on 40 patients in 2016, the major population belonged to the
192 stage IV, that is 85% of the patients.

193 More number of patients with advanced stage IV A in above said study groups can be
194 because of ignorance, low education and social stigmas. In our study the two arms had
195 comparable distribution of patients with majority being T2,T3 lesion accounting for
196 approximately 70% of the patient population.

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198 **Pattern of nodal disease**

199 In our study patients (22.44%) had N0 disease, 49 patients that is 54.44% had N1 disease
200 and 19 patients (21.11%) had N2 disease. None of patients had more than N2 nodal status.
201 Because by the criteria of inclusion only selective nodal dissection patients were included and
202 majority of N3 patients had undergone radical neck dissection.

203 In the two arm in our study the N0 & N1 disease was more common in control arm
204 (84.44%). and in test arm N1, N2 Disease was more prevalent (90%).

205 In the study done by Arulalan et al⁴ on 40 patients in 2016, Comparison of spinal
206 accessory dysfunction following neck dissection with harmonic scalpel and electrocautery – A
207 randomized study, they had majority of nodal burden of N2 in each arm that is total of 34
208 patients that is 85%, it is comparable with our study.

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210 **Distribution of subsite of origin of carcinoma in oral cavity squamous cell carcinoma**

211 In our study population, the most common sub-site for origin of squamous cell
212 carcinoma in oral cavity was buccal mucosa (GB sulcus), accounting for 5 patients (38.89%) of
213 the patients. It was followed by carcinoma of tongue (31 patients, 34.4%), lower alveolus (36
214 patients, 16.4%), floor of mouth and lip (11 patients each, 12.22%), hard palate (2 patient,
215 2.22%) respectively.

216 In a study by Jatin P. et al⁷ most common sub-site of origin of primary carcinoma in oral
217 cavity was oral tongue (36%) followed by floor of mouth (33%) gums (21%) and retromolar
218 trigone (5%) respectively.

219 In the study done by Arulalan et al⁴ on 40 patients, 21 (52.5%) patients had carcinoma of
220 tongue and 14 (35%) patients had carcinoma of buccal mucosa which was comparable to our
221 study.

222 In all study groups, buccal mucosa and tongue were the most common sub-site of origin
223 of carcinoma, probably due to higher incidence of chewable tobacco consumption and keeping
224 tobacco in gingivobuccal sulcus.

225 The two arms in our study were comparable in terms of most common site involved
226 (tongue and buccal mucosa, >70%).

227

228 **The type of incision**

229 Utility incision was the only incision used by the Chief Surgeon due to personal
230 preferences. The simple idea behind it was that level 5 was not targeted and utility incision
231 serves better to tackle level 1 to 4 nodes. It was based upon the early study done by Crile G⁹ in
232 1906. It avoided the area of posterior triangle of neck which is notorious during raising the flap
233 and causing the injury to nerve when it enters the trapezius muscle.

234

235 **Requirement of oral NSAIDs after 48 hours**

236 In our study 47 patients (52.22%) did not require post-op analgesia after 48 hours; only
237 43 patients (47.78%) complained of pain and oral NSAIDs were continued.

238 Upon comparison, though the VAS score at 48 hours was 1.33 ± 1.13 and 1.96 ± 1.38 in study
239 and control arm respectively, but the requirement of NSAIDs were more in study arm then test
240 arm (19 v/s 24 patients that is 42.22% v/s 53.33%). And 26 v/s 21 patients that is 57.78% v/s
241 46.67 % did not require any analgesia after 48 hours in control and test arm respectively. $P=$
242 0.399 , that is not significant.

243 Similarly in a study by Arulalan et al⁴ in 40 patients, at 48 hours the pain score in HS
244 group was 2.55 (10 patients, 50%) while in EC group 2.50 (9 patients that is 45%), this was
245 found to be statistically non significant ($P=0.609$) and they concluded that “the patient who
246 underwent surgery by harmonic scalpel had relatively lesser pain compared to those with electro
247 cautery at 48 hours”. It could be justified with the study by Beriat et al¹⁰, in his study its reported
248 that the mean maximum temperature values of surrounding tissues was 93.93 ± 2.76 °C for the

249 monopolar electrocautery group and 108.23 ± 7.64 °C for the ultrasonic scalpel group. This
250 could be the reason for more pain observed in the early post operative period in the harmonic
251 scalpel group as compared to electrocautery.

252 In contrast to our study and above said study by Arulalan et al, a study by Ferri et al¹¹ on
253 61 patients who showed a significant reduction in pain score at 48 hours with no requirement of
254 NSAIDs in patients operated with harmonic scalpel as compared to electro cautery, $P=0.001$ with
255 the mean VAS of 1.76 v/s 3.99 in harmonic and electrocautery group respectively. Shoulder pain
256 at follow up was assessed at the end of 1st week, 1st month and 3rd month.

257 At the end of 1st week the mean VAS score of HS group was 0.13 ± 0.50 while that of EC
258 group was 0.91 ± 1.00 (p value 0.001) which was statistically significant. At 1st month, mean
259 VAS score of HS group was 0.00 and EC group was 0.49 ± 0.87 (p value 0.045) which was
260 significant. At 3rd month VAS score in HS group was 0.00 whereas in EC group it was $0.44 \pm$
261 0.84 , p value 0.69, which was found to be not statistically significant.

262 This shows that during 1st week and 1st month pain was significantly less in HS arm as
263 compare to EC arm indicating that use of harmonic is associated with less morbidity to patients.
264 This also shows that with time the pain in EC arm reduces and almost equals the HS arm but
265 despite that minimal shoulder pain remains in the electro cautery group even after 3 months of
266 selective neck dissection.

267 This is in contrast to the study by Arulalan et al.⁴ In their study shoulder pain at follow up
268 was assessed at 1 week, 1 month, 3 month and 6 month. At 1 week, mean VAS score of HS
269 group was 2.15 ± 1.461 and EC group was 3.30 ± 1.689 (P value 0.137) which was not
270 significant (contrast to our study). At 1 month the mean VAS score of HS group was $0.70 \pm$
271 1.174 while EC group it was 0.85 ± 1.226 (P value 0.840) which was statistically non significant
272 (contrast to our study). At 3 month VAS score in HS group was 0.00 whereas in EC group it was
273 0.40 ± 0.68 , P value 0.00, which was found to be statistically significant (contrast to our study).

274 At 6 months the mean VAS score in HS group was 0.00, while in EC group it was $0.15 \pm$
275 0.366 with P value 0.00, which was statistically significant. This shows some persisting shoulder
276 pain remains in the electro cautery group even after 6 months of selective neck dissection. This
277 could be made understood by the study by Emam TA et al¹², that lateral thermal injury at the
278 surgical site with harmonic scalpel was less than <1.5 mm as compared to electrocautery which
279 was 15 mm. This could be the reason for persisting pain even after 3 months after neck
280 dissection with electrocautery.

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282 **Abduction deformity at day 1**

283 In our study at day 1, no Grade 1 deformity was seen in both the arms. Grade 2 deformity
284 was seen in 22 (48.89%) patients and 17 (37.78%) patients in control and study arm respectively.
285 Whereas grade 3 deformity was seen in 23 (51.11%) patients and 28 (62.22%) patients in control
286 and study arm respectively. This is not statistically significant $P=0.395$.

287 This is in contrast to study by Arulalan et al.⁴ In his study grade 1 deformity was seen in
288 4 patients in harmonic group and no patients in Electrocautery group.

289 In HS group 4 patients had grade I, 7 patients had grade II and 9 patients had grade III
290 abduction while in the EC group no patient had grade I abduction, 7 had grade II and 13 had
291 grade III shoulder abduction, with p value 0.94 which was also statistically not significant.⁴

292 Study by Ferri et al¹¹ also showed a similar statistically non significant effect of either
293 method on the shoulder function. This shows similar effect of both harmonic scalpel and
294 electrocautery on the spinal accessory nerve during selective neck dissection.

295 The idea behind the shoulder function assessment in the immediate post operative period
296 was; to identify the unwanted nerve stimulation and damage caused by the device that is being
297 used in the vicinity of the spinal accessory nerve during the selective neck dissection. Our
298 observations showed no increased hazardous effect of harmonic scalpel on the spinal accessory
299 nerve in the immediate postoperative period. (P=0.395)

300 This is in contrast to study by Ferri et al¹¹ and Arulalan et al⁴ where immediate post op
301 harmonic scalpel caused more hazardous effect on the nerve. It could be justified with the study
302 by Beriat et al¹⁰, in his study its reported that the mean maximum temperature values of
303 surrounding tissues was 93.93 ± 2.76 °C for the monopolar electrocautery group and $108.23 \pm$
304 7.64 °C for the ultrasonic scalpel group. This could be the reason for more abduction deformity
305 observed in the early post operative period in the harmonic scalpel group as compared to
306 electrocautery.

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308 **Abduction deformity at day 7**

309 In our study at day 7, no grade 1 deformity seen. Grade 2 deformity was seen in 15
310 (33.33%) patients and 6 (13.33%) patients in control and study arm respectively. Whereas grade
311 3 deformity was seen in 30 (66.67%) patients and 39 (86.67%) patients in control and study arm
312 respectively. This is statistically significant P=0.045.

313 This is in contrast to study by Arulalan et al¹¹ where at 1st week HS group had 3 patients
314 with grade I, 9 patients with grade II and 8 patients with grade III; in EC group 2 patients had
315 grade I, 7 patients had grade II and 11 patients had grade III abduction.

316 But both the study showed that harmonic scalpel use was associated with early recovery
317 of shoulder function as compare to electrocautery.

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319 **Abduction deformity at one month**

320 In our study at one month, no grade 1 deformity seen in both the arms. Grade 2 deformity
321 was seen in 9 (20%) patients and 0 (0.00%) patients in control and study arm respectively.
322 Whereas grade 3 deformity was seen in 36 (80%) patients and 45 (100%) patients in control and
323 study arm respectively. This is statistically significant (P=0.003).

324 This is in contrast to the study by Arulalan et al⁴ in which at 1 month 5% patients had
325 grade I, 25% had grade II and 70% had grade III shoulder abduction in HS group; while in EC
326 group none of the patients had grade I, 40% had grade II and 60% had grade III abduction.

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328 **Abduction deformity at 3rd month**

329 In our study the harmonic arm continued to improve and attained grade 3 function but
330 electrocautery arm 11 patients that is 24.44% had grade 2 deformity which was 2 patients more
331 than the one month observation. And grade 3 deformity was seen in 4 patients. So the
332 electrocautery group didn't worsen except 2 patients. $P < 0.001$

333 In the study by Arulalan et al,⁴ at 3 months 1 patient had grade I, 3 patients had grade II
334 and 16 patients had grade III shoulder abduction in the HS group while in EC group 6 patients
335 had grade II and 14 had grade III. In this study also both the groups were recovering but
336 harmonic group improved significantly, similar to our study except that they still had one grade 1
337 deformity patient in harmonic group.

338 To summarize the abduction deformity, our study suggests that the reduction in shoulder
339 function by harmonic scalpel is relatively temporary and almost complete recovery is attained at
340 3 months as compared with electro cautery ($P = 0.45$). The reason behind this could be due to fact
341 that less amount of energy is delivered to the neighbouring tissues with harmonic scalpel than
342 when using electrocautery. Moreover the lateral thermal damage and deeper tissue damage have
343 been shown to be lower in harmonic scalpel as compared to electrocautery^{12,13} resulting in less
344 surgical stress to surrounding tissue and early healing in harmonic scalpel group.

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346 **Visible loss of muscle mass/ atrophy/winging of scapula at the end of 3rd month**

347 Both the group was comparable at the end of 3 months with 100% recovery as compare
348 to opposite limb. It is because selective neck dissection causes lesser shoulder dysfunction when
349 compared to other types of neck dissections due to lesser degree of level V manipulation during
350 the surgical procedure resulting in less damage to the accessory nerve and the neck plexus.

351 In the study by Arulalan et al⁴, similar results were attained by the end of 6 month. The
352 time duration in their study was more this could be due to the contact time used by the devices at
353 the time of dissection. As shown in the study by Hefermehl LJ et al¹³, they stated that monopolar
354 instruments exhibited a mean critical thermal spread of 3.5 (2.3) mm when applied for 1 sec.
355 After 2 sec, the increase in spread was >20 mm. in contrast, the spread of the harmonic
356 instrument for 1 and 2 seconds was 1.3 (0.2) and 1.6 (0.3) mm respectively ($P = 0.03$).

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358 **3rd month quality of life (QOL)**

359 In our study we added QOL as a parameter showing effect of the energy instruments
360 upon patient's daily life. So in control group 27 (60%) patients and in test arm 31 (68.89%)
361 patients had good quality of life that is grade 1. 13 (28.89%) and 14 (31.11%) patients had grade
362 2 QOL in EC and HS arm respectively. 5 (11.11%) patients had grade 3 QOL in EC arm and
363 none in HS arm.

364 So at the end of 3rd month QOL was not statistically significant with a P value of 0.07.
365 The mean affection of QOL at 3rd month in HS group was 1.31 ± 0.47 and in EC group 1.51 ± 0.69
366 which is not statistically significant. ($P = 0.314$)

367 So to conclude after 3 months the quality of life from patient's perspective was same
368 irrespective of the instruments used.

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Duration of neck dissection in minutes

The mean duration of neck dissection in EC group was 69.78±8.98 minutes and in HS group was 90.33±13.75 minutes. P=<0.001

This signify that time taken in surgery was increased when HS was used as compare to EC as harmonic scalpel is slow to use and time consuming. But this can be overcome by the time and practice

Conclusion

We concluded from our study that though the technique of neck dissection (harmonic v/s electro cautery) has significant impact on shoulder dysfunction. Despite that in postoperative period shoulder function measured by way of shoulder pain and shoulder abduction recover almost fully during follow-up period without causing significant morbidity and with minimal effect on quality of life. There are few recommendations we would like to suggest that if incorporated, they might significantly affect the outcome and better results.

Nerve conduction study and electromyogram should be added in the study to get a better objective outcome, although it will increase the treatment cost to the patient. Use of temperature probs/video-thermography to assess the thermal spread to the surrounding structures can also be added.

Also use of enzymatic assessment of temperature spread by evaluation of thermal damage at the protein level can be done which requires a modified lactate dehydrogenase (LDH) assay. As a ubiquitous Krebs-cycle protein, LDH is an established marker for cell damage.

Creating a heat sink effect by using cold saline during use of energy instruments. Will it decrease the damage and lateral spread of heat? Will it be feasible to get a muscle biopsy to document and prove the atrophy of muscle? These are some of the questions that can be answered only by conducting further studies involving a significant number of patients.

Competing interests: Authors have declared that no competing interests exist

Ethical approval: Ethical approval was obtained from the ethical committee of the institution.

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