

**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 Focus** 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. For up to one month pain scores were lower for Harmonic Focus **and** shoulder function was better through 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

37 With time several instruments made their impact on surgery like monopolar cautery,
38 bipolar cautery, radiofrequency ablator, hemo clips etc with aim to reduce the blood loss and
39 intra operative time during head neck surgery.¹ Harmonic scalpel (HS) using ultrasonic energy
40 became popular in head and neck surgeries since its introduction in 1990.^{2,3} Harmonic scalpel
41 does reduce the blood loss and intra operative time for neck dissection. However there is very
42 limited data comparing the harmonic scalpel with other conventional electrosurgical techniques
43 with regard to nerve injury especially **spinal accessory nerve (SAN)** and its morbidity
44 postoperatively after neck dissection. In this hospital based comparative study, we compared the
45 efficacy of the HS and electrosurgical technique, with regard to SAN injury after selective neck
46 dissection for oral cavity cancer. We assessed the shoulder function and shoulder pain
47 immediately following neck dissection and in the subsequent follow up visits.

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50 **Material and methods**

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

67 Pain was measured by visual analogue scale (continuous scale usually 10 cm in length, anchored
68 by 2 verbal descriptors, 0 for normal and 5 for moderate pain and 10 for extreme pain) was
69 assessed at day 1, day 2, day 7 and 1st month and 3rd month. The spinal accessory nerve
70 function and shoulder pain was evaluated at day 1, 1st week, 1st month and 3rd month to asses
71 for recovery of shoulder function in both groups. Shoulder movements were assessed by means
72 of degree of abduction and graded as grade I/0–90; grade II/90–135; grade III/135–180 degree.
73 Quality of life was measured by using simple questionnaire (can perform routine self care
74 activity only, can perform household chores, can do strenuous weight bearing e.g. lifting a sac of
75 10 kg on shoulder)

76 Data was entered in excel sheet to prepare a master chart & was subjected for statistical
77 analysis. Continuous variables were summarized as mean and SD and were analyzed by using
78 unpaired and paired t-test. Nominal/categorical variables were summarized as proportions (%)
79 and was analysed by using chi square test/fisher exact test. Ordinal variables e.g. VAS score
80 were summarized as median and range & were analyzed by using Mann Whiteny U Test and
81 Wilcoxcan Signal Rank Test. P value of <0.05 was taken as significant. Med calc 16.4 version
82 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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Figure 3 – Harmonic Generator

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91 **Results**

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

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

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

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

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

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

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

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N0 disease - 18(40%)in control arm and only4(8.89%) in study arm.

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

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

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No N 3 lesion was there in both the arms.

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

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117 **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

118 Fisher Exact Test; P = 0.399

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

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122 **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

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

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

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

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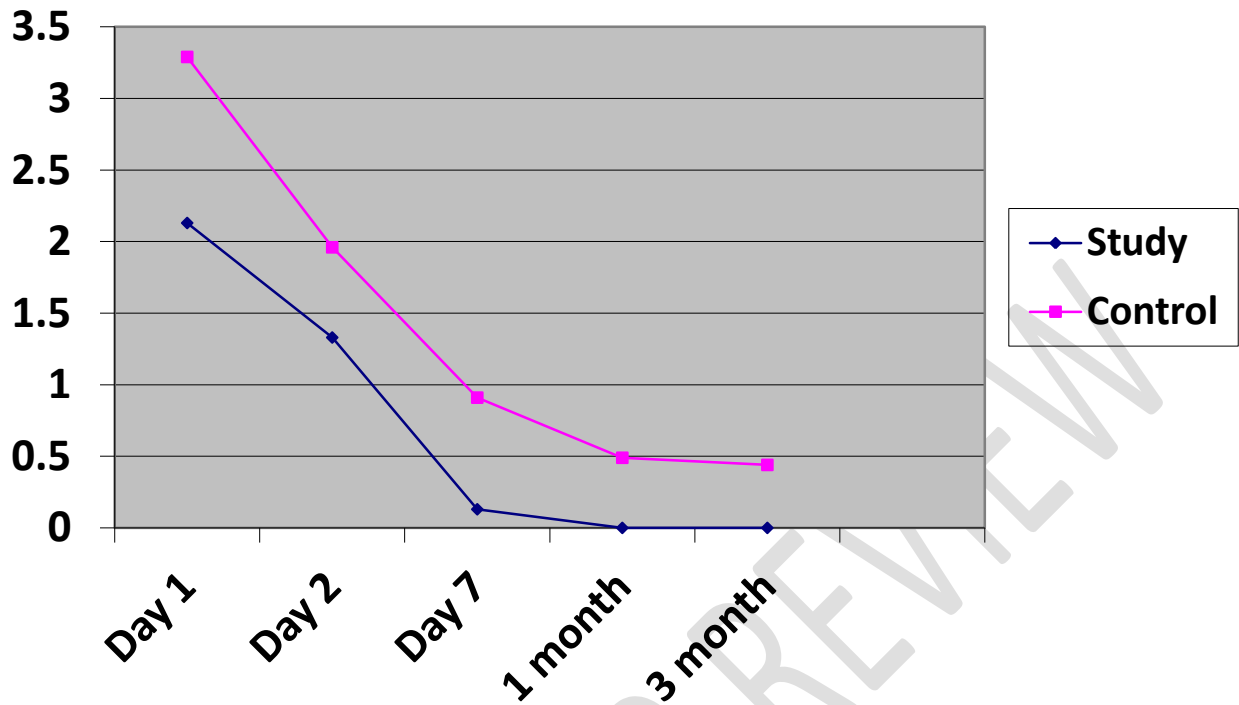
131 **Table 3 - Comparison of Pain by VAS in both arms**

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	

132 * Mann-Whitney Rank Sum Test

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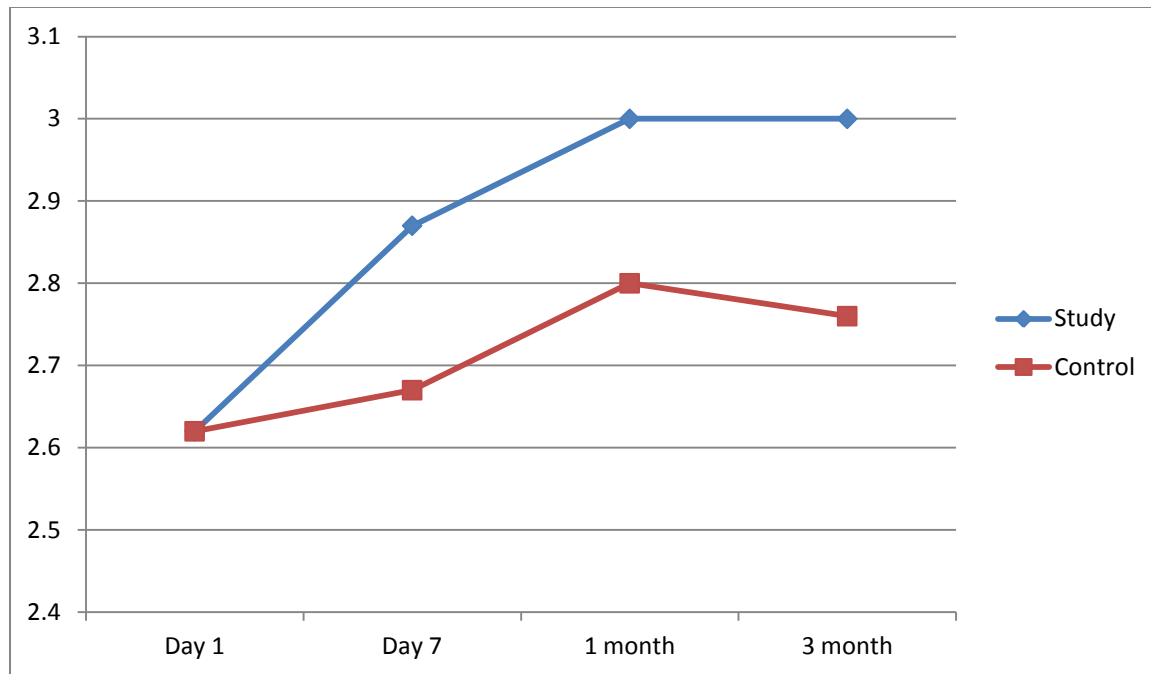


135
136 **Figure 4 – Comparison of pain by mean VAS at various time periods**

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138 **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	

139 * Mann-Whitney Rank Sum Test



140
141 **Figure 5 – Comparison of abduction deformity at various time periods**

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

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

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

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

147
148 **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	

149 * Mann-Whitney Rank Sum Test

150
151 There was no difference in quality of life at end of 3 months in both the arm.

152 153 **Discussion**

154 155 **Age and sex distribution**

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

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

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

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

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

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

172 The Karnofsky Performance Scale (KPS) score is a widespread metric to stratify patient
173 prognosis, morbidity and determine appropriate management in Head and Neck surgery. Low
174 preoperative KPS values have been associated with delayed recovery of Spinal Accessory nerve.
175 So in our study we had chosen the patient with KPS 90 to rule out any factor which can affect the
176 outcome of study in terms of patient's functional condition. Both the arms in our study had a
177 KPS of 90, so ruling out any kind of functional differences in the selected population under
178 study.

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181 **Histology**

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

189

190 **Stage distribution**

191 In our study group 20 patients (22.2%) had pathological stage I disease while 36.67%,
192 30% and 11.11% of the patients had stage II, III and IVA disease, respectively. In a study by
193 Jatin P. et al⁷ on, "The Patterns of Cervical Lymph Node Metastases From Squamous Carcinoma
194 of the Oral Cavity", out of total 512 patients, 19%, 29%, 36% and 16 % of the patients had stage
195 I, II, III and IV disease, respectively.

196 In a study by Liao CT, et al⁸ "Tongue and buccal mucosa carcinoma: is there a difference in
197 outcome?", patients with tongue and buccal mucosa had stage I, II, III and IV disease in 23.7%,
198 28.3%, 20.2% 17.9% and 12%, 25.6%, 22.9% , 39.6% of the patients, respectively.

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

201 More number of patients with advanced stage IV A in above said study groups can be
202 because of ignorance, low education and social stigmas. In our study the two arms had
203 comparable distribution of patients with majority being T2,T3 lesion accounting for
204 approximately 70% of the patient population.
205

206 **Pattern of nodal disease**

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

211 In the two arm in our study the N0 & N1 disease was more common in control arm
212 (84.44%). and in test arm N1, N2 Disease was more prevalent (90%).

213 In the study done by Arulalan et al⁴ on 40 patients in 2016, Comparison of spinal
214 accessory dysfunction following neck dissection with harmonic scalpel and electrocautery – A
215 randomized study, they had majority of nodal burden of N2 in each arm that is total of 34
216 patients that is 85%, it is comparable with our study.
217

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

219 In our study population, the most common sub-site for origin of squamous cell
220 carcinoma in oral cavity was buccal mucosa (GB sulcus), accounting for 5 patients (38.89%) of
221 the patients. It was followed by carcinoma of tongue (31 patients, 34.4%), lower alveolus (36
222 patients, 16.4%), floor of mouth and lip (11 patients each, 12.22%), hard palate (2 patient,
223 2.22%) respectively.

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

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

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

233 The two arms in our study were comparable in terms of most common site involved
234 (tongue and buccal mucosa, >70%).
235

236 **The type of incision**

237 Utility incision was the only incision used by the Chief Surgeon due to personal
238 preferences. The simple idea behind it was that level 5 was not targeted and utility incision
239 serves better to tackle level 1 to 4 nodes. It was based upon the early study done by Crile G⁹ in

240 1906. It avoided the area of posterior triangle of neck which is notorious during raising the flap
241 and causing the injury to nerve when it enters the trapezius muscle.

242

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

244 In our study 47 patients (52.22%) did not require post-op analgesia after 48 hours; only
245 43 patients (47.78%) complained of pain and oral NSAIDs were continued.

246 Upon comparison, though the VAS score at 48 hours was 1.33 ± 1.13 and 1.96 ± 1.38 in study
247 and control arm respectively, but the requirement of NSAIDs were more in study arm then test
248 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
249 46.67 % did not require any analgesia after 48 hours in control and test arm respectively. P=
250 0.399, that is not significant.

251 Similarly in a study by Arulalan et al⁴ in 40 patients, at 48 hours the pain score in HS
252 group was 2.55 (10 patients, 50%) while in EC group 2.50 (9 patients that is 45%), this was
253 found to be statistically non significant (P=0.609) and they concluded that “the patient who
254 underwent surgery by harmonic scalpel had relatively lesser pain compared to those with electro
255 cautery at 48 hours”. It could be justified with the study by Beriat et al¹⁰, in his study its reported
256 that the mean maximum temperature values of surrounding tissues was 93.93 ± 2.76 °C for the
257 monopolar electrocautery group and 108.23 ± 7.64 °C for the ultrasonic scalpel group. This
258 could be the reason for more pain observed in the early post operative period in the harmonic
259 scalpel group as compared to electrocautery.

260 In contrast to our study and above said study by Arulalan et al, a study by Ferri et al¹¹ on
261 61 patients who showed a significant reduction in pain score at 48 hours with no requirement of
262 NSAIDs in patients operated with harmonic scalpel as compared to electro cautery, P=0.001 with
263 the mean VAS of 1.76 v/s 3.99 in harmonic and electrocautery group respectively. Shoulder pain
264 at follow up was assessed at the end of 1st week, 1st month and 3rd month.

265 At the end of 1st week the mean VAS score of HS group was 0.13 ± 0.50 while that of EC
266 group was 0.91 ± 1.00 (p value 0.001) which was statistically significant. At 1st month, mean
267 VAS score of HS group was 0.00 and EC group was 0.49 ± 0.87 (p value 0.045) which was
268 significant. At 3rd month VAS score in HS group was 0.00 whereas in EC group it was $0.44 \pm$
269 0.84 , p value 0.69, which was found to be not statistically significant.

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

275 This is in contrast to the study by Arulalan et al.⁴ In their study shoulder pain at follow up
276 was assessed at 1 week, 1 month, 3 month and 6 month. At 1 week, mean VAS score of HS
277 group was 2.15 ± 1.461 and EC group was 3.30 ± 1.689 (P value 0.137) which was not
278 significant (contrast to our study). At 1 month the mean VAS score of HS group was $0.70 \pm$
279 1.174 while EC group it was 0.85 ± 1.226 (P value 0.840) which was statistically non significant

280 (contrast to our study). At 3 month VAS score in HS group was 0.00 whereas in EC group it was
281 0.40 ± 0.68 , P value 0.00, which was found to be statistically significant (contrast to our study).
282 At 6 months the mean VAS score in HS group was 0.00, while in EC group it was 0.15 ± 0.366
283 with P value 0.00, which was statistically significant. This shows some persisting shoulder pain
284 remains in the electro-cautery group even after 6 months of selective neck dissection. This could
285 be made understood by the study by Emam TA et al¹², that lateral thermal injury at the surgical
286 site with harmonic scalpel was less than <1.5 mm as compared to electrocautery which was 15
287 mm. This could be the reason for persisting pain even after 3 months after neck dissection with
288 electrocautery.

289

290 **Abduction deformity at day 1**

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

295 This is in contrast to study by Arulalan et al.⁴ In his study grade 1 deformity was seen in
296 4 patients in harmonic group and no patients in Electocautery group.

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

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

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

308 This is in contrast to study by Ferri et al¹¹ and Arulalan et al⁴ where immediate post op
309 harmonic scalpel caused more hazardous effect on the nerve. It could be justified with the study
310 by Beriat et al¹⁰, in his study its reported that the mean maximum temperature values of
311 surrounding tissues was 93.93 ± 2.76 °C for the monopolar electrocautery group and $108.23 \pm$
312 7.64 °C for the ultrasonic scalpel group. This could be the reason for more abduction deformity
313 observed in the early post operative period in the harmonic scalpel group as compared to
314 electrocautery.

315

316 **Abduction deformity at day 7**

317 In our study at day 7, no grade 1 deformity seen. Grade 2 deformity was seen in 15
318 (33.33%) patients and 6 (13.33%) patients in control and study arm respectively. Whereas grade

319 3 deformity was seen in 30 (66.67%) patients and 39 (86.67%) patients in control and study arm
320 respectively. This is statistically significant $P=0.045$.

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

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

326

327 **Abduction deformity at one month**

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

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

335

336 **Abduction deformity at 3rd month**

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

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

346 To summarize the abduction deformity, our study suggests that the reduction in shoulder
347 function by harmonic scalpel is relatively temporary and almost complete recovery is attained at
348 3 months as compared with electro cautery ($P=0.45$). The reason behind this could be due to fact
349 that less amount of energy is delivered to the neighbouring tissues with harmonic scalpel than
350 when using electrocautery. Moreover the lateral thermal damage and deeper tissue damage have
351 been shown to be lower in harmonic scalpel as compared to electrocautery^{12,13} resulting in less
352 surgical stress to surrounding tissue and early healing in harmonic scalpel group.

353

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

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

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

365

366 **3rd month quality of life (QOL)**

367 In our study we added QOL as a parameter showing effect of the energy instruments
368 upon patient's daily life. So in control group 27 (60%) patients and in test arm 31 (68.89%)
369 patients had good quality of life that is grade 1. 13 (28.89%) and 14 (31.11%) patients had grade
370 2 QOL in EC and HS arm respectively. 5 (11.11%) patients had grade 3 QOL in EC arm and
371 none in HS arm, although this was not statically significant. (P=0.056)

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

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

377

378

379 **Duration of neck dissection in minutes**

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

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

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386

387 **Conclusion**

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

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

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

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

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407 **Competing interests:** Authors have declared that no competing interests exist

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

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