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Title: Evaluation of muscle activity during the performance of conventional and non-conventional abdominal exercises

Purpose: To compare and evaluate muscle activation patterns produced by the "Ab Collar" to various conventional and non-conventional abdominal exercises.

Method:

Participants: Ten participants were included in the pilot study. All participants were physically active. This ensured that the population was homogenous for training experience.

Procedure: Each participant took part in one 60 minute testing session. The testing session required each participant to perform 8 exercises with 2-3 minute breaks between each exercise; this minimized the effects of fatigue. Eight total exercises were analyzed for the experiment. The exercises that were examined were the *Ab Collar, bent knee crunches, straight leg crunches, flutter kicks, Swiss Ball exercises, twist crunches, knee ups and the Ab Rocker.* Exercises were randomized and counter balanced for all participants to account for order and fatigue effects. Participants performed 1 set of 5 repetitions for each exercise listed above.

Dependent Measures: Muscle activation patterns of each participant were monitored using Electromyography (EMG) electrodes. EMG electrodes were placed on the Sternocleidomastoid, Splenius Capitis, and Rhomboid to assess muscle activity in the neck and upper back region. Three additional electrodes were placed on the upper and lower Rectus Abdominis, and the External Ooblique to assess muscle activity for in the abdominal musculature. Maximum EMG signal was for one repetition was used to determine how well each exercise activated a given muscle

Notes: This experiment focused on how well each abdominal exercise activated each muscle. This gave us a direct means of assessing the effectiveness of the "Ab Collar."

General Summary of Results:

The overall results of the study revealed that the Ab Collar ranked third overall out of the eight abdominal exercises. The abdominal exercises that ranked ahead of the Ab Collar were the Swiss Ball crunch (1st) and knee up (2nd). The exercises that had overall ranks below the Ab Collar were the Ab Rocker, bent knee crunch, straight leg crunch, twist crunch, and flutter kicks.

The following section will detail the effects of each exercise on each muscle examined

Upper abdominals - Greater upper abdominal activation is beneficial in abdominal exercises. Swiss Ball crunches and twist crunches produced significantly more activation of the upper abdominals than the flutter kick. The Ab Collar produced more (although not significantly) activation of the upper abdominal than the straight leg crunch, bent knee crunch, Ab Rocker, knee up, and flutter kick. The Ab Collar produced less (although not significantly) upper abdominal activation than the than Swiss Ball crunch and twist crunch. The crunch, using the Ab Collar, is one of the best exercises at activating the upper abdominal musculature.

Lower abdominals - Greater lower abdominal activation is beneficial in abdominal exercises. Swiss Ball crunches produced significantly greater lower abdominal muscle activation than the Ab Rocker, twist crunch, knee up, and flutter kick. The Ab Collar produced more (although not significantly) muscle activation of the lower abdominals than bent knee crunch, Ab Rocker, twist crunch, knee up, and flutter kick. In addition, Ab Collar produced less (although not significantly) activation of the lower abdominals than the straight leg crunch. The crunch, using the Ab Collar, is one of the best exercises at activating the Lower Abdominal musculature.

Oblique - Greater oblique activation is beneficial in abdominal exercises. Swiss Ball crunches and twist crunches were significantly better than the flutter kick, bent knee crunch, and Ab Rocker for activation of the Oblique. The Ab Collar was better (although not significantly) than straight leg crunch, flutter kick, bent knee crunch, and Ab Rocker for activation of the Oblique. Also, the Ab Collar was worse (although not significantly) than the twist crunch, Swiss Ball crunch, and knee up for activation of the Oblique. The crunch, using the Ab Collar, improves activation of the Oblique (side of stomach) over a crunch without the Ab Collar but overall is not one of the better exercises for working the Oblique.

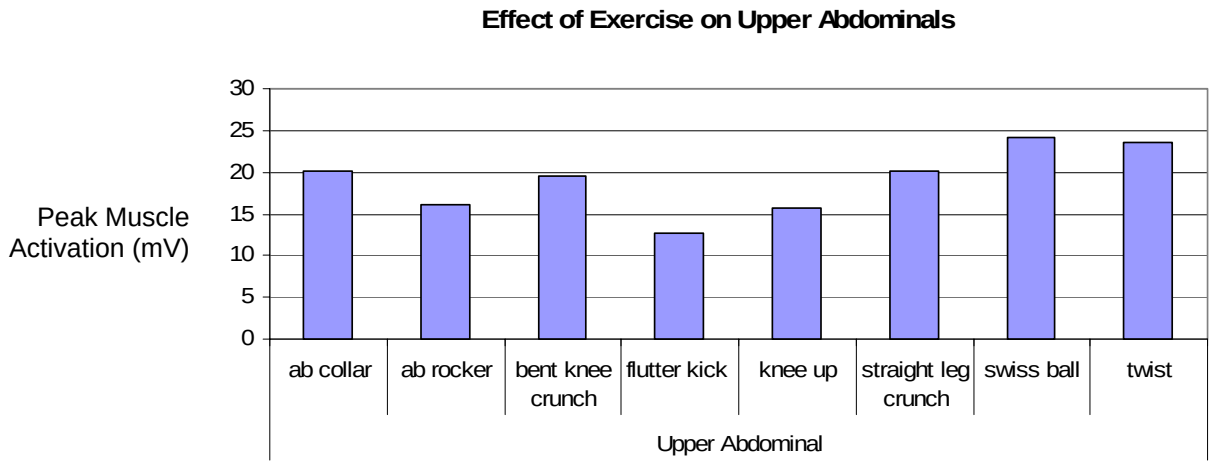
Rhomboid - Ideally, rhomboid activation is minimized during abdominal exercises. Straight leg crunches produce significantly greater activation of the rhomboid than the Swiss Ball crunch, flutter kick, and knee up. The Ab Collar produced significantly less activation of the rhomboid than the knee up. In addition, the Ab Collar produced more (although not significant) activation of the

rhomboid than the ab rocker, bent knee crunch, Swiss Ball crunch, flutter kick, and knee up. The crunch, using the Ab Collar, does a very good job of minimizing activation of the rhomboid muscle (upper back).

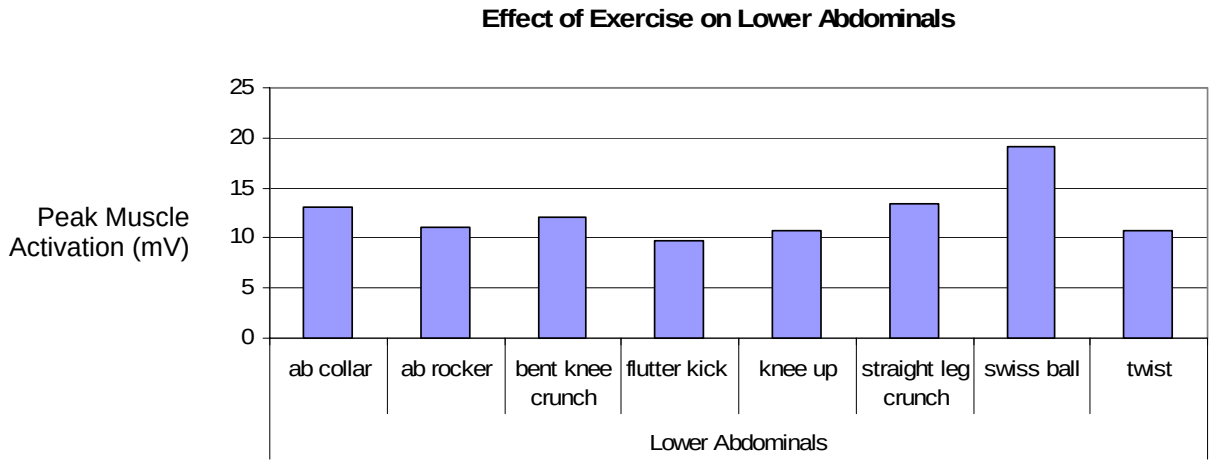
Splenius Capitis – Ideally, activation of the Splenius Capitis is minimized during abdominal exercises. The flutter kick produced significantly greater activation of the Splenius Capitis than the Swiss Ball crunch, flutter kick, and knee up. The Ab Collar produced significantly less activation of the Splenius Capitis than the knee up. Moreover, the Ab Collar produced more (although not significant) activation of the Splenius Capitis than the Ab Rocker, bent knee crunch, Swiss Ball crunch, flutter kick, and knee up. The crunch, using the Ab Collar, does not have a beneficial effect on activation of the Splenius Capitis (back of neck).

Sternocleidomastoid - Ideally, activation of the Sternocleidomastoid is minimized during abdominal exercises. The flutter kick, knee up, straight leg crunch, and Ab Rocker, Swiss ball crunch, and bent knee crunch produce significantly less activation of the Sternocleidomastoid than the Ab Collar and twist crunch. The Ab Collar produces less (although not significant) activation of the sternocleidomastoid than the twist crunch. The crunch using the Ab Collar does not have a beneficial effect on activation of the Sternocleidomastoid (front of neck).

Graphs



* A higher activation is better



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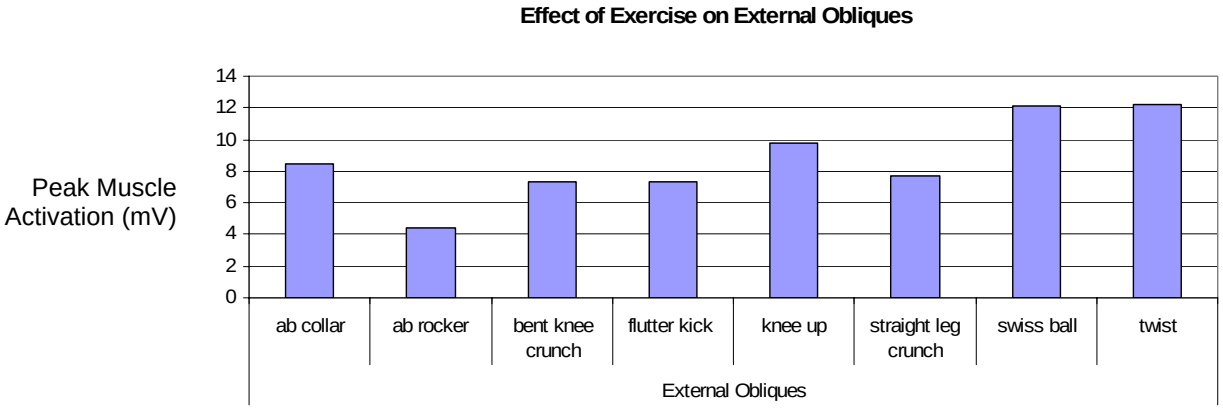

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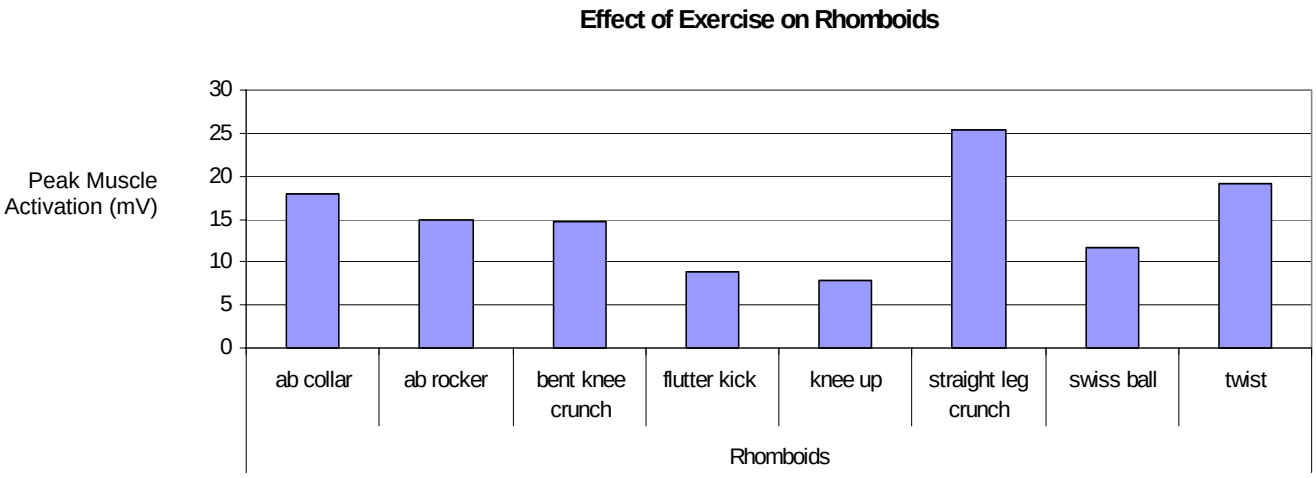

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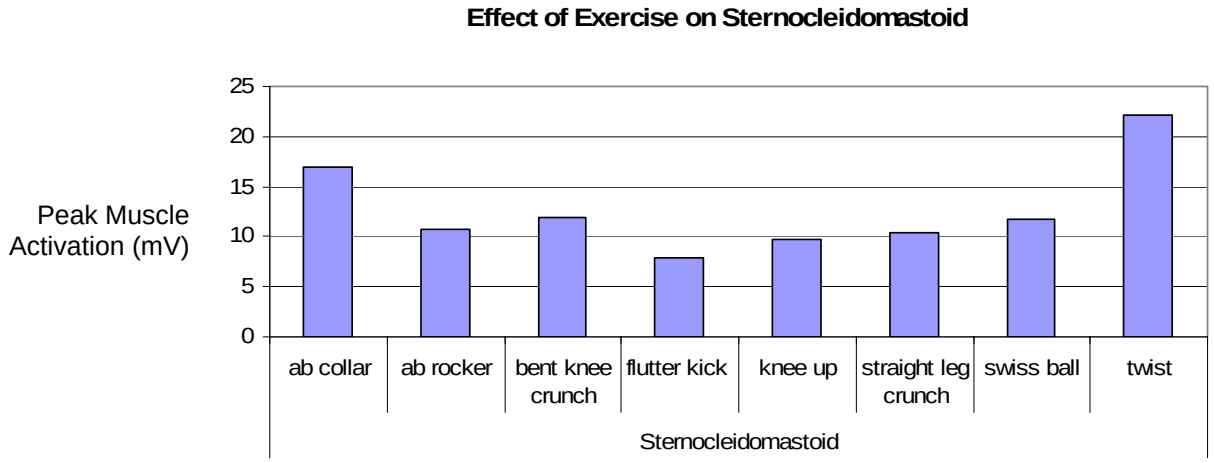
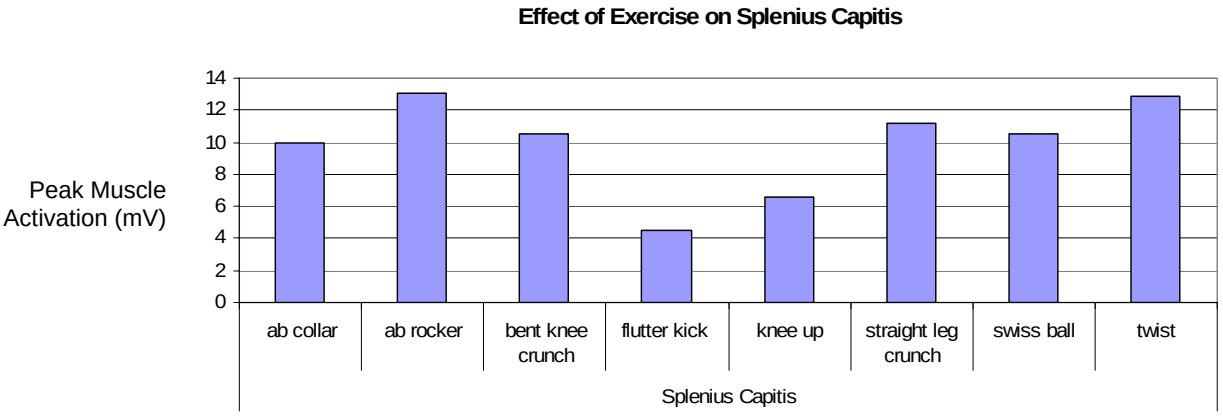


* A lower activation is better



* A lower activation is better

Statistical Analysis

ANALYSIS OF VARIANCE TABLE FOR <u>Upper Abdominal</u>

SOURCE	DF	SS	MS	F	P
SUB (A)	9	3513.66	390.407	6.49	0.0000
EXER (B)	7	1111.32	158.760	2.64	0.0186
A*B	63	3791.05	60.1754		
TOTAL	79	8416.03			

LSD (T) COMPARISON OF MEANS OF Upper Abdominal BY EXER

RANK	HOMOGENEOUS EXER	MEAN	GROUPS
1.	Swiss Ball Crunch	24.243	A
2.	Twist Crunch	23.549	A
3.	Ab Collar	20.223	ABC
4.	Straight Leg Crunch	20.220	ABC
5.	Bent Knee Crunch	19.585	ABC
6.	Ab Rocker	16.165	ABC
7.	Knee Up	15.703	ABC
8.	Flutter	12.618	C

- Greater Upper Abdominal activation is beneficial in abdominal exercises.
- Swiss ball crunches and twist crunch produce significantly more activation of the Upper Abdominals than the flutter kick.
- Ab Collar produces more (although not significantly) activation of the Upper Abdominal than the straight leg crunch, bent knee crunch, ab rocker, knee up, and flutter kick.
- Ab Collar produces less (although not significantly) Upper Abdominal activation than the than Swiss ball crunch and twist crunch.

CONCLUSION: The crunch using the Ab Collar is one of the best exercises at activating the Upper Abdominal musculature.

ANALYSIS OF VARIANCE TABLE FOR <u>Lower Abdominal</u>

SOURCE	DF	SS	MS	F	P
SUB (A)	9	3445.68	382.854	13.75	0.0000
EXER (B)	7	612.902	87.5575	3.14	0.0066
A*B	63	1754.45	27.8485		
TOTAL	79	5813.04			

LSD (T) COMPARISON OF MEANS OF Lower Abdominal BY EXER

RANK	EXER	MEAN	GROUPS
1.	Swiss Ball Crunch	19.133	A
2.	Straight Leg Crunch	13.520	ABC
3.	Ab Collar	13.082	ABC
4.	Bent Knee Crunch	11.980	ABC
5.	Ab Rocker	11.089	C
6.	Twist Crunch	10.815	C
7.	Knee Up	10.741	C
8.	Flutter	9.7222	C

- Greater lower abdominal activation is beneficial in abdominal exercises.
- Swiss ball crunches produces significantly greater Lower Abdominal muscle activation than the Ab Rocker, twist crunch, knee up, and flutter kick.
- Ab Collar produces more (although not significantly) muscle activation of the Lower Abdominals than bent knee crunch, Ab Rocker, twist crunch, knee up, and flutter kick.
- Ab Collar produces less (although not significantly) activation of the Lower Abdominals than the straight leg crunch.

CONCLUSION: The crunch using the Ab Collar is one of the best exercises at activating the Lower Abdominal musculature.

ANALYSIS OF VARIANCE TABLE FOR <u>Oblique</u>

SOURCE	DF	SS	MS	F	P
SUB (A)	9	1200.79	133.421	9.12	0.0000
EXER (B)	7	488.412	69.7731	4.77	0.0003
A*B	63	922.094	14.6364		
TOTAL	79	2611.30			

LSD (T) COMPARISON OF MEANS OF Oblique BY EXER

RANK	EXER	MEAN	GROUPS
1.	Twist Crunch	12.206	AB
2.	Swiss Ball Crunch	12.142	AB
3.	Knee Up	9.8321	ABC
4.	Ab Collar	8.4983	ABC
5.	Straight Leg Crunch	7.6821	ABC
6.	Flutter	7.2742	BC
7.	Bent Knee Crunch	7.2538	BC
8.	Ab Rocker	4.4298	BC

- Greater Oblique activation is beneficial in abdominal exercises.
- Swiss ball and twist crunch are significantly better than the flutter kick, bent knee crunch, and Ab Rocker for activation of the Oblique.
- Ab Collar is better (although not significantly) than straight leg crunch, flutter kick, bent knee crunch, and Ab Rocker for activation of the Oblique.
- Ab Collar is worse (although not significantly) than the twist crunch, Swiss ball crunch, and knee up for activation of the Oblique.

CONCLUSION: The crunch using the Ab Collar improves activation of the Oblique (side of stomach) over a crunch without the Ab Collar but overall is not one of the better exercises for working the Oblique.

ANALYSIS OF VARIANCE TABLE FOR <u>Rhomboid</u>

SOURCE	DF	SS	MS	F	P
SUB (A)	9	3152.84	350.316	2.68	0.0106
EXER (B)	7	2364.04	337.720	2.59	0.0207
A*B	63	8229.05	130.620		
TOTAL	79	13745.9			

LSD (T) COMPARISON OF MEANS OF Rhomboid BY EXER

RANK	EXER	MEAN	GROUPS
1.	Knee Up	7.7944	A
2.	Flutter	8.8268	AB
3.	Swiss Ball Crunch	11.631	AB
4.	Bent Knee Crunch	14.610	BC
5.	Ab Rocker	14.766	BC
6.	Ab Collar	18.037	BC
7.	Twist Crunch	19.125	BC
8.	Straight Leg Crunch	25.421	C

- Ideally, Rhomboid activation is minimized during abdominal exercises.
- Straight leg crunch produces significantly greater activation of the Rhomboid than the Swiss ball crunch, flutter kick, and knee up.
- Ab Collar produces significantly less activation of the Rhomboid than the knee up.
- Ab Collar produces more (although not significant) activation of the Rhomboid than the ab rocker, bent knee crunch, Swiss ball crunch, flutter kick, and knee up.

CONCLUSION: The crunch using the Ab Collar does a very good job at minimizing activation of the Rhomboid muscle (upper back).

ANALYSIS OF VARIANCE TABLE FOR Splenius Capitis

SOURCE	DF	SS	MS	F	P
SUB (A)	9	752.946	83.6607	4.73	0.0001
EXER (B)	7	620.965	88.7093	5.02	0.0002
A*B	63	1113.82	17.6797		
TOTAL	79	2487.73			

LSD (T) COMPARISON OF MEANS OF Splenius Capitis BY EXER

RANK	EXER	MEAN	GROUPS
1.	Flutter	4.5139	A
2.	Knee Up	6.5531	AB
3.	Ab Collar	10.007	BC
4.	Bent Knee Crunch	10.488	BC
5.	Swiss Ball Crunch	10.540	BC
6.	Straight Leg Crunch	11.200	BC
7.	Twist Crunch	12.883	BC
8.	Ab Rocker	13.146	BC

- Ideally, activation of the Splenius Capitis is minimized during abdominal exercises.
- Flutter kick produces significantly greater activation of the Splenius Capitis than the Swiss ball crunch, flutter kick, and knee up.
- Ab Collar produces significantly less activation of the Splenius Capitis than the knee up.
- Ab Collar produces more (although not significant) activation of the Splenius Capitis than the Ab Rocker, bent knee crunch, Swiss ball crunch, flutter kick, and knee up.

CONCLUSION: The crunch using the Ab Collar does not have a beneficial effect on activation of the Splenius Capitis (back of neck).

ANALYSIS OF VARIANCE TABLE FOR Sternocleidomastoid

SOURCE	DF	SS	MS	F	P
SUB (A)	9	795.889	88.4321	2.81	0.0077
EXER (B)	7	1498.94	214.134	6.82	0.0000
A*B	63	1979.43	31.4195		
TOTAL	79	4274.26			

LSD (T) COMPARISON OF MEANS OF Sternocleidomastoid BY EXER

RANK	EXER	MEAN	GROUPS
1.	Flutter	7.8962	A
2.	Knee Up	9.6975	A
3.	Straight Leg Crunch	10.370	A
4.	Ab Rocker	10.657	A
5.	Swiss Ball Crunch	11.757	AB
6.	Bent Knee Crunch	11.852	AB
7.	Ab Collar	16.906	BC
8.	Twist Crunch	22.130	C

- Ideally, activation of the Sternocleidomastoid is minimized during abdominal exercises.
- The flutter kick, knee up, straight leg crunch, and Ab Rocker, Swiss ball crunch, and bent knee crunch produce significantly less activation of the Sternocleidomastoid than the Ab Collar and twist crunch.
- Ab Collar produces less (although not significant) activation of the Sternocleidomastoid than the twist crunch.

CONCLUSION: The crunch using the Ab Collar does not have a beneficial effect on activation of the Sternocleidomastoid (front of neck).